

MODIFIED VAC DRESSING IN STERNAL WOUND INFECTION MANAGEMENT. CHEAP AND FEASIBLE TECHNIQUE IN DEVELOPING COUNTRY

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ABSTRAK

Infeksi luka sternum adalah kasus yang jarang, namun dapat menimbulkan komplikasi yang serius pada pembedahan jantung. Pada kurun waktu terakhir, beberapa metode pengobatan telah diterapkan, dimana sistem VAC (vacuum assisted closure) menunjukkan hasil yang paling menjanjikan. Namun metode pengobatan dengan sistem VAC ini membutuhkan biaya yang mahal dan perlengkapan yang banyak serta kebutuhan listrik yang terus-menerus. Modifikasi sistem VAC ini yang digunakan untuk mengobati infeksi luka sternum didapatkan teknik yang murah dan layak untuk digunakan di negara yang berkembang. Teknik ini dapat digunakan sebagai alternatif dari sistem VAC dressing yang asli dan menunjukkan fungsi dalam memberikan tekanan negatif yang cukup untuk luka. (FMI 2016;52:225-230)

Kata kunci: infeksi luka sternum, modifikasi VAC dressing

ABSTRACT

Sternal wound infection is a rare but serious complication of cardiac surgery leading to prolonged hospital stay and higher mortality. In the last decades several treatment modalities have been described, of which vacuum-assisted closure (VAC) shows the most promising results. However, the VAC therapy system is expensive, requires extensive amounts of product and needs a power source at all times. Modified VAC dressing to treat sternal wound infection is cheap and feasible technique to use in develop country. This technique can be use as an alternative to the original vacuum-assisted closure and hadshown to serve its function in providing adequate vacuum pressure for wounds. (FMI 2016;52:225-230)

Keywords: sternal wound infection, modified VAC dressing

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INTRODUCTION

Deep sternal wound infections (DSWI), namely mediastinitis and osteomyelitis, are a serious complication occurring in 1% to 5% of patients after cardiothoracic operations in individual studies. Post-sternotomy mediastinitis is debilitating and often fatal, with high mortality rates of up to 30% (Roemer et al 2011). Intravenous antibiotics and several surgical techniques had been used in the past for their treatment; however, they have been associated with increased short and long-term mortality (Fleck et al 2006, Bovill et al 2008). It also implies a prolonged hospital stay and increased nursing care, it is also considered to have a substantial impact on the health care system economy (Christian et al 2013).

Before 1980, sternal debridement, mediastinal irrigation, and rewiring was the preferred approach, which was followed by a hype for coverage with autologous (omental or muscle) flaps. A decade ago, plate fixation came into play but remained poorly accepted. Recently,

negative pressure wound therapy, also termed vacuum therapy, was introduced as another treatment modality, especially in the case of deep sternal wound infection, and has gained widespread acceptance within a short period of time for its simplicity (Leopold & Christof 2013).

Sternal Wound Infection

Median sternotomy was reintroduced by Julian in 1957 after its initial description by Milton in 1897 and become the most common approach for cardiac surgery. Despite the use of sterile technique, perioperative antibiotics and careful wound management, surgical site infections resulting in mediastinitis still become a serious problem (Roemer et al 2011). Various risk factors have been related to the development of deep sternal wound complications.

Deep sternal complications involve not only skin and subcutaneous tissue but may also affect the bone. Infection of the sternal wires can also be present. With

regard to the specific surgical treatment, deep sternal complication can be discriminate as following pathologies: noninfected sternal instability, deep sternal wound

infection without sternal instability, and deep sternal wound infection with sternal instability (Leopold & Christof 2013).

Table 1. Risk factors for deep sternal wound complication (Singh et al 2011, Michael et al 2010)

Pre-Op	Intra-Op	Post-Op
BMI/Obesity	Longer operation time	IABP support
Coronary artery disease	Number of grafts	ICU stay > 2days
Diabetes insulin dependent	Redo surgery	More blood loss (repeat transfusion)
Low ejection fraction	Use of BIMA (bilateral internal mammary artery)	Re-exploration
Male gender	Excessive use of bone wax/diathermy	Prolonged ventilation
Mechanical ventilation		Renal failure
NYHA class		
Peripheral arterial disease		
COPD		
Steroid Therapy		
Previous mediastinal irradiation		



Fig. 1. Sternal Example of vacuum-assisted closure (VAC) therapy application in a sternal wound (Christian et al 2013, De Caridi et al 2014) CDC has been published definition of mediastinitis and osteomyelitis

Table 2. US Centers for Disease Control and Prevention definition of mediastinitis and osteomyelitis (Horan et al 2008)

