Vacuum assisted closure therapy for the diabetic foot

Sylvie Hampton

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1 Diabetic foot wounds present a great challenge to wound care.

2 VAC therapy is designed to promote faster formation of granulation tissue.

3 VAC therapy uses controlled suction to provide evacuation of wound fluid and bacteria.

4 Mobilisation of the patient is possible with the ambulatory VAC therapy.

5 Diabetic foot ulcers are prone to clinical infection and the removal of bacteria will reduce the potential for this to occur.

KEY WORDS

- **Diabetic foot wounds**
- **Vacuum assisted closure**
- **Dressings**
- **Wound management**
- **Healing**

Sylvie Hampton, Tissue Viability Nurse, Eastbourne

Introduction

Optimal treatment for large diabetic foot wounds is ill defined. Eginton et al (2003) found that vacuum assisted closure (VAC) dressings were associated with a decrease in all wound dimensions while wound length and width increased with moist dressings. VAC is an adjunctive therapy that uses negative pressure to remove fluid from open wounds through a sealed dressing and tubing which is connected to a collection container (Sibbald and Mahoney, 2003). VAC therapy is a simple dressing to use and, if healing rates are increased, there is a compelling argument for its use in treating the diabetic foot.

Diabetic foot wounds present a great challenge to wound care practitioners (McCallon et al, 2000) because these ulcers have a multifactorial aetiology, with polyneuropathy, biomechanical stress, infection, deficient footwear (and ischaemia) as the major factors (Bakker and Schaper, 2000). The principal treatments for diabetic ulcers are relief of pressure, restoration of skin perfusion, treatment of infection, intensive wound care, metabolic control, treatment of comorbidity and education of the patient. Nevertheless, wound healing is slow (Bakker and Schaper, 2000).

A warm, moist and clean environment must be maintained to enhance wound healing. Success in these efforts not only preserves quality of life for patients with diabetes but is also cost-effective for the healthcare system (Muha, 1999). Therefore, it is vital for new methods of treatment to be investigated to ensure the highest quality and most cost-effective method of care is always provided. One such treatment that is worthy of investigation is vacuum assisted closure (VAC) therapy.

What is VAC therapy?

VAC therapy is designed to promote the formation of granulation tissue for faster healing in the wound beds of patients with acute and chronic wounds (Fisher and Brady, 2003). VAC therapy greatly reduces tissue oedema, diminishes the circumference of the extremity and decreases the surface area of the wound with profuse granulation tissue forming and rapidly covering bone (DeFranzo et al, 2001).

VAC therapy uses controlled suction to provide evacuation of wound fluid, decrease bacterial colonisation, stimulate granulation tissue and reduce the need for dressing changes (Domkowski et al, 2003). VAC therapy is widely accepted for the treatment of non-infected non-ischaemic diabetic foot wounds (Espensen et al, 2002). Basic studies have shown beneficial effects on wound blood flow and proliferation of healing granulation tissue when VAC therapy is used. However, the concept of VAC therapy is easily explained.

VAC therapy explained

Vacuum assisted wound closure (VAC) is a wound management technique that exposes the wound bed to negative pressure by way of a closed system. Oedema fluid is removed from the extravascular space (*Figure 1*), thus eliminating an extrinsic cause of microcirculatory embarrassment and improving blood supply during the phase of inflammation. In addition, the mechanical tension from the vacuum may directly stimulate cellular proliferation of reparative granulation tissue (Webb, 2002). The vacuum exerts a mechanical

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1 VAC therapy acts by removal of excess tissue fluid from the extravascular space, which lowers capillary after-load and thereby promotes the microcirculation.

2 The dressings are made of sterile open-cell foam, which is cut to size and placed into or onto the wound bed. The wound site is then covered with an adhesive plastic sheet.

3 The practitioner makes a small hole in the centre of the plastic sheet and the tubing is connected to the sheet, over the hole, by a small plastic dressing.

4 The further end of the tubing is then connected to the VAC pump. Continuous or intermittent subatmospheric suction pressure of approximately 125 mmHg is then applied to the wound site.

force on the tissues and attracts the wound edges centripetally (Voinchet and Magalon, 1996), and is a closed system, which applies negative pressure to the wound tissues (Webb and Schmidt, 2001).

Theoretically, VAC therapy acts by removal of excess tissue fluid from the extravascular space, which lowers capillary after-load and thereby promotes the microcirculation. Additionally, the mechanical effect of the vacuum on the tissue at the wound surface appears to result in an exuberant proliferation of healing granulation tissue (Webb and Schmidt, 2001).

