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Annals of Surgical Case Reports & Images

Volume 3 | Research Article

Endoluminal vacuum assisted closure in the management of esophageal injury: Our experience and how we utilize it

***Corresponding Author:** Benjamin Smith*

Email: benjamin.smith3@prismahealth.org

Abstract

Esophageal injury is a diagnosis associated with a high morbidity and mortality. There has been a push recently for less invasive treatment with endoscopic adjuncts. Endoluminal vacuum assisted closure, E-V.A.C is a promising technique that we have been utilizing since 2022. In this study we aim to evaluate our treatment success and determine a treatment framework for patients with varying degrees of injury.

Methods: Retrospectively, we collected data on all adult individuals undergoing E-V.A.C at our institution since 2022. We collected demographic data, etiology of injury, location of injury and Pittsburg severity score at time of admission. We also recorded the number of wound V.A.C changes along with the timing of all changes. We followed the patients with chart review to determine complications.

Results: We included 31 individuals for review. We had a rate of healing of 96.8%. We changed the wound V.A.C every 3.8 days on average. We tended to change the V.A.C more frequently in individuals with a higher PSS score, although we did not achieve statistical significance. Average length of stay was 27.1 days with an average length of treatment of 15.5 days. We used 4.5 wound V.A.Cs per injury on average.

Discussion: In this retrospective review, we have shown a high rate of healing and have identified factors that may shorten or prolong care. We have also identified treatment failures. We can use this information to best offer this treatment to the most appropriate patients and have a clearer framework for treating this difficult injury.

Benjamin Smith, MD*; William Bolton, MD; James Stephenson, MD; Brian Rundall, MD

Department of Surgery, Prisma Health, Greenville, South Carolina, USA.

Received: Apr 14, 2026

Accepted: May 05, 2026

Published Online: May 12, 2026

Journal: Annals of Surgical Case Reports & Images

Online edition: https://annscri.org

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Cite this article: Smith B, Bolton W, Stephenson J, Rundall B. Endoluminal vacuum assisted closure in the management of esophageal injury: Our experience and how we utilize it. Ann Surg Case Rep Images. 2026; 3(1): 1127.

Introduction

Esophageal injuries and anastomotic leaks represent a potentially devastating diagnosis associated with marked morbidity and mortality [1]. These injuries have historically been treated with attempts at primary repair if minor, while larger injuries require more life altering operations such as esophagectomy. Primary repair is a major operation and has a high rate of recurrent leaks and stricture. Esophagectomy is a life-altering procedure with significant perioperative risk and limited reconstructive options. Esophageal reconstruction is prone to anastomotic leak with rates varying from 5-30% in the literature [2]. More recently there have been attempts at conservative measures through endoscopy, which challenges the traditional approach [3]. These options include clipping, suturing, Self-Expanding Metal Stents (SEMS), and Endoluminal Vacuum Assisted Closure (E-V.A.C). Any one of these can

be combined with operative or interventional radiology management to control contamination. We have found that the primary "damage control" operation, if required, can often be done using minimally invasive techniques when endoscopic adjuncts are utilized for dealing with the esophageal defect. While these advanced endoscopic procedures are often performed by our gastroenterology colleagues, they can easily be learned and implemented by the surgeon [4].

Endoscopically placed clips and suturing are generally reserved for small defects and are especially practical in partial thickness injury. The use of clips and sutures requires clean wound edges to approximate [5]. This is not often the case in esophageal injury. Despite these limitations, clips are readily available in the endoscopy suite, relatively cheap, and easy to deploy.

Esophageal stents, more traditionally used for malignant stenosis or obstruction, are also used in the management of esophageal injury and anastomotic leak. These are readily available and easily deployed to cover a large area [3]. Esophageal stents are prone to migration, which requires repositioning of the stent [5]. These stents are not tolerated well in the proximal esophagus and can cause severe gastric reflux when placed across the gastroesophageal junction. For our purposes, the issue with esophageal stents is that they do not address the underlying necrosis and contamination [6]. Stent migration rates are reported as high as 40%, and healing rates are variable in the literature [5].

