A practical guide for using VAC therapy on post-operative diabetic foot wounds

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Article points

1. Increasing evidence is emerging for the use of vacuum-assisted closure (VAC) therapy in post-operative diabetic foot wounds.
2. Success of therapy is dependent on the management of intrinsic and extrinsic factors such as underlying diabetes, peripheral ischaemia, infection and pressure offloading.
3. VAC therapy is generally started in hospital and can be continued in the community once the individual is medically stable and the wound is showing steady progress.

Key words

- Vacuum-assisted closure
- Topical negative pressure therapy
- Post-operative wounds

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Increasing evidence is emerging in the use of topical negative pressure therapy for the effective management of post-operative diabetic foot wounds to achieve faster wound closure and reduce the incidence of post-op wound complications (Andros et al, 2006). This article aims to share the clinical observations and experience of 5 years of continuous vacuum-assisted closure therapy use on post-operative diabetic foot wounds in a London teaching hospital.

Topical negative pressure (TNP) therapy has emerged in recent years as a popular and effective adjunctive treatment for a variety of wound types (Banwell and Musgrave, 2004). The principle of the technique is based upon a vacuum or regulated suction force applied uniformly across the wound surface within a sealed occlusive polyurethane foam dressing – called vacuum-assisted closure (VAC) therapy. This airtight dressing is connected to a disposable canister (to collect material from the wound) within the VAC therapy unit via a therapeutic pad and detachable tubing system.

In theory, the application of controlled TNP to a wound will assist to achieve the faster development of granulation tissue leading to wound contracture and a reduction in wound volume via the following mechanisms:

- Removing excess interstitial fluid and allowing tissue decompression.
- Removing infectious materials.
- Encouraging mechanical stretching and approximation of wound edges.
- Providing a closed, moist healing environment.
- Promoting graft survival and graft uptake.

A full understanding of the mechanisms of VAC at a microscopic level is currently unknown, but it has been postulated that it aids the stimulation of angiogenesis and improves local blood flow within the wound bed (Andros et al, 2006). Morykwas et al (1997) suggested that the accelerated rate of granulation tissue formation is secondary to transmission of applied forces to tissues at the periphery of the wound and the mechanical deformation of cells.

There are an increasing number of studies that suggest the use of VAC therapy on diabetic foot wounds produces favourable outcomes. However, most of these are small uncontrolled studies with small sample sizes and some use saline moistened gauze, which is generally considered an outdated wound treatment. Nonetheless, all report faster healing rates and fewer complications for wounds treated with VAC. In addition to this, consensus conferences have been held involving key opinion leaders with multidisciplinary diabetic foot experience, resulting in the publication of guidelines (Armstrong et al, 2004; Andros et al; 2006).

Although VAC therapy can be used on a diabetic foot wound of any size and location the available evidence indicates it to be particularly effective on large, complex post-operative diabetic foot wounds.

Little evidence exists reporting its efficacy on chronic indolent diabetic foot ulcers which have not undergone surgical intervention. It is the author's opinion and experience that the use of VAC therapy for chronic diabetic foot ulcers would serve only to help 'kick start' a static lesion when used for a short period, such as 1–3 weeks.

When used correctly, VAC therapy is very useful in speeding up the granulation process and reducing wound volume in post-operative diabetic foot wounds (Page et al, 2004). It is the authors' experience that it can be used effectively on varying sizes of post-operative wounds from a minor toe amputation to a large soft tissue surgical debridement, as well as on well perfused neuropathic wounds, revascularised ischaemic wounds and over exposed bone and tendon. It may also be used with caution on infected wounds (Andros et al, 2006; De Franzo et al, 2001).

Precise application and maintaining an airtight seal is paramount to achieve desired outcomes. Some types of diabetic foot TNP dressings can be tricky to apply due to the numerous contours and web spaces so successful application requires trained and experienced personnel. Success of therapy is also dependent on the additional management of underlying diabetes, peripheral ischaemia, infection and pressure offloading.

The following guide on using VAC therapy for the management of post-operative diabetic foot wounds is intended to impart knowledge and clinical experience on aspects of its use which are not generally found in the literature. A full 'step by step' guide is beyond the scope of this article, but is available from KCI Medical (Kidlington).

Table 1. Contraindications for TNP therapy.

