



# Use of vacuum-assisted closure in the treatment of complex intrapleural infections

Uporaba zapiranja ran z vakuumom pri zdravljenju zapletenih intraplevralnih okužb

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## Abstract

**Background:** Debilitated patients with chronic empyema, who are not fit enough to undergo thoracotomy and decortication due to lung entrapment, may be offered a lower-risk alternative – an open-window thoracostomy. Vacuum-assisted closure (VAC) may accelerate empyema drainage and wound closure.

**Methods:** In this study, we compared two cohorts of patients receiving open-window thoracostomy (OWT) with or without VAC dressing. We included patients with chronic or postresectional empyema with multiple comorbidities or in poor general condition or on immunosuppression.

**Results:** Delayed wound closure by thoracoplasty was performed in 8 (28%) patients in the OWT group and 8 (53%) patients in the OWT-VAC group (OR 2.54; 95% CI: 0.704-9.168). Time until DWC was significantly shorter ( $p < 0.001$ ) in the OWT-VAC group (48.5, IQR: 27.5 days) compared to the OWT group (316.5, IQR: 102.5 days). Regarding complications, we found no significant differences between the two groups, except for air leak, which was found in 0 (0%) patients in the OWT group and 6 (40%) patients in the OWT-VAC group (OR 1.67; 95% CI: 1.10-2.52;  $p < 0.001$ ). The percentage of patients who required re-do surgery did not differ significantly between the groups - 1 (3%) patient in the OWT group vs. 2 (13%) patients in the OWT-VAC group (OR 7.0; 95% CI: 0.66 – 74.29;  $p = 0.07$ ).

**Conclusion:** Our experience shows that using VAC therapy in OWT can significantly shorten the overall treatment time. It can be safely used at home and in an outpatient setting.

## Izvleček

**Izhodišča:** Bolnikom s kroničnim empiemom, ki so v slabem splošnem zdravstvenem stanju in niso sposobni za torakotomijo in dekortikacijo zaradi ujetih pljuč, lahko ponudimo alternativno možnost z nižjim tveganjem, in sicer torakostomo. Zapiranje rane z vakuumom (VAC) lahko pospeši dreniranje empiema in zapiranje rane.

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**Metode:** V naši študiji smo primerjali dve kohorti bolnikov, ki so prejeli torakostomo z vakuumsko (VAC) prevezo ali brez nje. Vključili smo bolnike s kroničnim empiemom ali empiemom po resekciji, ki so imeli več boleznih in/ali v slabem splošnem zdravstvenem stanju in/ali so jemali imunosupresivna zdravila.

**Rezultati:** Zapiranje rane s torakoplastiko (ZST) je bilo opravljeno pri 8 (28 %) bolnikih v skupini ne-VAC in pri 8 (53 %) bolnikih v skupini VAC (RO 2,54; 95 % IZ: 0,70-9,17). Čas do ZST je bil pomembno krajši ( $p < 0,001$ ) v skupini VAC (48,5; IQR: 27,5 dni) v primerjavi s skupino ne-VAC (316,5; IQR: 102,5 dni). Pri zapletih nismo našli pomembnih razlik med obema skupinama, razen pri puščanju zraka, ki ni bilo prisotno pri nobenem bolniku v skupini ne-VAC in pri 6 (40 %) v skupini VAC (RO 1,67; 95 % IZ: 1,13-2,52;  $p < 0,001$ ). Delež bolnikov, ki so potrebovali ponovno operacijo, se med skupinama ni pomembno razlikoval – 1 (3 %) bolnik v skupini ne-VAC in 2 (13 %) bolnika v skupini VAC (RO 7,0; 95 % IZ: 0,66 – 74,29;  $p = 0,07$ ).

**Zaključek:** Naše izkušnje kažejo, da lahko uporaba VAC pri torakostomi pomembno skrajša celokupni čas zdravljenja. Lahko se varno uporablja pri bolnikih v ambulanti in v domačem okolju.

## 1 Introduction

Pleural space infections comprise a broad spectrum of diseases. In the early stages, parapneumonic effusion and thoracic empyema may be treated with chest tube drainage or a video-thoracoscopic procedure. However, failure to do so early may necessitate a more invasive procedure – thoracotomy and decortication due to lung entrapment (1). In a debilitated patient, these procedures may carry a substantial risk. Complicated chronic empyema in these patients may therefore require a lower-risk alternative – an open window thoracostomy (OWT) (1,2). Fenestration of the thoracic wall allows for a quick resolution of sepsis but also creates a complex malodorous wound that can be socially debilitating. Studies have already shown that accelerated OWT empyema drainage may be achieved with the help of vacuum-assisted closure (VAC) (3,4,5,6,7). Additionally, VAC treatment seems to facilitate the patient's return to their daily activities by concealing the wound odour and allowing the dressing changes to be made only weekly (7).