V.A.C therapy has been proven to improve wound healing through its ability to decrease inflammatory phase reactants, reduce bacterial load, and promote angiogenesis [7]. While typically used on external wounds, recent endeavors have utilized this tool endoluminally. First described in treating low colorectal anastomotic leaks, E-V.A.C has been utilized on a wide array of gastrointestinal injuries with promising results [8]. There are numerous case reports and several case series demonstrating safety and efficacy of this method [1-4,6,10-13,15-17]. When used for anastomotic leak, there is evidence that E-V.A.C reduces the rate of surgical revision [10]. While its safety and efficacy has been established in the literature, there is no consensus on duration of treatment, timing of wound V.A.C changes, pressure settings, or technical aspects of placement. Figure 1 and 2 demonstrates an esophageal defect before and after E-V.A.C therapy.

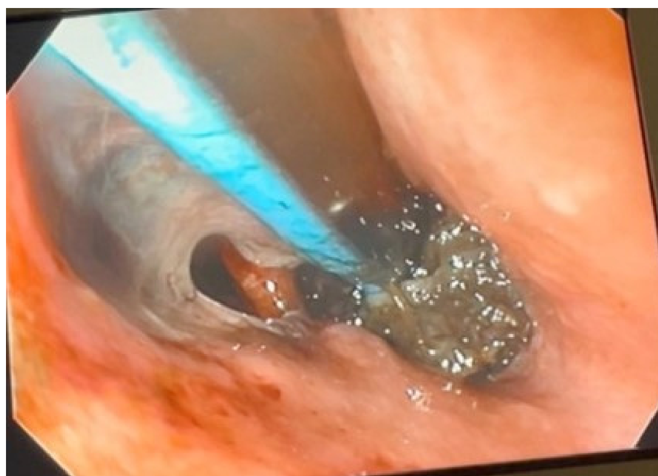

Figure 1: Esophageal defect with necrosis, wound V.A.C in place below defect, prior to being pulled into position.

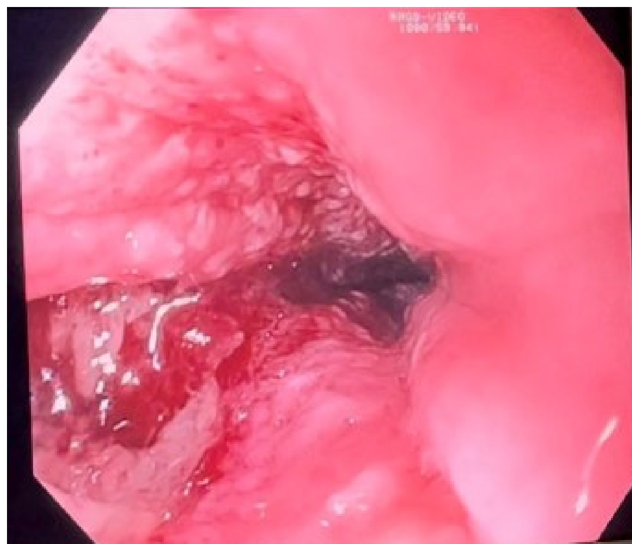

Figure 2: The same esophageal defect after E-V.A.C treatment.

The wound V.A.C can be custom made at the time of procedure (Figure 3) or bought ready-made as there is a commercially available option on the market (Esosponge Braun B Melsungen, Germany). Two recent meta-analyses have shown that E-V.A.C therapy is associated with higher rates of wound closure, lower morbidity, and shorter duration of treatment as compared with stenting [11,12]. It also showed safety and healing rates superior to stent placement in the pediatric population as well, especially relevant in esophageal atresia [6]. Ward et al. found in a 2019 study that it took 10 V.A.C placements to achieve proficiency. The procedure time quickly diminished after several cases as well [4]. This was true for both a surgeon and gastroenterologist.

Figure 3: A custom made endovac utilizing a nasogastric tube and wound V.A.C sponge material.

Identifying and grouping patients is helpful for developing treatment strategies for different injury severities. The Pittsburgh esophageal Perforation Severity Score (PSS) has been in use since its development in 2009. It has assisted practitioners in decision making by giving an objective score based on clinical information [13]. This model was validated in a retrospective multi-institutional study by Scweigert et al. in 2016. This study grouped patients into 3 categories based on the patients PSS. They designated a low score as 0-2, intermediate as 3-5, and high as greater than 5. They were able to identify

statistically significant morbidity and mortality, length of stay, need for operative management and other differences amongst the groups. This led to a proposed treatment algorithm (Figure 1). This important study identifies the role of endoscopic techniques in the management of these injuries (particularly the low and intermediate severity groups); however, the endoscopic management is limited to stenting [14]. This study allows us to group our patients in a similar fashion to compare their relative clinical courses (Figure 4).