TNP therapy should not be used in the presence of the following conditions:

- Malignancy in the wound.
- Untreated osteomyelitis.
- Necrotic tissue with eschar.
- Exposed organs and blood vessels.

Table 2. Situations requiring caution when using TNP therapy on diabetic foot wounds.

TNP therapy should be used with caution in the presence of the following:

- Infection or cellulitis.
- Anticoagulation therapy.
- Poor patient treatment adherence.
- Critical or non-reconstructable vascular disease.
- Severe small vessel disease.
- Heavy colonisation with antibiotic resistant micro-organisms.

Which patient? Which wound?

TNP therapy will be suitable for the majority of post-operative diabetic foot wounds (see *Tables 1* and *2*). Therapy is generally started in hospital and consensus guidelines recommend that it is applied approximately 24 hours after surgery when complete haemostasis has been achieved (Andros et al, 2006). VAC should be used with caution in individuals treated with anticoagulation therapy. Occasionally it may be advisable to wait several days after the operation before commencing treatment, during which time the canister used to collect any material removed from the wound will need to be monitored carefully by a healthcare professional for the presence of a constant trickle of fresh blood. For the patient with renal failure it may also be advisable under certain circumstances to wait up to 12 hours following haemodialysis before applying a VAC dressing.

The individual with the wound should fully understand the commitment to treatment required from them and agree to adhere to the periods of restricted ambulation. It is generally advisable to avoid using VAC therapy on individuals with a poor history of concordance to treatment unless in a supervised hospital ward environment. VAC therapy may be used on immobile individuals with dementia in a supervised setting.

It is possible to manage VAC therapy in a community setting once the individual has been discharged home. This generally occurs once the individual is medically stable and the wound is showing steady progress on VAC therapy.

Prior to discharge, the person undergoing the therapy must be carefully assessed to establish their suitability for home therapy (see KCI document on VAC therapy in the community). For example, a person living with severe peripheral neuropathy may have sensory loss and muscle wasting in their hands which would render them unable to clamp and disconnect the tubing. Similarly, people with advanced retinopathy may be unable to see and operate the control screen. The individual or their carer must be able to remove the VAC dressing and apply a normal dressing within 2 hours if a problem should occur with the therapy system.

When considering an individual's suitability for home VAC therapy it is important to liaise closely with community nurses and podiatrists to establish skill level and training needs. Where additional training is necessary, community colleagues may be invited onto the wards for demonstration and education prior to patient discharge. Additionally, it is possible to arrange for education specialists from the dressing's manufacturer to visit patients' homes to provide training to them and the community staff.

The neuro-ischaemic foot

It is generally preferred that the ischaemic diabetic foot ulcer is revascularised prior to surgical debridement and the application of VAC therapy (Clare et al, 2002; Andros et al, 2005). However for those wounds where this is not possible, but which have a transcutaneous oxygen tension >10 mmHg, VAC therapy may still be used. Favourable healing outcomes have been observed in these wound types under carefully monitored conditions (such as in hospital with dressing changes after 1–3 days). In the presence of post-operative tissue die-back, the clinician should ideally wait until this process has halted and any necrotic tissue has been sharp debrided back to viable tissue, as much as possible, before commencing VAC therapy. VAC therapy should also be used with caution in the

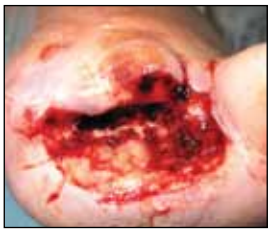

Figure 1a. A post-operative wound prior to application of TNP in an individual with diabetes and systemic lupus erythematosus.

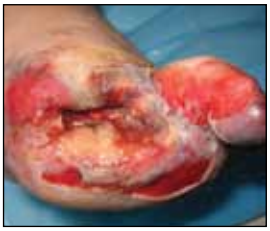

Figure 1b. Infection of the same wound 48 hours after TNP therapy.

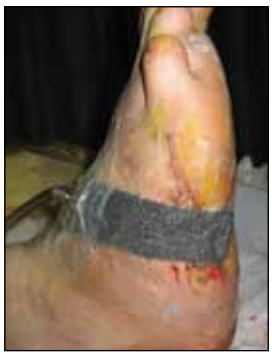

Figure 2. Tubing system tracked away from a plantar wound to avoid focal point of pressure.

