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Endoscopic Vacuum Therapy in Boerhaave Syndrome: A Contemporary Narrative Review

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ABSTRACT

Boerhaave syndrome remains a life-threatening condition due to rapid mediastinal contamination and sepsis, prompting growing interest in minimally invasive alternatives to surgery. Alongside surgery and endoscopic stenting, endoscopic vacuum therapy (EVT) has emerged over the past decade as an organ-preserving treatment option that combines defect closure with continuous internal drainage—an advantage over conventional stents, which often migrate and fail to control underlying contamination. This narrative review synthesizes current evidence on the role of EVT and hybrid vacuum–stent technologies in the management of spontaneous esophageal rupture. Across recent multicenter cohorts, observational studies, and case series, EVT demonstrates high defect closure rates (80–90%), particularly when applied early in contained perforations and in patients at increased operative risk. Comparative data suggest that, while stents provide effective luminal sealing, EVT offers a distinct advantage in controlling sepsis through active drainage, thereby reducing the need for adjunctive interventions in selected cases. Hybrid systems such as the VACStent further integrate luminal patency, sealing, and negative pressure, allowing nutritional intake while maintaining effective drainage. However, the available evidence remains heterogeneous and largely non-randomized, and EVT appears less effective in the presence of extensive contamination, large chronic cavities, or advanced sepsis. Current data support EVT as a central component of individualized, multimodal management strategies for Boerhaave syndrome, complementing rather than replacing surgical and stent-based approaches. Further prospective and comparative studies are required to refine patient selection and optimize treatment algorithms..

Keywords: Boerhaave syndrome, Esophageal perforation, Endoscopic vacuum therapy, Negative pressure therapy, Minimally invasive therapy

Introduction

Boerhaave syndrome represents the most severe form of esophageal perforation, characterized by a spontaneous, full-thickness rupture often precipitated by sudden intraluminal pressure changes.[1,2] Mortality remains high, particularly when diagnosis is delayed beyond 24 hours, due to rapid contamination of the mediastinum and pleural cavity and subsequent sepsis.[3,4] Historically, management has relied on surgical repair with extensive drainage or endoscopic stenting.[2,4] While covered stents seal the luminal defect, they lack the ability to drain infected cavities and are prone to migration, leading to persistent leakage or the need for repeated interventions.[3,5]

Endoscopic vacuum therapy (EVT) has emerged as a minimally invasive alternative capable of simultaneously promoting defect closure and active drainage.[2,6,7] EVT adapts negative pressure wound therapy to the intraluminal or intracavitary setting, encouraging granulation tissue formation, reducing cavity size, and evacuating contaminated fluids.[7,8] A polyurethane sponge is connected to a transnasal tube linked to a vacuum system and positioned either within the esoph-

ageal lumen (endoluminal EVT) or directly inside a cavity (intracavitary EVT).[9,10] Continuous negative pressure—typically around –125 mmHg—collapses the defect, drains infected fluid, reduces local edema, improves perfusion, and promotes granulation tissue formation.[6,7] Sponges are generally exchanged every 3–5 days; some centers perform weekly exchanges in select cases.[9-11]

Both custom-made and commercially available EVT systems such as the EsoSPONGE®, are currently in use.[9,12] More recently, hybrid platforms including the vacuum-assisted covered stent (VACStent) have been developed, integrating negative pressure therapy with luminal sealing and self-expanding stent-based anchoring.[13-15] These allow ongoing drainage through a sponge-cylinder interface while maintaining luminal patency, a unique advantage over conventional EVT that often precludes oral intake.[14]

Over the last decade—and especially from 2018 onward—evidence has accumulated supporting EVT and hybrid EVT–stent technologies such as the VACStent in the management of esophageal perforations, including Boerhaave syndrome.[9,11,15,16] This focused review synthesizes current evidence for these modalities, emphasizing patient selection, comparative outcomes, and their role within modern management algorithms.

Review

Literature Search Strategy

A narrative literature search was conducted using the Web of Science database without time restrictions. English-language publications addressing endoscopic vacuum therapy in the management of esophageal perforations, including Boerhaave syndrome, were identified using relevant keywords. Titles and abstracts were screened for relevance, and full texts were reviewed when appropriate. Studies were selected based on their clinical relevance and contribution to understanding the indications, outcomes, technical aspects, and limitations of EVT.