The purpose of our study is to share and analyze our experience using E-V.A.C therapy in the treatment of esophageal perforation and anastomotic leak. We aim to better understand our treatment patterns so we can give patients and families more realistic expectations. We also hope to identify patient factors that make this technique successful.

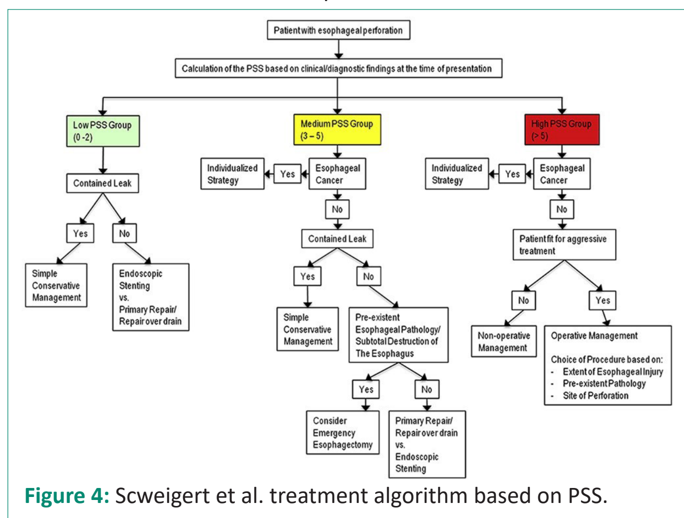

Figure 4: Scweigert et al. treatment algorithm based on PSS.

Methods

We received institutional review board approval to retrospectively review patients who have undergone E-V.A.C for esophageal perforation or anastomotic leak at our institution. We included patients between 18-99 years old. These patients' care ranged from 2022 through 2025. We collected demographic data, etiology of esophageal injury, location of injury, and Pittsburg severity score at time of admission. We also recorded the number of wound V.A.C changes along with the timing of when these changes occurred. Patients' charts were reviewed to determine complications. All procedures were performed by 4 thoracic surgeons, whose technique is similar. Success was defined as closure of the perforation with use of E-V.A.C We grouped our patients into PSS groups of 0-2 as low, 3-5 as intermediate, and greater than five as high. We performed statistical analysis with T-Test and ANOVA to determine differences among these groups for length of stay data, treatment duration, frequency of V.A.C change, and number of wound V.A.C placements required per injury.

Results

At the time of this report, 34 patients met inclusion criteria. Three of which were excluded as their care is ongoing. Of these 31 individuals 16 (51.6%) were male and 15 (48.4%) were female.

The age range was 28-97 years old with a median age of 64. Average BMI is 29.5. Twenty-seven (87.1%) patients were white and 4 (12.9%) were African American. Eight (25.8%) of these individuals had cancer with anastomotic leaks after resection. Twenty-three (74.2%) leaks were due to benign causes, iatrogenic being the most common (58%). The majority of leak locations were in the lower esophagus (41.9%), while anastomotic leakage was the second most common location (25.8%). All anastomotic leaks were related to either esophagogastrostomy or esophagojejunostomy. Five patients (16.1%) underwent an initial surgical attempt at repair which failed, requiring E-V.A.C therapy (Table 1).

We achieved wound closure in 30 of 31 patients (96.8%). Wound closure with the wound V.A.C in place was achieved in 27 (87.1%). 2 (6.5%) of these wounds healed to the point where a V.A.C could not be placed, and subsequently went on to heal the remaining defect without the V.A.C. There was one (3.2%) withdrawal of care. The patient's wound V.A.C was removed and she was transitioned to hospice care. There was one treatment failure. There were no deaths while undergoing E-V.A.C therapy.

We performed 140 wounds V.A.C placements over the study period. On average the V.A.C was changed every 3.8 days. This equates to 4.5 wound V.A.Cs per patient. The average length of wound V.A.C treatment was 15.6 days with an average length of stay of 28.7 days.