<p>Mediastinitis must meet at least one of the following criteria:</p> <ul style="list-style-type: none"> (i) Patient has organisms cultured from mediastinal tissue or fluid obtained during a surgical operation or needle aspiration. (ii) Patient has evidence of mediastinitis seen during a surgical operation or histopathological examination. (iii) Patient has at least one of the following signs or symptoms with no other recognized cause: fever (>38°C), chest pain or sternal instability and at least one of the following: <ul style="list-style-type: none"> (a) Purulent discharge from mediastinal area. (b) Organisms cultured from blood or discharge from mediastinal area. (c) Mediastinal widening on X-ray. <p>Osteomyelitis must meet at least one of the following criteria:</p> <ul style="list-style-type: none"> (i) Patient has organisms cultured from bone. (ii) Patient has evidence of osteomyelitis on direct examination of the bone during a surgical operation or histopathological examination. (iii) Patient has at least two of the following signs or symptoms with no other recognized cause: fever (>38°C), localized swelling, tenderness, heat or drainage at suspected site of bone infection and at least one of the following: <ul style="list-style-type: none"> (a) Organisms cultured from blood. (b) Positive blood antigen test (e.g. Haemophilus influenzae, Streptococcus pneumoniae). (c) Radiographic evidence of infection (e.g. abnormal findings on X-ray, CT scan, MRI, radiolabel scan [gallium, technetium etc.]). <p>CT: computed tomography; MRI: magnetic resonance imaging</p>

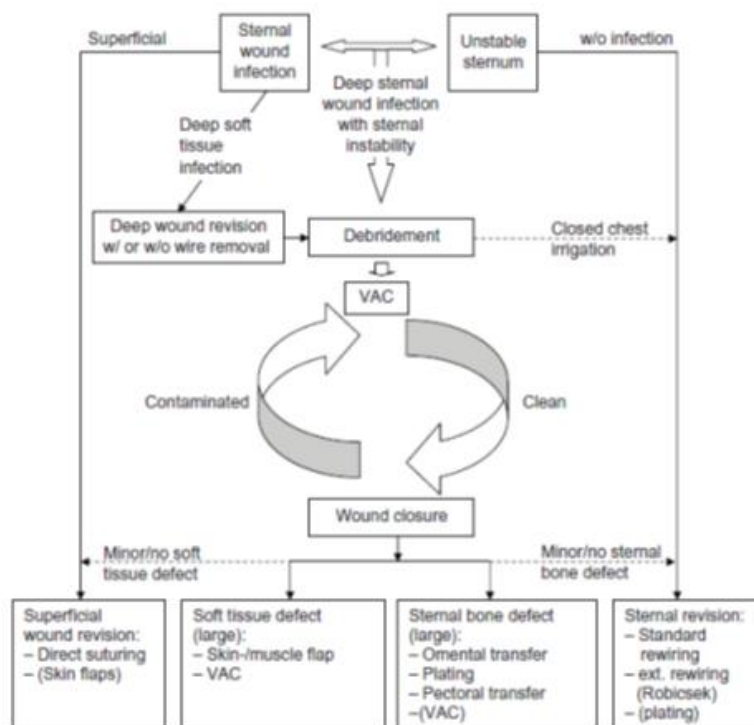


Fig. 2. Treatment algorithm (Leopold & Christof 2013)

Currently, the European and American cardiothoracic societies provide no guidelines for the treatment of deep sternal wound complications. Patients are treated in many different ways according to general surgery rules of infection and institutional experience. General recommendations for clear-cut and extreme conditions are simpler to suggest, whereas borderline or complex wound situations mandate a more individualized decision making (Fig. 3) (Leopold & Christof 2013).

Microbial swabs of the sternal wound found the majority of pathogens found in both deep and superficial sternal wound complications belonged to the normal skin flora, more often caused by coagulase-negative staphylococci (*S. epidermidis*) (Richard et al 2010). However, a number of more aggressive agents was also identified (Table 3).

Table 3. Pathogens identified in deep or superficial wound complications (Claudia et al 2013)

No.	Pathogens found in sterna wound infection
1	Coagulase-negative Staphylococci (<i>S. epidermidis</i> , <i>warneri</i> , <i>capitis</i> , <i>hominis</i> , <i>micrococcus luteus</i>)
2	Enterobacteriaceae (klebsiellae, <i>P. aerogenes</i> , <i>serratia</i> , <i>E. coli</i>)
3	<i>Staphylococcus aureus</i> (MRSA)
4	<i>Enterococcus faecalis</i>
5	<i>Candida</i> species
6	<i>Corynebacterium amycolatum</i>

Vacuum-assisted Closure Therapy (VAC therapy)

VAC therapy is a therapeutic method using a special sponge or gauze dressing with a vacuum device to promote wound healing. Negative pressure (sub atmospheric pressure from 75-150 mmHg) is applied to the wound through a special sealed dressing in a continuous or intermittent manner. This novel technology was introduced for medical practices since it was introduced by Morykwas et al (1997) which was based on the work of Fleischmann (1995) (Argenta et al 1997, Morykwas et al 1997, Chiummariello et al 2012).

The VAC therapy has a complementary function and the range of its indications includes pressure sores, stasis ulcers, chronic wounds such as diabetic foot ulcers, post traumatic and post operative wounds, infected wounds such as necrotizing fasciitis or sternal wounds, soft-tissue injuries, bone exposed injuries, abdominal open wounds and for securing a skin graft (Chiummariello et al 2012).