Evidence for EVT in Boerhaave Syndrome

The most robust data originate from a multicenter German study by Wannhoff et al., which included 57 patients with Boerhaave syndrome.[17] EVT was used as the primary therapy in 25 patients and achieved an 80% success rate.17 Mortality in the EVT group (8%) was lower than in the non-EVT group (25%), and primary EVT independently predicted treatment success in multivariable analysis.[17] These findings suggest that EVT not only is feasible but may be superior to stenting or primary surgery in selected cases.[17]

Luttikhold et al. reported on 27 patients with esophageal perforations—including iatrogenic and Boerhaave causes—treated with EVT across five European centers.[16] The overall success rate was 89%, with failures primarily related to underlying critical illness rather than technical EVT inadequacy.[16] Adverse events were infrequent but included hemorrhage and defect expansion during sponge exchange.[16]

In a 17-patient Norwegian series of Anundsen et al., Boerhaave syndrome was managed with stents, EVT, or a combination.[5] Despite a high rate of complications (88%), healing occurred in all survivors, and the 90-day mortality was only 6%.[5] These results support EVT's value in multimodal management strategies.

A UK case series reported successful EVT outcomes in three surgically unfit Boerhaave patients, reinforcing its applicability in high-risk populations.[10] Earlier British experience demonstrated complete resolution of leakage in two frail patients, highlighting EVT's usefulness in elderly or comorbid patients.[12]

Collectively, these studies demonstrate that EVT provides closure rates of approximately 80–90% and may reduce mortality compared with traditional management (Table 1).[6,10,16,17] Treatment duration ranges from 12 to 28 days, with the need for multiple endoscopies typical of the technique.[6,9,16]

Comparative Evidence: EVT Versus Stenting

Endoscopic stenting has long been a mainstay of less invasive therapy; however, its limitations—migration, inadequate drainage, and residual leaks—are well documented.[3-5] A 2025 systematic review and meta-analysis found an 86.1% pooled sealing rate for stents in esophageal defects and a 14.9% failure rate.[18] EVT demonstrated a pooled sealing rate of 54.1% with high heterogeneity, but sensitivity analyses yielded an improved closure rate of 89.6%.[18] These findings indicate that, when performed in appropriate settings and patient subsets, EVT achieves closure rates comparable to or exceeding those of stents.[6,18]

The tertiary-center experience from Kooij et al. emphasizes that stents often require additional surgical or percutaneous drainage and that delayed diagnosis significantly worsens outcomes.[3] In their cohort, stent management alone frequently required escalation to drainage procedures.[3] In contrast, EVT intrinsically provides drainage, potentially reducing the need for adjunct operations.[6,9]

Thus, EVT and stents should not be viewed as competing therapies; rather, choice depends on perforation characteristics,

Table 1. Key studies evaluating endoscopic vacuum therapy (EVT) in Boerhaave syndrome

Study (Year)	Study Design	Patients (Boerhaave)	EVT Role	Success / Closure Rate	Mortality	Key Notes
Wannhoff et al. (2025)	Multicenter retrospective	57 (25 EVT primary)	Primary EVT	80%	8% (EVT group)	EVT independently predicted treatment success
Luttikhold et al. (2023)	Multicenter retrospective	27 (mixed etiologies)	Primary EVT	89%	Not reported	Failures related to critical illness
Anundsen et al. (2024)	Retrospective cohort	17	EVT / stent / combined	Healing in all survivors	6% (90-day)	High complication rate, effective multimodal care
Soussi et al. (2024)	Case series	3	Primary EVT	100%	0%	Surgically unfit patients
Alakkari et al. (2019)	Case series	2 (Boerhaave and anastomotic leak)	Primary EVT	100%	0%	Frail, elderly patients

degree of contamination, and patient stability. EVT excels when drainage is critical, whereas stents may be favored when rapid luminal sealing and oral intake are prioritized—unless hybrid technologies are available.[2,7,19]

Hybrid EVT–Stent Technologies: The Rise of the VACStent

Hybrid devices aim to combine the sealing effect of covered stents with the drainage and healing advantages of EVT. The VACStent is the most widely reported system.[13-15]

A systematic review by Kehagias et al. identified 65 patients treated with VACStent, including 10% with Boerhaave syndrome.[13] Technical success was 100% and clinical success 77%, with a mean treatment duration of 8.8 days.[13] Notably, most patients tolerated liquid intake during therapy, an advantage over traditional EVT.[13]

Initial evaluations of Lange et al. showed that the VACStent can overcome stent migration through vacuum anchoring while facilitating defect healing.[14] Early monocentric experiences of another center reported successful outcomes in three patients, including one with Boerhaave syndrome, with exchanges required approximately every seven days.[11]

In a prospective case series by Pattynama et al., all ten treated patients (including one Boerhaave case) achieved defect closure, with median treatment lasting 18 days.[15] Similarly, Ylli et al. reported successful closure in four patients in 2025—two with Boerhaave syndrome—without procedural complications.[20]

These reports suggest that VACStent may reduce the number of required interventions, improve patient comfort, and permit continued nutrition while delivering effective drainage.[11,13-15] Although evidence remains early-phase and observational, hybrid EVT–stent technologies represent an important evolution in minimally invasive management (Table 2).