Pittsburgh Perforation Severity Scores ranges from 0 to 14 with an average of 5.7 and median of 4. With 4 (12.9%) patients being in the "low" group, 14 (45.2%) in the "intermediate" group, and 13 (41.9%) in the "high" group. Length of stay tended to be longest in the high severity group (35.7 days average) compared with the intermediate and low group (24.5 and 21 days respectively) although this was not statistically significant (p value .126). Length of treatment (days with wound V.A.C in place) followed a similar trend 11.5 days, 14.6 days, 20.4 days for the low, intermediate and high groups respectively without statistical significance (p value .43). The number of wound V.A.Cs used for each group was found to be 2.5, 3.79, 5.92 V.A.Cs for the low, intermediate and high group without statistical significance (p value .22). The V.A.C was changed more frequently in higher severity scores, every 4.6 days in low, 3.9 days in intermediate, 3.4 days in high severity, although this difference is not statistically significant (p value .122). There was statistical significance in comparing length of stay data between the intermediate group and the high group (p value .037) (Tables 1 & 2).

Stricture requiring endoscopic dilation was the most major complication encountered, this occurred in 8 patients (25.8%). Two of these patients were in the anastomotic leak group. The remainder were iatrogenic. Only one of these patients had their esophageal perforation from dilating a preexisting stricture. No other common complications were captured by this chart review.

Table 1: Characteristics.

Characteristic	Population #	Low (PSS 0-2)	Intermediate (PSS 3-5)	High (PSS >5)
Total number	31	4	14	13
Male	16 (51.2%)	2	6	8
Female	15 (48.4%)	2	8	5
Age >75	6 (19.4%)	0	4	2
Etiology: Anastomotic	8 (25.8%)	0	2	6
Etiology: Foreign Body	6 (19.4%)	2	2	2
Etiology: Iatrogenic	15 (48.4%)	2	9	4
Etiology: Barotrauma	2 (6.5%)	0	1	1

Table 2: Characteristics.

Characteristic (avg)	Total	Low (PSS 0-2)	Intermediate (PSS 3-5)	High (PSS >5)
Length of stay	27.1	21.0	24.5	35.7
Length of treatment	15.5	11.5	14.6	20.4
# of vacs used	4.5	2.50	3.79	5.92

Discussion

As previously discussed, esophageal injury and anastomotic leak is associated with significant morbidity and mortality. In one large study, mortality was over 10% in esophageal anastomotic leaks requiring operative intervention. This study also identifies patient factors such as obesity, smoking history, and chronic heart failure among other commonly encountered comorbidities as individual risk factors for anastomotic leak [1]. As our patient population becomes more and more comorbid, the treatment method chosen to deal with their complications should be individualized.

Previous studies have revealed the efficacy of SEMS and have even shown the same rate of healing when compared with primary surgical repair. These studies have also demonstrated decreased morbidity, hospital stay, and cost [3]. More recent studies have revealed that E-V.A.C is associated with improved rates of healing, shorter duration of treatment, and lower morbidity when compared with SEMS [11,12].

We achieved closure in 96.8% which is comparable to what has been found in the recent literature (70%-100%) [1-4,6,10-13,15-17]. We have found E-V.A.C to be a helpful adjunct in managing the esophageal defect, even in patients that require sepsis controlling operations. This simplifies the initial procedure, making a minimally invasive “damage control” procedure possible, thus avoiding the morbidity of a thoracotomy and prolonged operative time, in often unstable individuals. In this hybrid approach, we utilize E-V.A.C use for most injuries, not only reserving it for the minor, contained leaks or more comorbid individuals.

We were unable to obtain statistically significant differences when comparing the differences between the three PSS groups. We were able to draw statistical significance between intermediate and high groups in the length of stay data. This likely indicates that having so few individuals in the low group underpowered the study to detect any difference if present. We did include anastomotic leak in our population, whereas they did not. Although we still were unable to draw statistically significant results after removing this patient population. There was a clear trend in length of stay, length of treatment, frequency of V.A.C changes and number of V.A.C changes based on PSS. Going forward, one can see how it would be beneficial to calculate a patient’s PSS to be able to give them and their family a treatment framework and manage expectations.

