

## Original article

# A vacuum assisted closure system in complex wounds: a retrospective study

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## ARTICLE INFORMATION

## Article history:

Received July 26, 2009

Accepted February 7, 2010

Online April 7, 2010

## Keywords:

Vacuum-assisted closure (VAC)  
therapy

Complex wounds

Therapy

## A B S T R A C T

**Introduction:** Vacuum-assisted closure (V.A.C.) therapy is a dynamic and non-invasive system for improving wound healing. This novel therapy is based on applying air suction at a controlled sub-atmospheric pressure. The most important benefits of this therapy include a reduction in the wound area together with induction of new granulation tissue formation, effective wound cleansing (removal of small tissue by suction), and the continuous removal of wound exudate.

The aim of this study is to describe our experience with V.A.C. therapy for complex wounds.

**Material and methods:** We retrospectively evaluated our experiences with V.A.C. therapy between April 2007 and August 2008. We employed a “suprafascial” V.A.C. system and an open abdomen V.A.C. system. Descriptive statistical techniques were applied and percentages and means were calculated.

**Results:** V.A.C. therapy was applied in 20 patients, of whom 16 (80%) had complex abdominal wounds and 4 (20%) had wounds in other locations. We employed a “suprafascial” V.A.C. system in 17 patients (85%) and an “intra-abdominal” V.A.C. system in 3 patients (15%). Two patients (10%) developed fistula during interabdominal V.A.C. therapy (urinary and enteric) but closure was achieved before therapy was finished. Mean hospital stay was 38.3 days (7–136). No mortality was directly due to the V.A.C. system. Two patients (10%) died due to their septic condition and the rest are still alive. Mean therapy length was 29.17 days (1–77) in the suprafascial group and 18 days (7–49) in the abdominal group. Average costs were €3197.97 (119.1–10780.25) per patient.

**Conclusions:** V.A.C. therapy can improve and accelerate abdominal wound healing even in the presence of infection and bowel fistula.

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## Sistema de cierre asistido por vacío en heridas complejas. Estudio retrospectivo

### R E S U M E N

#### Palabras clave:

Sistema de cierre asistido por vacío  
Heridas complejas  
Tratamiento

**Introducción:** La terapia de cierre asistido por vacío (VAC) es un sistema no invasivo y dinámico que ayuda a promover la cicatrización mediante la aplicación de presión negativa en el lugar de la herida, favoreciendo la reducción del área de la herida, eliminando el exceso de fluidos y estimulando la angiogénesis.

El objetivo de este trabajo ha sido describir nuestra experiencia con la terapia VAC en heridas complejas.

**Material y método:** Analizamos de forma retrospectiva nuestra experiencia entre abril del 2007 y agosto del 2008. Empleamos 2 tipos de terapia VAC, la «suprafascial» y el dispositivo para abdomen abierto o «intraabdominal». Se aplicó estadística descriptiva con cálculo de porcentajes y medias.

**Resultados:** La terapia VAC fue empleada en un total de 20 pacientes con heridas complejas, de las cuales 16 (80%) tenían una localización abdominal y el resto, 4 (20%), otras localizaciones. En 17 (85%) pacientes el dispositivo VAC empleado fue «suprafascial», mientras que en los otros 3 (15%) se utilizó el dispositivo VAC «intraabdominal». Durante la terapia VAC tuvimos 2 casos (10%) de fístula, una urinaria y otra entérica. En ambos casos, la modalidad VAC empleada fue la «intraabdominal» y las fístulas se resolvieron antes de la retirada de la terapia VAC. La estancia media hospitalaria fue de 38,3 días (7-136). No hubo mortalidad directamente relacionada con la terapia VAC. Dos pacientes (10%) fallecieron en situación de shock séptico refractario, mientras que el resto (90%) vive en la actualidad. El dispositivo VAC «suprafascial» se mantuvo una media de 29,17 días (1-77), y el «intraabdominal» 18 días (7-49). El coste por paciente se estimó en 3.197,97 € (119,1-10.780,25).

**Conclusiones:** La terapia VAC puede mejorar y acelerar la cicatrización de las heridas abdominales complicadas también en presencia de contaminación grave o fístulas intestinales.

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## Introduction

Vacuum assisted closure (V.A.C.) therapy is a non-invasive dynamic system that helps promote wound healing by applying controlled negative pressure to the site of the wound. It provides a humid closed environment and simultaneously eliminates excess fluid that could inhibit wound healing. In this manner wound volume decreases while wound healing is accelerated. It is possible to treat wounds of any size.

There are 2 types of therapy: the abdominal dressing for treatment of the open abdomen replacing the classic Bogota Bag, and suprafascial therapy for the closure of complex wounds.