The VAC system

The dressings are made of sterile open-cell foam (*Figure 2*), which is cut to size and placed into or onto the wound bed. The wound site is then covered with an adhesive plastic sheet (*Figure 3*). The practitioner makes a small hole in the centre of the plastic sheet and the tubing is connected to the sheet, over the hole, by a small plastic dressing (*Figure 3*). The further end of the tubing is then connected to the VAC pump. Continuous or intermittent subatmospheric suction pressure of approximately 125 mmHg is then applied to the wound site (DeFranzo et al, 2001); although this is adapted according to the individual's needs. Special dressing drapes can be obtained for difficult areas (such as the foot) and new adhesive strips also assist with maintaining an airtight seal.

Mobilisation during VAC therapy

The Mini-VAC is a small battery controlled system that allows the patient to continue mobilising during therapy. However, it is a small system and cannot be used when large amounts of fluid are likely to be lost. Nevertheless, it is an ideal system for patients with smaller, diabetic wounds on the feet.

Both the large VAC and the smaller ambulatory system can be disconnected for short periods to allow the patient time to shower or bathe.

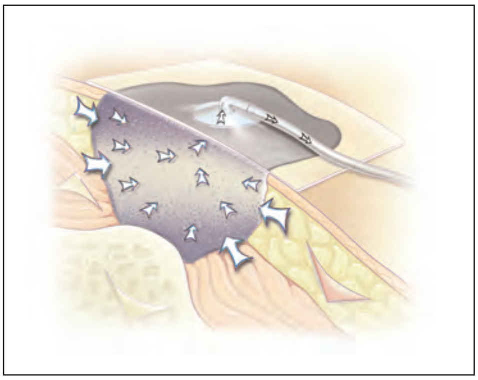

Figure 1. Fluid is removed from the wound bed through suction

Figure 2. VAC machine and the sponge dressing

Clinical efficacy

To assess the quality of evidence, a Medline search was conducted from 1997 to 2003 for articles relating to diabetic foot ulcers treated with VAC therapy. Only three papers were found on the subject:

- Fourteen of 17 (82%) wounds successfully healed; four underwent split-thickness skin grafting for wound closure (Clare et al, 2002).
- Armstrong et al (2002) found that 90.3% of patients treated with VAC therapy, healed (without the need for further bony resection) in a mean 5.5 weeks. The remaining 9.7% went on to require higher level amputation (below knee amputation = 3.2%).
- Satisfactory healing in the VAC group was achieved in 22.8 (±17.4) days compared with 42.8 (± 32.5) days in the control group (McCallon et al, 2000).

There have been many papers on the clinical efficacy of VAC therapy in various other types of wounds. Ford et al (2002)

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1 The VAC negative pressure technique is emerging as an acceptable option for wound care of the lower extremity, although not all patients are candidates for such treatment, and those patients with severe peripheral vascular disease or smaller forefoot wounds may be best treated by other modalities.

2 The technique is contraindicated in patients with thin, easily bruised or abraded skin, those with neoplasm as part of the wound floor and those with allergic reactions to any of the components that contact the skin.

3 The mainstay of wound care remains debridement. Vacuum assisted wound closure is not a substitute for this (Webb and Schmidt, 2001) probably because rehydration of necrotic tissue requires moisture and the VAC system removes moisture from the wound. This could potentially dry necrotic eschar even further.

4 Wounds of the lower extremity can occur in multiple sites, posing the problem of providing a vacuum dressing to more than one wound from one suction pump machine.

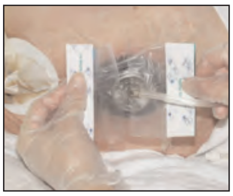

Figure 3. The adhesive film and connection of the tube

Figure 4. Degloving injury in the diabetic foot

showed that the mean number of capillaries per high-power field was greater in the VAC group ($p = 0.75$). There were 15 cases of biopsy-proven osteomyelitis underlying the ulcers; three (37.5%) improved with VAC and none improved with the hydrogel which was used as a control dressing ($p= 0.25$). VAC promoted an increased rate of wound healing and favourable histological changes in soft tissue and bone compared with the hydrogel (Ford et al, 2002).

Complications with VAC therapy are uncommon (Fisher and Brady, 2003) and clinical experience with the technique has resulted in a low incidence of minor reversible irritation to surrounding skin and no major complications (Webb, 2002).

Contraindications

The VAC negative pressure technique is emerging as an acceptable option for wound care of the lower extremity, although not all patients are candidates for such treatment and those patients with severe peripheral vascular disease or smaller forefoot wounds may be best treated by other modalities (Clare et al, 2002). The technique is contraindicated in patients with thin, easily bruised or abraded skin, those with neoplasm as part of the wound floor and those with allergic reactions to any of the components that contact the skin (Webb, 2002). The manufacturers recommend avoiding VAC therapy in patients with active bleeding in their wounds and patients on anticoagulation.

In addition to neuropathy, ischaemia is a major factor contributing to the progress and morbidity of the disease (Khammash and Obeidat, 2003). The mainstay of wound care remains debridement. VAC therapy is not a substitute for this (Webb and Schmidt, 2001) probably because rehydration of necrotic tissue requires moisture and the VAC system removes moisture from the wound. This could potentially dry necrotic eschar even further.