The average rate of V.A.C changes are every 3.8 days. This is similar to the average in the literature. Anecdotally, we have found that we do not see as much epithelialization and wound closure in a smaller time interval. We have also found that the sponge and tubing tend to get clogged with the longer intervals. From our data comparing the three PSS groups, patients tend to get more frequent V.A.C changes when they have higher severity scores. More changes as well as more frequent changes may be beneficial for areas with significant necrosis as the V.A.C change itself helps debride the wound back to healthy tissue. Although this could be a bias towards more aggressive care towards clinically sicker individuals.

While we are obviously strong believers in this technique, we have found some limitations. We have found healing is slower when the leak is at the level of the lower esophageal sphincter. This may indicate that gastric fistulae do not respond as readily to the technique. This has been shown to be true in one study with 100% healing rates in esophageal injuries compared with 83% in gastric [4]. Two of the patients whose wounds stalled with EV.A.C treatment had a chronic fistula at the gastroesophageal junction. After repeated V.A.C changes there was improvement to the point where a V.A.C could not be placed, although there was a persistent fistula present. Both individuals did heal with expectant management. One patient, our only true failure of E-V.A.C therapy had persistent leakage at an esophageal injury related to spinal surgery with ongoing erosion of bone fragments into the esophagus. She went on to require esophagectomy. One patient had a withdrawal of care during treatment and was transferred to a hospice service after her wound V.A.C was removed. Understanding the expected time of treatment and number of procedures is important and useful in informing patients and families who are making goals-of-care related decisions.

Given the requirement for serial changes, E-V.A.C is labor intensive. Depending on institutional operating room or gastroenterology suite availability, serial E-V.A.C changes may not be feasible. These patients remain inpatient, even if sepsis is controlled and alternate nutrition initiated. This is a drawback, although home E-V.A.C with outpatient changes is a feasible possibility. Despite this, Rousa et al.’s meta-analysis on the topic revealed no change in hospital stay for those undergoing E-V.A.C compared with SEMS for management of esophageal injury [11].

Cost is an obvious consideration as well, especially if these changes are required to be done in the operating room. One study found that E-V.A.C procedures were 2.5 times more expensive when done in the operating room compared with the gastroenterology suite, a cost of $4,528 versus $11,889 at their institution [16]. When compared with stenting there are, on average, slightly more than 3 additional “device changes” required per patient as reported in Scognamiglio et al.’s meta-analysis. It is likely, however, there is less device related cost. While it will vary by institution, one study found that the average institutional price per a readily available SEMS was $2,650 per stent with a patient insurance cost of $4,500 [17]. While our chart review does not capture cost data, it is important to keep this a consideration.

Conclusion

From this review of our experience and of the currently available literature, one can see how this is a promising treatment method. We have seen positive results in multiple anatomical locations and in multiple disease processes. Having assessed our data on the timeline of treatment for various severity of injuries gives us more information to provide to our patients, as well as allows us to have a better framework for treatment. Our success in using E-V.A.C as an adjunct for management of all injuries and leaks, and our use of a hybrid surgery-endoscopy approach for non-contained injuries and more sick individuals challenges previously established treatment algorithms. In this way we hope to decrease the morbidity and mortality of

one of the most dreaded afflictions. Below is our proposed treatment algorithm combining Scweigert et al.'s findings with our experience and review of the literature (Figure 5).

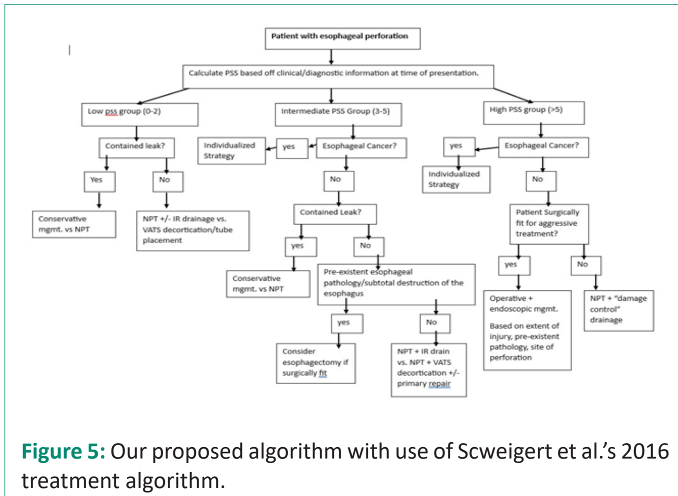

Figure 5: Our proposed algorithm with use of Scweigert et al.'s 2016 treatment algorithm.

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