We present our results with V.A.C. therapy for the closure of complex wounds.

The object of this study was to assess the effects of V.A.C. therapy in patients with complex infected wounds, in addition to associated morbidity.

## Material and methods

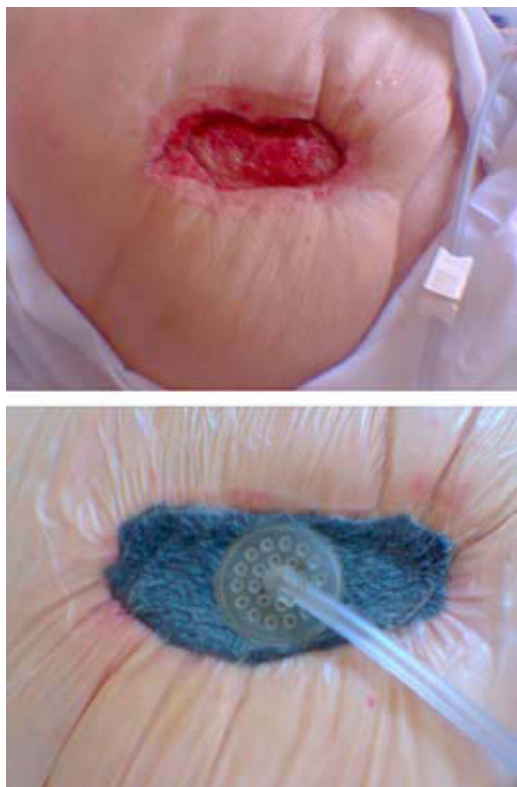
We retrospectively analysed our experience with the use of V.A.C. therapy between April 2007 and August 2008. We used descriptive statistics with calculation of percentages and means to calculate hospital stays and costs.

Below we describe how we placed the device for each form of treatment.

### Suprafascial V.A.C therapy

After cleaning the wound we applied GranuFoam®, a reticulated black polyurethane dressing with open pores which helps stimulate the formation of granulation tissue and has a high drainage capacity. It is therefore especially appropriate for wounds with copious exudates. The dressing must be the same size as the surface area of the wound being covered (Figure 1). Subsequently, the polyurethane is covered with an adhesive transparent plastic dressing attached to the suction tube which connects the system to the machine exerting negative pressure on the wound. The device has a container that makes it possible to quantify the amount and characteristics of the exudates. The polyurethane is also available in a grey model including silver fibres for very infected wounds.

We occasionally use a hydrophilic sheet of microporous polyvinyl alcohol (Vers-Foam®) that is very resistant to traction. It is applied directly to the wound, and the system described above (the GranuFoam® plus the adhesive dressing) is mounted on top of it. We use this additional layer in wounds with complex anatomies in order to tunnelise them and thus favour drainage. We have also used this layer with contained



**Figure 1 – Placement of polyurethane on the surface of the wound.**

eviscerations (without extensive visceral exposure) or in cases of intestinal fistulas; due to its physical characteristics, this dressing prevents tissue invasion, is resistant to tension and easy to manipulate, and does not adhere to the surface.

The objective with this system was to accelerate second intention healing of wounds.

#### *Open abdomen system*

We first place polyurethane foam encapsulated in a perforated non-adhesive transparent polyethylene sheet in which we wrap the viscera as if it were the parietal peritoneum. We place the GranuFoam® on the sheet, followed by the adhesive dressing to which we apply the tube with traction (Figure 2). The encapsulated foam can be placed directly over the intestinal loops, although if the greater omentum is present we place it between the visceral contents and the encapsulated foam. This system facilitates open abdomen treatment, allowing a delay of primary closure until the patient is stabilised, leaving the fascia intact and permitting collection and measurement of lost abdominal fluid. It contributes to abdominal stabilisation by its fixation effect and at the same time provides a barrier separating the abdominal contents from the environment and thereby protecting them.

We applied V.A.C. therapy at a continuous pressure of 125 mmHg when using the suprafascial system and at 75 mmHg in the open abdomen system, with a daily rest period



**Figure 2 – Placement of V.A.C. therapy in a clinical case of open abdomen.**

of up to two hours and the system was changed every 48-72 hours.

V.A.C. therapy was administered to a total of 20 patients. In some cases, for example in patients with large pressure sores due to prolonged bed rest, we used Y-shaped systems which make use of the same terminal to create a vacuum in 2 wounds at the same time.