Patient Selection and Indications for EVT in Boerhaave Syndrome

Successful application of endoscopic vacuum therapy in Boerhaave syndrome hinges on meticulous patient selection and accurate characterization of the perforation.[1,2,4] Across the published series, outcomes are most favorable when EVT is initiated early—ideally within the first 24 hours after symptom onset—at a stage when mediastinal contamination remains limited and the defect is amenable to endoscopic access.[3,4,21] Early-diagnosed patients tend to exhibit a contained transmural perforation or a discrete cavity that allows effective sponge placement and continuous drainage.[2,10] These anatomical conditions, combined with an intact hemodynamic profile, create an environment in which EVT can facilitate rapid collapse of the defect and control of the septic focus.[6,7,19]

EVT has demonstrated particular value in individuals who are poor candidates for major surgery.[5,10,12] Elderly, frail patients or those with severe comorbidities—groups represented in several case series from the United Kingdom and Europe—often derive significant benefit from this organ-preserving approach when conventional surgical repair carries prohibitive risk.[5,10,12] EVT is additionally advantageous when stent therapy is anticipated to be suboptimal, such as in situations with a high risk of stent migration or where sealing alone is unlikely to address the underlying sepsis due to persistent mediastinal contamination.[3,5,10]

Conversely, EVT proves less effective in the presence of extensive or uncontrolled contamination.[4,21] Patients with free perforation and gross mediastinal or pleural soilage frequently require prompt operative intervention to achieve adequate debridement and drainage before any endoscopic modality can be considered.[4,21] Very large or chronic cavities—typically greater than 8 cm, as noted in the early series from Ooi and colleagues—tend to respond poorly because negative pressure is insufficient to collapse the space, and sponge anchoring becomes unstable.[7,19] Extensive necrosis and the presence of devitalized tissue further undermine the likelihood of successful healing with EVT alone.[4,21] In the setting of profound hemodynamic instability or evolving multi-organ failure, immediate surgical source control remains the standard of care, with EVT reserved for later adjunctive management once physiological stability is restored.[4,10,21]

Across nearly all cohorts, the consistent determinant of clinical success is the adequacy of drainage.[6,9,10,19] EVT itself provides effective internal drainage of infected cavities, but in cases where the extent of contamination exceeds the capacity of the endoscopic system, supplemental percutaneous or surgical drainage is indispensable.[3,5,7] The need for thorough multidisciplinary evaluation—often involving endoscopists, thoracic surgeons, intensivists, and interventional radiologists—is underscored by rare but serious complications, such as bleeding or iatrogen-

Table 2. Hybrid endoscopic vacuum–stent (VACStent) therapy for esophageal defects

Study (Year)	Study Design	Patients	Boerhaave (%)	Technical Success	Clinical Success	Treatment Duration	Key Advantage
Kehagias et al. (2025)	Systematic review	65	~10%	100%	77%	8.8 days (mean)	Maintained oral intake
Lange et al. (2021)	Prospective case series	3	1 case	100%	100%	NR	Reduced migration
Klose et al. (2023)	Monocentric case series	3	1 case	100%	100%	~7 days/exchange	Stable anchoring
Pattynama et al. (2023)	Prospective series	10	1 case	100%	100%	18 days (median)	Combined sealing & drainage
Ylli et al. (2025)	Case series	4	2 cases	100%	100%	NR	No complications

ic perforation during device placement, highlighted in isolated reports such as that of Halliday et al.[16,22] These considerations reinforce that EVT is most successful when implemented within experienced centers equipped to handle the complexity and dynamic clinical evolution characteristic of Boerhaave syndrome.[2,21,22]

Technical Considerations and Complications

Technical execution of EVT plays a decisive role in determining clinical efficacy and minimizing complications. The choice between endoluminal and intracavitary placement is dictated by the morphology of the perforation.[2,15] Endoluminal sponge placement is preferred when the defect communicates openly with the esophageal lumen, allowing the sponge to apply circumferential negative pressure.[2,10] Intracavitary placement becomes necessary when a sizeable paraesophageal cavity is present, permitting the sponge to conform directly to the interior of the defect. Most centers employ continuous negative pressure at approximately −125 mmHg, a level shown to promote granulation and cavity collapse without excessive mucosal trauma.[6]