Figure 3. Suction pad positioned adjacent to the wound to avoid exerting pressure on peri-ulcer skin.

presence of severe small vessel disease such as systemic lupus and some end stage renal dialysis patients. It has been observed that these groups of individuals are more susceptible to developing infection beneath the occlusive VAC dressing such that it rarely succeeds to improve wound bed perfusion (*Figure 1*). The heavy colonisation of resistant Gram-negative organisms, such those within the *Klebsiella* species and *Acinetobacter* genus, have been observed to favour the wound conditions created beneath the VAC dressing on these wound types. Even in the absence of clinical infection they have proved very difficult to eradicate and may further contribute to impaired wound healing.

It is not advisable to use VAC therapy on the critically ischaemic wound with little to no healing potential (transcutaneous oxygen tension <10mmHg). The presence of devitalised tissue within these wounds and the lack of subcutaneous tissue perfusion will prevent the VAC from achieving the above functions and usually serves to aid further deterioration of the wound by promoting infection. Therefore, some people with severe non-reconstructable vascular disease are best treated with other modalities (Clare et al, 2002).

Wound and skin preparation

Before application of VAC, any peri-wound callus should be completely debrided. All necrotic and sloughy tissue within the wound should also be debrided as much as possible. If a thin layer of necrotic tissue remains within the wound post debridement, VAC therapy may still be commenced. The effect of negative pressure will help to loosen up the necrosis over a short period of time and facilitate further sharp debridement at a later stage. The podiatrist skilled in wound debridement is in an ideal position to perform this during dressing changes. It is important that any haemorrhage which may have occurred during the debridement process is completely arrested prior to application of VAC therapy.

The peri-wound skin should be examined for signs of excoriation, maceration and acute cellulitis. If any of these are present in the diabetic foot wound it is advisable to treat and allow full recovery before applying the occlusive drape. In individuals whose skin has a high moisture level the use of a liquid barrier will further aid adhesion of the occlusive drape.

Dressing application

In the author's opinion, with skill and experience it is possible to use VAC therapy on a diabetic foot wound of any size and location. If the wound is located on the plantar aspect or borders of the foot, it is necessary to track the tubing away from the wound as it will act as a focal point of pressure during ambulation (*Figure 2*). Where wounds are smaller than the actual size of the suction pad it is also necessary to place the tubing system onto an additional piece of sponge adjacent to the wound in order to avoid applying undue pressure to the peri-ulcer skin (*Figure 3*). Where two or more wounds are present in close proximity it is possible to use a bridging technique to apply VAC across both wounds (*Figure 4*). It is necessary to protect the delicate peri-wound skin with additional drape, especially if the wound is small, to avoid skin damage from any sponge overlap (*Figure 5*).

Achieving and maintaining an airtight seal

Achieving a lasting airtight seal around contours and web spaces can be difficult. In the author's experience, success is more likely if the drape is cut into strips of varying sizes and applied in a parallel fashion, overlapping each by 2–3cm. It may also be necessary to apply some thin strips interdigitally when dressing a wound located near the toes.

Once the dressing is established and the desired negative pressure has been achieved, precautions should be taken to maintain it during weight bearing. The dressing seal should be protected from the effects of friction during weight bearing by the application of a dressing pad directly on top of it, held in place by a cotton wool bandage (*Figure 6*). The tubing should be positioned on top of the bandage so as not to apply pressure to the skin. It is also useful to attach the tubing further up the leg with a surgical tape. This will help to prevent the suction pad being pulled away from the dressing by any sudden pulling.

A negative pressure setting of 125mmHg of continuous therapy is, in the author's experience, preferable in the diabetic foot. Intermittent therapy during ambulation can contribute to loss of the airtight seal as wound exudate can be forced beneath the seal under pressure. Intermittent therapy can also cause maceration of the peri-ulcer skin on diabetic foot wounds (*Figure 7*).

Occasionally a micro leak may occur in the seal. It may be too small to activate the unit alarm but can contribute to skin maceration. This should be suspected if the suction unit is unusually loud and is struggling to achieve the desired level of negative pressure.