## 2 Methods

### 2.1 Patients

We designed a study to compare a prospective cohort with a historical cohort. The historical cohort included patients with thoracic empyema who received OWT without VAC dressing, and the prospective cohort included patients who received OWT with VAC dressing (OWT-VAC). After introducing the new treatment method in our department in December 2019, its advantages and accelerated healing became apparent with the first few patients. That is why we decided to

use only OWT-VAC from then on and to compare the prospective cohort with the historical one.

Inclusion criteria for patients with chronic or post-resectional empyema were the following:

- poor general condition (Karnofsky index  $\leq 50\%$ ) or
- multiple comorbidities ( $\geq 3$  organ diseases, such as diabetes mellitus, chronic kidney disease, heart failure, etc.) or
- immunosuppression (induced by medication following organ transplantation).

We defined the primary outcome as the time until delayed wound closure (time between two procedures – OWT formation and thoracoplasty) and the secondary outcomes as the percentage of complications (hypotension, bleeding, air leak, and re-infection) and re-do surgery.

Data were collected prospectively and retrospectively for all the patients who received OWT for chronic or postresectional empyema between February 2010 and September 2021. The study was approved by Slovenia's National Medical Ethics Committee (approval number 0120-230/2020-3; date 14. 07. 2020).

Statistical data analysis was performed using the Chi-square test for categorical variables, the independent samples t-test, and the Mann-Whitney U test for numeric variables. A p-value less than 0.05 ( $p < 0.05$ ) was considered significant. Normally distributed continuous variables were presented as mean  $\pm$  standard deviation (SD) and asymmetrically distributed continuous variables as median and interquartile interval (IQR). The odds ratio with a confidence interval of 95% (OR, CI 95%) was used to estimate differences between the treatment groups.

## 2.2 Surgical management

All patients underwent the procedure under general anaesthesia. The empyema sac was located according to a preoperative computed tomography scan. A 5 cm incision was made, resection of a minimum of one rib was performed, the cavity was opened, and an Eloesser flap was created.

**OWT group:** Saline-soaked gauzes were inserted into the cavity and changed daily. Patients were discharged home with the same dressing, which was changed regularly by a field nurse at home.

**OWT-VAC group:** Black Granufoam (KCI Medical, San Antonio, TX, USA) was inserted into the cavity, Whitefoam or a silicone membrane was used to cover possibly exposed lung or mediastinum. The suction was typically set to -125 mmHg. In the case of the patient's hypotension, we reduced the setting to -75 mmHg. After discharge, VAC therapy was continued on an outpatient basis, with the dressing being changed every 5-7 days. In the presence of an air leak due to an alveolepleural fistula (APF), we covered the fistula with polyethylene non-adherent dressing (Eurodressing, Eurofarma SPA, Belpasso, Italy). In this case, VAC dressing required more frequent changing.

## 3 Results

Between February 2010 and September 2021, 44 patients were enrolled in the trial. The first 29 patients received saline-soaked dressing after OWT, and the last

15 received OWT-VAC. There were no significant differences between OWT and OWT-VAC groups regarding age, sex, multimorbidity, immunosuppression, malignancy, and postresectional or postpneumectomy empyema (Table 1).

There was also no significant difference between the two groups regarding the delayed wound closure (DWC) rate. In the OWT group, DWC was performed in 8 (28%) patients; in the OWT-VAC group, it was done in 8 (53%) patients (OR 2.54; 95% CI: 0.70-9.17). Other patients did not receive DWC because they either died or were lost to follow-up. Time until DWC was much shorter ( $p < 0.001$ ) in the OWT-VAC group (48.5, IQR: 27.5 days) compared to the OWT group (316.5, IQR: 102.5 days) (Table 2).

We found no major complications (e.g., severe bleeding or shock due to mediastinal shift) in any group. Of 29 patients in the OWT group, 7 (24%) had complications. In 2 (7%) patients, postoperative bleeding was observed, and 5 (17%) patients had re-infection (Table 2).

Of 15 patients in the OWT-VAC group, 8 (53%) developed some complications, one patient (7%) experienced postoperative hypotension, in 2 (13%) patients, postoperative bleeding was observed, in 6 (40%) patients air leak developed and 3 (20%) patients had re-infection. Regarding complications, we found no significant differences between the two groups, except for air leak, which was observed in 0 (0%) patients in the OWT group and 6 (40%) patients in the OWT-VAC group (OR 1.67; 95% CI: 1.10-2.52;  $p < 0.001$ ).