The interval between sponge exchanges typically ranges from three to five days, reflecting the balance between maintaining adequate suction efficiency and minimizing endoscopic manipulation.[11] In hybrid systems such as the VACStent, exchange intervals may extend to approximately seven days due to the inherent stability and luminal patency afforded by the stent–sponge configuration.[11] Overall treatment duration varies widely, often spanning 12 to 28 days depending on the initial severity of contamination, the size of the defect, and the patient's physiological response.[6,9,16] Multiple endoscopic procedures are usually required, with series reporting between three and twelve interventions over the treatment course.[6,9,15]

Complications associated with EVT, although relatively uncommon, warrant careful attention.[16] Hemorrhage may occur during sponge removal, particularly when granulation tissue has formed densely around the device.[16] Defect enlargement during exchange has been reported, albeit rarely, and underscores the need for gentle manipulation and appropriate device sizing.[16] Anastomotic or esophageal strictures can develop during follow-up, particularly after prolonged therapy, though most are amenable to endoscopic dilation.[6,9,13] Iatrogenic perforation during placement—described in early reports such as the case by Halliday et al.—is an uncommon but serious risk that highlights the importance of specialized training and adherence to meticulous technique.[22] When EVT is performed within experienced multidisciplinary teams, these adverse events are generally manageable and do not diminish the overall therapeutic efficacy of the modality.[2,21,22]

Outcomes and Long-Term Follow-Up

Across the published literature, EVT achieves consistently high closure rates for esophageal defects, including Boerhaave syndrome.[6,9,16] Reported healing rates typically range from 80% to 94%, with several multicenter studies demonstrating that EVT can obviate the need for esophagectomy or major surgical intervention in the majority of cases.[6,9,16,17] Mortality rates reported in EVT cohorts vary between 6% and 14%.[3,5] Importantly, these deaths are generally attributable to the severity of the underlying septic state or comorbid illness rather than direct complications of EVT itself, reinforcing its safety profile.[5,16]

Beyond short-term outcomes, EVT appears to provide durable long-term results.[23] A prospective study by Dhayat et al. examining quality of life after upper gastrointestinal EVT demonstrated that overall GIQLI scores approximated those observed in patients who had undergone esophagectomy without anastomotic leakage.[23] Except for modest reductions in social function, EVT-treated patients reported comparable symptom control, emotional well-being, and physical capacity.[23] These findings suggest that EVT not only resolves the acute perforation effectively but does so while preserving a satisfactory long-term quality of life, underscoring its value as an organ-preserving intervention.[16,17,23]

Integration of EVT into Contemporary Management Algorithms

The evolving evidence base supports a nuanced, patient-specific approach to integrating EVT into the management of Boerhaave syndrome.[1,2,21] In early-diagnosed cases, particularly when the perforation is contained and the degree of mediastinal contamination is limited, EVT has emerged as a highly effective primary therapy.[16,17] In these settings, EVT may be used alone or in combination with percutaneous or limited surgical drainage, depending on the extent of extraesophageal contamination.[4,5] Hybrid devices such as the VACStent offer the additional advantage of maintaining luminal patency and enabling nutrition while simultaneously providing negative-pressure therapy, making them particularly suitable when oral intake is desirable.[13,14]

In patients presenting more than 24 hours after perforation, the degree of contamination is typically greater, and a combined therapeutic approach becomes more appropriate.[3,4,21] This may include stent placement with surgical drainage, EVT with adjunctive drainage procedures, or sequential use of stents and EVT in cases where initial strategies fail.[3,14,21] When contamination is significant, EVT is often favored because it provides continuous drainage—addressing a limitation of stents, which may seal the defect but leave the underlying sepsis unaddressed.[3,6,19]

Severely septic or hemodynamically unstable patients remain candidates for immediate operative intervention to achieve rapid source control.[1,21] EVT may then be introduced in the postoperative period to facilitate ongoing drainage and promote secondary healing of persistent defects.[6,14] This staged approach reflects the complexity and heterogeneity of Boerhaave syndrome and mirrors the conclusions of multicenter studies and systematic reviews emphasizing early recognition, rapid control of contamination, and individualized multimodal therapy.[13,17,18]