Offloading during therapy

It is essential to provide the individual with an offloading device to protect the wound and dressing during ambulation, where ambulation is permitted. For dorsal wounds and minor toe amputations in people with reduced mobility, a simple surgical shoe is usually

Figure 4a. Two deep wounds situated in close proximity.

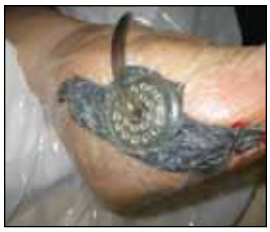

Figure 4b. Wounds bridged together using additional sponge.

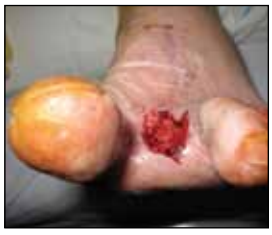

Figure 5. VAC drape applied to peri-ulcer skin around small wound to avoid skin damage.

Figure 6. Protection of the TNP dressing during ambulation.

adequate to protect the foot during mobilisation. For marginal wounds or ray amputations the traditional scotch cast boot can be effective. For larger plantar wounds a bi-valved total contact cast or aircast boot is usually required to achieve pressure relief. Special care should be taken to ensure that the leg is protected against the pressure produced by the tubing system when the cast is in place.

When to stop therapy

The 2006 consensus statement on VAC therapy for diabetic foot wounds (Andros et al, 2006) advises that in most cases VAC therapy should be used to achieve a healthy granular bed prior to consideration of other modalities or surgical procedures. For deep cavity wounds VAC therapy should ideally be continued until granulation has reached skin level. However, as with most acute wound therapy modalities, there will come a point during therapy when wound progress significantly slows down or becomes static (usually after 4–8 weeks). When this happens, cessation of therapy should be considered as VAC therapy will no longer be cost effective. It has also been observed by the author that on several occasions of prolonged VAC therapy use (>8 weeks) there is persistent colonisation of antibiotic resistant micro-organisms.

To reduce the risk of healing becoming static it is sometimes useful to have a therapy break every 5–7 days for up to 24 hours. This is also advisable if the peri-ulcer skin has become macerated or excoriated over a period of time. A break from therapy and the application of a silver dressing can also help if the wound becomes colonised during treatment. Allowing the person with the wound a break from therapy in general is advisable on occasion and usually contributes to improved adherence.

If the person who is undergoing VAC therapy is proving to be incompliant, then treatment should be stopped. This usually occurs in the form of excessive walking or spending extended periods detached from the unit. Both of these can contribute to the development of infection and general deterioration of the wound.

If a new wound started on VAC therapy does not respond to treatment within 7–14 days then therapy should be stopped (Andros et al, 2006).

Concluding remarks

VAC therapy is emerging as a useful and effective means of managing post-operative diabetic foot wounds (Armstrong, 2005). Currently, there is no evidence supporting its use in nonpostoperative wounds. In the author's experience, when used precisely and appropriately it can also assist in reducing hospital length of stay by allowing individuals with larger post-operative wounds to be discharged home earlier than previously possible. This can result in significant savings on bed days for secondary care trusts. However, VAC therapy it is not suitable for all wounds and patients. Some individuals find the restrictions imposed by the VAC unit difficult to tolerate, resulting in poor concordance. Funding for hire of the portable freedom units has proved difficult for some hospital care groups and PCTs. Although studies exist which indicate therapy to be cost effective in the majority of cases (Philbeck et al, 1999, Moues et al, 2005), initial costs for dressing and canister purchase and unit hire or purchase are high. It appears that many managers are focusing on these costs alone without taking into consideration the reduction in overall healing time, nursing imput and hospitalisations and are consequently failing to provide funding (European Wound Management Association, 2007). This has produced postcode inequalities of care, especially within PCTs.

To date, KCI Medical (Kidlington) holds the manufacturing rights to TNP therapy technology (in the form of the VAC advanced system for wound healing unit) as well as the patents for its accessories. However, new products are emerging such as the Exsudex wound drainage system (Synergy Healthcare, Derby) which provides regulated TNP at approximately 30% less cost than VAC therapy. This system uses Kerlix AMD dressings (a type of gauze), which is manually moulded into the wound. However, this product is relatively new and to-date no robust evidence exists to support its efficacy as an alternative to VAC therapy. ■

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