VAC uses medical grade components consist of cell polyurethane ether foam as a dressing (pore size is generally 400–600 mm). This foam is cut to fit and closely applied to the selected wounds. An evacuation tube with side ports, which communicate with the reticulated foam, is embedded in it. The aim of the reticulation being that the negative pressure will be

applied equally to the entire wound bed. An adhesive drape is then applied over the area with an additional 3–5 cm border of intact skin to provide an intact seal (Lambert et al 2005).

In 1998 Schneider et al. and Blackburn et al. described the use of the vacuum-assisted closure (VAC®) device negative pressure dressing (KCI, San Antonio, TX, USA) for stabilizing skin grafts by immobilizing themselves, limiting shear stresses, eliminating fluid collections and decreasing bacterial contamination: it led to a graft successful rate greater than 95% (Morykwas et al 2001).



Fig. 4. KCI's proprietary Vacuum Assisted Closure®, or V.A.C.® Therapy System (Lambert et al 2005)

In last decade vacuum-assisted closure (VAC) wound therapy system, has gradually gained ground and replaced most of the conventional types of wound treatment due to the faster wound healing, lower length of hospital stay and the subsequent lower in-hospital cost. Moreover, early studies showed that VAC therapy has the potential to reduce both in-hospital and long-term mortality (Matthew et al 2013).

The scientific understanding of the mechanisms of action of negative pressure wound treatment (NPWT) on open wound has grown steadily, some mechanisms are: Wound drainage: reduction of exudate, increased tissue perfusion the peristernal soft and muscular tissue (maximal efficacy between -75 and 100 mmHg), traction and superficial hypoperfusion induced by negative-pressure stimulate sprouting angiogenesis (via vascular endothelial growth factor gradient) and that cell stretching leads to differentiation (via transforming growth factor-1 expression) of myofibroblasts, known to positively increase neovascularization, extracellular matrix deposition and wound contraction; reduce lateral tension and bring the wound edges together, promoted granulation tissue formation by increasing wound fluid

partial pressure of oxygen and lactate levels; reduction of edema; reduce in hematoma and seroma; increasing the delivery of nutritive substances and assisting with the removal of purulent and non-viable material reduce bioburden (Karlakki et al 2013); and reduce bacterial biofilm production (invitro) (MV S 2012, Vincenzo et al 2014).

Although VAC therapy known have many benefits, some complications found like bleeding from a venous bypass graft during dressing changes, right ventricular rupture, painful, toxic shock syndrome, fluid depletion (Lambert et al 2005, Rainer et al 2010). The use of a wound dressing, such as paraffin gauze, in order to protect the RV from direct contact with the polyurethane foam has been recommended (Johan et al 2011).

Considering the VAC and traditional dressings in terms of cost, one might suppose a greater cost for treatment would be attached to the VAC. A certain cost is attached to the purchase or hire of a VAC unit but a published analysis reported that overall, cost of VAC treatment is lower (Lambert et al 2005). Shorter treatment times and fewer additional interventions helping to reduce the cost. Philbeck Jr et al. reviewed the case notes of 1032 patients with chronic wounds treated in the community with the VAC after failing to respond to conventional dressings. They reviewed the time taken to heal as well as analysed costs. The results were compared with published reports of costs of treating same types of wounds with conventional dressings. The average wound in the VAC treated patients took 97 days and \$14,546 to heal. The average wound of the same type treated conventionally took 247 days and \$23,465 to heal (Philbeck et al 1999).

Modified VAC Therapy Systems

However, the VAC Therapy system has its disadvantages. It is expensive and requires extensive amounts of product and machinery, as well as functioning suction, and a power source at all times. In addition, the VAC Therapy system requires a trained and vigilant nursing staff. To overcome those problems, the idea to invent a modification of VAC system with simple, accessible, save, massively produced and cheap materials took place. The modification aimed to reach the same benefits as the original one. In some countries the VAC systems modification were conducted by using accessible materials in each country as well using the device for different kinds of wound. The use of this simplest modified VAC (smVAC) has been proved as effective as original one (Danu & Rosadi 2012).



Fig. 5. The simplest vacuum assisted closure (smVAC) (Danu & Rosadi 2012)

Table 4. Specification of smVAC (Danu & Rosadi 2012)

Specification	Alternative	
Negative Pressure Supply Unit	Canister	Disposable Syringe 50 ml with three way infusion set 100 cc closed rubber-sealed vacuum bottle
Disposable unit	Dressing	Sterile gauge Grass tulle Transparant Adhesive-Occlusive Dressing (tegaderm®, opsite®)
	Tubing	Otsuka blood transfusion set (elastic ball type)

CONCLUSION

VAC therapy is a safe and cost-effective method of treating complex sternal and thoracic wounds in patients undergoing cardiothoracic surgery. VAC therapy promotes faster wound healing, with shorter hospital stay and subsequent lower in-hospital cost, reducing the mortality rate in the long term. The benefits of modified VAC is that it is cheaper and can be constructed using simple clinical devices. This device can be used as an alternative device.

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