The parameters studied were:

- patient information: sex, age, associated pathological conditions, clinical situations and current survival
- wound location
- type of V.A.C. therapy used and length of time used
- complications related to V.A.C. therapy
- hospital stay and ICU stay
- costs

## Results

In 17 patients (85%) the V.A.C. suprafascial device was used, whereas the 3 remaining patients (15%) had the V.A.C. device for open abdomen or intra-abdominal therapy (Figure 3). All



Figure 3 – Intra-abdominal V.A.C. system.

20 cases were complex wounds; 16 (80%) were abdominal and the remaining 4 (20%) were soft tissue wounds located in the limbs (Table).

The mean age of the patients was 60.52 years (30-78). Women made up 35% of the group (7/20) and 65% were men (13/20). All patients had associated pathological conditions, and 50% had multiple associated pathological conditions (more than 3 systemic diseases).

Mean hospital stay was 38.3 days (7-136), and 45% (9/20) of the patients spent some time in the ICU.

The clinical situations of our patients were varied. In 19 cases (95%) their wounds became complicated due to different septic conditions, whereas the remaining case was a patient with colon and bladder lesions caused by trauma. Of the complicated septic wounds, 8 were secondary peritonitis, 2 were anastomotic dehiscences, one a rectal stump dehiscence (Hartmann) and 5 were gut perforations; 3 dehiscences of laparotomies (late-onset contained eviscerations); a complex chronic sinus of the abdominal wall of a morbidly obese patient who underwent operations on several occasions; 3 post-herniorrhaphy infected wounds; 2 cases of limb fasciitis; one case of limb cellulitis; one myositis of a limb (Table).

During V.A.C. therapy, 2 patients (10%) had fistulae, one urinary and one intestinal. The 2 patients had intra-abdominal V.A.C. devices of the open abdomen type. As a result, 66% of the patients with V.A.C. open abdomen therapy suffered complications; however, it is necessary to be cautious with this percentage since it is based on a group of only 3 patients. In both cases, the fistulae resolved before withdrawal of V.A.C. therapy and we do not know up to what point this therapy had any influence on the pathogenesis of the fistula.

All the wounds suffered superinfection. We found a high frequency (8/20=40%) of multiresistant bacteria (*Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and *Escherichia coli* BLEE) in cultures of samples from wounds.

The intra-abdominal V.A.C. device was kept in place for a mean period of 18 days (7-49). In this group we obtained complete closure after withdrawal of V.A.C. therapy. In the other 2 patients the system was used as a substitute for the classic Bogota bag until the patients' clinical condition

Table – Clinical situations, type, morbidity and V.A.C. location

Clinical situations	Wound location	V.A.C. type	Position of the foam	Additional Versfoam sheets	Complications
Cellulitis n=1	Limb	SF	Subcutaneous	Yes	No
Fasciitis n=2	Limb	SF	Fascia	No	No
Myositis n=1	Limb	SF	Muscular	Yes	No
Abdominal trauma n=1	Abdomen	OA	IA	No	Yes
Secondary peritonitis n=8	Abdomen	2 OA 6 SF	2 IA 6 Fascia	No	1 Yes 7 No
Dehiscences of laparotomies n=3	Abdomen	SF	Fascia	Yes	No
Chronic sinus n=1	Abdomen	SF	Subcutaneous	No	No
Post-herniorrhaphy wounds n=3	Abdomen	SF	Fascia	No	No

IA, intra-abdominal; n, number of cases; OA, open abdomen; SF, suprafascial; V.A.C., vacuum-assisted closure.





**Figure 4 – Suprafascial V.A.C. system applied over a mesh.<sup>1</sup> Granulation tissue after V.A.C.<sup>2</sup> therapy. Graft over granulation tissue.<sup>3</sup>**

improved and definitive abdominal closure was performed.

The suprafascial V.A.C. device was kept in place for a mean period of 29.17 days (1-77).

In most cases (18/20, 90%), the wounds closed by second intention after withdrawal of V.A.C. therapy.

In a patient from the open abdomen group we carried out a combination of treatments. This patient had abdominal compartment syndrome and in a first stage the abdomen was closed with a Bogota bag. The bag was replaced by an intra-abdominal device which was kept in place until the conditions were right (approximately 2 weeks) to perform wall closure with a double-layered polypropylene monofilament mesh enclosed in 2 sheets of polydioxanone and another with a layer of oxidized cellulose on the intestinal facet. After this intervention, the patient developed skin margin necrosis with mesh exposure. Over this area, we then placed a suprafascial V.A.C. device until good granulation tissue was formed, after which we covered it with a skin graft taken from the thigh. This patient is one of the survivors of our series (Figure 4).

The mean estimated cost per patient was €3197.97 (119.1-10780.25).