Shortcomings of EVT Therapy

Despite the encouraging clinical outcomes reported with endoscopic vacuum therapy, a balanced appraisal of the available evidence highlights several important limitations and less favorable scenarios.[8,18] EVT appears most effective in early-diagnosed, hemodynamically stable patients with contained perforations and limited cavity size, whereas outcomes are less favorable in the presence of extensive mediastinal or pleural contamination, large or chronic cavities, or delayed presentation—settings in which prompt surgical source control remains essential.[3,4,19,21] Several series have demonstrated that inappropriate reliance on endoscopic therapy may necessitate subsequent escalation to surgery, underscoring that EVT should not delay definitive operative management when sepsis is uncontrolled.[3,4,21] Furthermore, EVT is a resource-intensive intervention, often requiring multiple endoscopic exchanges over prolonged treatment periods and extended hospital stays.[5,6,9,12,22] Although generally safe, procedure-related complications such as bleeding during sponge exchange, defect enlargement, esophageal strictures, and rare iatrogenic perforation have been reported.[6,9,16,22] From an evidence standpoint, current data are derived predominantly from retrospective cohorts and case series, with substantial heterogeneity in patient selection, technical protocols, and outcome definitions, limiting direct comparison with surgical or stent-based strategies.[8,18,24] These considerations emphasize that EVT should be regarded not as a universal replacement for surgery or stenting, but as a complementary modality within a multidisciplinary, patient-specific treatment algorithm implemented in experienced centers.[1-3]

Future Directions

Despite notable progress, several critical knowledge gaps limit the ability to standardize EVT-based management. Foremost among these is the absence of randomized controlled trials directly comparing EVT, stenting, and hybrid modalities such as VACStent.[8,13,18] Current evidence, though encouraging, is derived almost exclusively from observational studies and case series, making comparative effectiveness and optimal treatment sequencing difficult to define with certainty.[8,13,18]

Standardization of EVT technique is another pressing need. Parameters such as negative pressure settings, optimal exchange intervals, and treatment duration vary considerably between centers and studies.[11,19,24] Establishing harmonized protocols could improve reproducibility, reduce complications, and facilitate multicenter trials.[16,22,24] Advances in patient stratification—including the identification of clinical or radiologic biomarkers predictive of EVT success—would further refine selection criteria and optimize treatment pathways.

Economic evaluations are notably lacking. Given the prolonged inpatient stays and repeat endoscopic procedures often required, determining the cost-effectiveness of EVT relative to stenting or surgery will be increasingly important as its use expands. Technological innovation remains a promising avenue, with ongoing development of smaller, more adaptable sponges, integrated monitoring systems, and devices tailored to complex anatomies. Hybrid stent–vacuum platforms such as the VACStent hold substantial potential but require larger prospective studies to clarify their ideal indications, durability, and long-term safety.

Limitations of the Review

This narrative review has several inherent limitations that should be acknowledged. The available evidence on endoscopic vacuum therapy in Boerhaave syndrome is dominated by retrospective cohorts, case series, and observational studies, with a marked absence of randomized controlled trials, which restricts the strength of comparative conclusions. Considerable heterogeneity exists across the included studies with respect to patient selection, timing of intervention, defect size, extent of contamination, technical execution of EVT (endoluminal vs intracavitary), negative pressure settings, exchange intervals, and definitions of technical and clinical success, limiting direct comparability and precluding formal quantitative synthesis. In addition, reporting bias cannot be excluded, as favorable outcomes are more likely to be published, particularly in early experience and single-center reports. many reports originate from high-volume tertiary centers with specialized endoscopic and surgical expertise. Outcomes achieved in these settings may not be reproducible in lower-volume institutions, potentially limiting external validity. Furthermore, most studies combine Boerhaave syndrome with other etiologies of esophageal perforation or anastomotic leakage, making disease-specific inferences less precise. Finally, long-term outcomes, cost-effectiveness, and standardized patient-reported measures remain inconsistently reported, underscoring the need for prospective, multicenter studies with uniform protocols to more clearly define the role of EVT and hybrid technologies within contemporary management algorithms.

Conclusion

Endoscopic vacuum therapy has rapidly evolved into a first-line, organ-preserving option for many patients with Boerhaave syndrome. Across multiple cohorts and multicenter analyses, EVT achieves high defect closure rates, provides effective sepsis control, and demonstrates favorable mortality and quality-of-life outcomes. Hybrid technologies like VACStent further expand the therapeutic armamentarium by combining sealing, drainage, and luminal patency in a single platform. While EVT is not universally applicable—particularly in patients with extensive contamination or delayed presentation—it has fundamentally shifted the minimally invasive management paradigm for spontaneous esophageal rupture. Future well-designed comparative studies will be essential to refine patient selection, standardize practice, and define the optimal role of EVT and hybrid technologies in the modern management algorithm for Boerhaave syndrome.

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