The main limitation to applying VAC occurs when attempting to maintain an airtight seal over irregular surfaces surrounding a wound (Greer et al, 1999). Nevertheless, the new technique of applying the film, the adhesive strips and the new shaped film drapes all remove this limitation, making it easily applied.

Wounds of the lower extremity can occur in multiple sites, posing the problem of providing a vacuum dressing to more than one wound from one suction pump machine (Greer et al, 1999). This is also easily overcome through the use of 'Y' tubes that permit several sites to be treated with the same machine, and the linking or 'bridging' of sponges between wound sites, which allow several wounds to be treated simultaneously.

Degloving injuries and skin grafts

Degloving injuries (*Figure 4*) range from the easily missed injury to obvious massive tissue damage. The serious nature of these wounds is exacerbated by mismanagement (Meara et al, 1999). It is generally accepted that the degloved tissue should be excised, defatted, fenestrated, and reapplied as a full-thickness skin graft with dressings that provide gentle, evenly distributed pressure and avoid shear stress to the newly grafted skin. Numerous types of dressings have been devised but all are cumbersome and time-consuming and (often after 72 h), a skin graft covered with a bolstered dressing has poor take

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1 Serious infection or severe ischaemia, unfortunately, often necessitates amputation, and failure to control diabetic foot ulcers at an early stage can lead to life-threatening infection or amputation.

2 VAC therapy facilitates rapid granulation of wounds and reduces bacterial colonisation rates.

3 VAC therapy has proven cost-efficient, safe and effective as a treatment modality in wound care (Kaufman and Pahl, 2003).

4 Appropriate use of this therapy achieves a rapid granular bed in diabetic foot wounds and demonstrates promise in treatment of this population at high risk for amputation (Armstrong et al, 2002).

secondary to shear stresses, as well as hematoma formation or serum collection, negating the effectiveness of the stabilising dressing (Blackburn et al, 1998; Sposato et al, 2001). VAC therapy offers a rapid, effective and easy-to-use alternative to traditional methods (Meara et al, 1999) and is extremely efficacious, with increased graft-take due to total immobilisation of the graft, thereby limiting shear forces, elimination of fluid collections, bridging of the graft and decreased bacterial contamination (Blackburn et al, 1998). VAC therapy provides a safe and effective method for securing skin grafts and is associated with improved graft survival as measured by a reduction in number of repeated grafts (Scherer et al, 2002).

Pain

Pain is uncommon in diabetic foot disorders, but it may herald the onset of limb-threatening complications, such as deep infection (Sibbald et al, 2003). Neuropathy is most commonly painless (Sibbald et al, 2003), but a third of patients experience disturbing burning, stinging, stabbing, or shooting sensations.

For patients who do experience pain using VAC devices, the aetiology and management of wound pain can be complex. Strategies that include local wound management to reduce all types of pain and holistic psychological care to reduce the ache and anguish that may accompany dressing change procedures may help provide comfort and reduce pain and suffering (Krasner, 2002).

Infection

Serious infection or severe ischaemia, unfortunately, often necessitates amputation, and failure to control diabetic foot ulcers at an early stage can lead to life-threatening infection or amputation (Birrer et al, 1996). Diabetic foot complications are actually the largest non-traumatic cause of lower extremity amputations, accounting for almost 1.3% of patients with diabetes requiring amputations per year. Most of these complications are the result of infections caused by ulcerations of the foot that are not recognised or treated in an appropriate and timely fashion (Khammash and Obeidat, 2003).

Infected wounds and subsequent treatment varies according to the location of the wound and wound size (Wongworawat et al, 2003) that makes VAC therapy, which is consistent in treatment and can be cut to an exact size, an optimum treatment for the infected wound. This method seems to enhance the rapidity of wound reduction, and because it is a closed system of treatment, it has the added benefit of minimising exposure of staff and other patients to communicable diseases. VAC systems add another option in the care of musculoskeletal infections (Wongworawat et al, 2003).

VAC therapy facilitates rapid granulation of wounds and reduces bacterial colonisation rates. This method was adopted by Ballard and McGregor (2001) as a suitable therapy for treatment of patients who had complex diabetic wounds with a high-risk of infection or reinfection.

Conclusion

The management of chronic, non-healing, draining wounds remains challenging for the wound care nurse and other healthcare providers involved in skin integrity care. VAC therapy is cost-efficient, safe and effective as an alternative treatment modality in wound care (Kaufman and Pahl, 2003). Appropriate use of this therapy provides an optimum healing environment in diabetic foot wounds and provides a treatment option for this population at high risk for amputation (Armstrong et al, 2002). ■

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> 'The management of chronic, non-healing, draining wounds remains challenging for the wound care nurse and other healthcare providers involved in skin integrity care. VAC therapy is cost-efficient, safe and effective as an alternative treatment modality in wound care.'

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