At present, 18 patients (90%) are alive. We had no mortality directly related to V.A.C. therapy. However, 2 patients in the series (10%) died from refractory septic shock due to peritonitis which was secondary to an ischemic colitis in one case and to anastomotic dehiscence in the other. The V.A.C. device used in these patients was the open abdomen system in the first case and the suprafascial system in the second.

## Discussion

During the last few years V.A.C. negative pressure therapy has become a new therapeutic alternative for acute or chronic wounds of different origins.

The V.A.C. system is a non-invasive, controlled therapy which uses negative pressure over the wound to promote healing in a humid and closed environment, favouring the elimination of excess fluid, stimulating angiogenesis and the formation of granulation tissue and decreasing bacterial colonization.

More than 200 years ago, negative pressure was used in ancient Chinese medicine to treat wounds. However, its use has not become widespread until recently.<sup>1</sup>

Although many articles describe the success of V.A.C. therapy, there are cases in which this treatment is contraindicated.<sup>1</sup> In an attempt to draw up a protocol for its use, the European Wound Management Association (EWMA) has published a series of directives related to the use of this therapy, and they can be found at this address: [www.ewma.org](http://www.ewma.org)<sup>2</sup>

The Spanish Association of Surgeons also arrived at a consensus for the employment of this technique in general surgery.<sup>3</sup> In this consensus it was concluded that this therapy is useful for the management of open wounds located anywhere, even those in the abdomen with or without an undamaged wall. The application of V.A.C. therapy in this type of wounds is frequent and in fact most of our patients had this indication.

In one patient we used a suprafascial V.A.C. device for use in mobile conditions. It is the same V.A.C. system with a smaller machine that the patient can easily carry around. In this way the patient may go home, undergo treatment while

maintaining mobility, and come into hospital periodically for the wound to be checked.

The second point on which consensus was achieved was the use of V.A.C. therapy in dehiscent wounds with enteral fistulae. Here, the use of V.A.C. therapy was recommended in certain cases. In our series only one patient had an enteral fistula. When this complication appeared, the patient already had an open abdomen V.A.C. system and we do not know up to what point V.A.C. therapy could have influenced fistula pathogenesis. V.A.C. therapy was not suspended at any time and the patient evolved favourably with fistula resolution.

The third point addressed in the consensus was the use of V.A.C. therapy in whole wall wounds,<sup>4</sup> that is, the use of V.A.C. therapy in open abdomen either caused by trauma or by abdominal compartmental syndrome or in the context of a deferred abdominal closure. In these cases, the use of negative pressure therapy and particularly the application of the dressing especially designed for that purpose, allows provisional closure of the abdominal cavity and access for subsequent exploration, while protecting intestinal contents, improving exudate management and allowing it to be measured, and preserving the incision margins in an optimum state for so that they can be subsequently brought together and closed with no fascia retraction.

In our series 3 patients belonged to this group. One of them developed compartment syndrome after percutaneous surgery of a ruptured abdominal aortic aneurysm, whereas the other 2 cases were deferred abdominal closures due to laparotomy dehiscences with associated evisceration and infections of both wounds.

In situations of emergency surgery in which it was not possible to perform a primary closure of the abdominal cavity, we changed the device used to obtain a temporary abdominal closure. Whereas before we used to routinely use the Bogota bag,<sup>5</sup> recently we have begun to use V.A.C. therapy, because although it is more expensive, it has the advantage of permitting management and measurement of exudates and it preserves the wound's skin margins.

Our results are comparable to those of other authors such as Robledo-Ogazón et al.<sup>6</sup> His series was larger than ours, containing 38 patients of which only one suffered a complication with an intestinal perforation and subsequent death. Similarly to our conclusions he did not attribute this mortality to V.A.C. therapy.

The V.A.C. system is an expensive therapy in comparison with conventional systems used for the treatment of wounds. However, several studies have provided scientific evidence that VAC therapy has clinical and economic advantages.<sup>1,7-10</sup> It is necessary to carry out an overall assessment and keep in mind that V.A.C. therapy makes wound management easier; the device is changed every 2-3 days, resulting in savings of nursing time and dressing material, and most importantly, a decrease in patient discomfort and acceleration of normal wound healing, with an accompanying decrease in hospital stay.<sup>1,2</sup>

## Conclusions

V.A.C. therapy can improve and accelerate healing of wounds even in the case of very contaminated wounds or wounds with fistulae.

The intra-abdominal V.A.C. device can be used for the treatment of open abdomen, making it possible to subsequently obtain definitive closure by leaving the fascia undamaged.

The cost of V.A.C. therapy has to be examined with caution, and it must be emphasised that the use of this therapy can reduce overall hospital stay in these patients, which also enters into final costs.

## Conflict of interest

The authors affirm that they have no conflicts of interest.

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