**Table 1:** Baseline characteristics of the patients.

Characteristic	Total n=44	OWT n=29	OWT-VAC n=15	OR (95% CI)	p-value
Age, mean $\pm$ SD (range)	66 $\pm$ 9.2 (43-83)	66 $\pm$ 10.1 (43-83)	65 $\pm$ 7.5 (49-78)		0.75
Sex					0.74
• Female	7 (16%)	5 (17%)	2 (13%)		
• Male	37 (84%)	24 (83%)	13 (87%)		
Multiple morbidities ( $\geq 3$ )	29 (44%)	19 (66%)	10 (67%)	1.05 (0.28-3.94)	0.94
Immunosuppression	3 (7%)	2 (7%)	1 (7%)	0.96 (0.08-11.58)	0.98
Malignancy	25 (57%)	16 (55%)	9 (60%)	1.22 (0.34-4.32)	0.76
Postresectional empyema	19 (43%)	11 (38%)	8 (53%)	1.41 (0.40-4.91)	0.59
Postpneumectomy empyema	7 (16%)	7 (24%)	0 (0%)	0.79 (0.66-0.96)	0.06

Legend: SD – standard deviation; OR – odds ratio; CI – confidence interval.

**Table 2:** Primary and major secondary outcomes.

Outcome	OWT n=29	OWT-VAC n=15	OR (95% CI)	p-value
DWC by thoracoplasty - no. of patients (%)	8 (28%)	8 (53%)	2.54 (0.70-9.17)	0.15
Time until DWC – no. of days, median (IQR)	316.5 (102.5)	48.5 (27.5)		<0.001
Complications – no. of patients (%)	7 (24%)	8 (53%)	5.11 (1.28-20.49)	0.02
• Hypotension	0	1 (7%)	1.07 (0.94-1.23)	0.16
• Bleeding	2 (7%)	1 (7%)	0.96 (0.08-11.58)	0.98
• Air leak	0	6 (40%)	1.67 (1.10-2.52)	<0.001
• Re-infection	5 (17%)	3 (20%)	1.20 (0.25-5.89)	0.82
Re-do surgery – no. of patients (%)	1 (3%)	2 (13%)	7.00 (0.66-74.29)	0.07

Legend: DWC – delayed wound closure; IQR – interquartile range; OR – odds ratio; CI – confidence interval.

The percentage of patients who required re-do surgery did not differ significantly between the groups (OR 7.0; 95% CI: 0.66 – 74.29;  $p=0.070$ ). Only one (3%) patient in the OWT group required an additional procedure due to re-infection, and 2 (13%) patients in the OWT-VAC group required additional procedures due to re-infection and bleeding.

## 4 Discussion

Treatment of complex chronic intrapleural infections in patients with poor general condition and multiple morbidities remains challenging. In the last decade, vacuum-assisted closure use in treating chronic empyemas has increased in thoracic surgery (6).

Our study indicates that using VAC in OWT can significantly accelerate healing and shorten overall treatment time in patients with chronic empyema. This observation confirms the results of earlier retrospective studies (4,5,6,7). Additionally, VAC provides a hermetically tight dressing that conceals the wound odour and prevents discharge spillage. Another significant advantage is the possibility of using VAC therapy in an outpatient setting, which allows for early discharge, although dressing changes might present additional strain for the outpatient clinic.

Early-on fears of mediastinal traction with possible catastrophic hypotension and shock after using VAC intrapleurally have proven unnecessary (3). Although our VAC series contained no patients with postpneumectomy empyema, studies have already demonstrated that VAC therapy can be used safely and effectively in such

patients, even in the presence of bronchopleural fistula (BPF) (8).

During the SARS-CoV-2 pandemic, Konagaya et al. have shown the efficacy and advantages of OWT-VAC in treating a COVID-19-related empyema with prolonged air leak due to an unresolved alveolopleural fistula (APF) (9). This finding might indicate that neither BPF nor APF is a contraindication for VAC therapy.

A good alternative for treating chronic pleural empyema might also be using VAC with the instillation of a local antiseptic solution. In 2014, Hofman et al. first reported the polyhexanide solution flushing application in patients with OWT-VAC (10). Nevertheless, one must be cautious in choosing suitable patients. The use of antiseptic instillation in a patient with BPF or APF might lead to severe chemical pneumonitis. Because some of the patients presented with air leak at the time of OWT creation and some developed it later during treatment, we decided against using local antiseptic solution instillation in this cohort of patients.

To our knowledge, no randomized trials have investigated the use of VAC for intrathoracic infections. Because of the small number of patients, such studies would be difficult to conduct, and considering the apparent benefits of VAC and significantly accelerated healing, designing such a study would not be justified.

### 4.1 Study limitations

The main limitations of our study are the limited number of patients and its design - it is a retrospective study with two cohorts. The relatively small sample

might be the reason for some of the non-significant outcome results.

## 5 Conclusion

Our experience shows that VAC therapy in OWT can significantly shorten the overall treatment time.

It might be a safe and effective treatment for complex intrathoracic infections, and it can be safely used at home and in an outpatient setting.

## Conflict of interest

None declared.

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