Clinical challenges of using ambulatory VAC therapy in diabetic foot ulcer treatment

Abstract

Wound management continues to present a major health challenge throughout the world. In an attempt to meet the demanding difficulties encountered in the management of chronic ulcers, clinicians often seek the intervention of technology and evidence-based methods for assistance. Advanced wound technology has conveyed a series of benefits in wound care, and whilst these advancements have been appreciated, it is equally important to emphasise that such technology has introduced some new challenges for clinicians. The purpose of this paper was to highlight the practical and clinical challenges encountered by the authors when using ambulatory vacuum assisted closure therapy in the management of diabetic foot ulceration.

Introduction

Vacuum assisted closure (VAC) therapy as an adjunct to wound management has been documented since its inception thirteen years ago (KCI, Inc, San Antonio, Texas, USA). VAC therapy is also referred to as negative pressure wound therapy (NPWT), or topical negative pressure (TNP), or as sub-atmospheric pressure dressing (SPD). It is a system involving controlled application of sub-atmospheric pressure to a wound using intermittent or continuous negative pressure to assist in the promotion of wound healing.

Claims of successful therapy with VAC have been emphasised in acute surgical wounds such as abdominal wounds,1 partial-thickness burns,2 traumatic wounds,3 skin grafts,4,6 pressure ulcers7 and also in the treatment of chronic diabetic ulcers affecting the lower limb.8-10 It is well known that the diabetic population with poorly controlled diabetes mellitus is at increased risk of developing complications related to arterial insufficiency, peripheral polyneuropathy,13 and recurrent infection,14 which in turn potentiates the risk of developing chronic non-healing ulcerations. Studies have indicated that 2–3% of diabetic patients will develop a foot ulcer each year, compared with 15% who will develop a foot ulcer during their lifetime.15,16

Contraindications and warnings

VAC therapy is contraindicated in patients with wound malignancies, untreated osteomyelitis, chronic critical limb ischaemia, and if used directly on exposed blood vessels, nerves, tendons, ligaments, bowel and bone structures.23 Extreme caution should also be taken if: the patient is taking anticoagulant medication or platelet aggregation inhibitors; is sensitive to the silver impregnated dressing (VAC granuFoam silver dressing); or has weak blood vessel walls as a result of infection, trauma, or radiation. It should also not be used on severely necrotic ulcers.23

Basic technique of using VAC therapy

NPWT is a flexible therapy that can be used for both in- and out-patients. The VAC system uses Sensa TRAC (Therapeutic Regulated Accurate Care) technology which is able to maintain a target pressure and relay data to the therapy unit for monitoring. The VAC system consists of a transparent exudate-collecting canister, dressing foam, adhesive transparent drape and a TRAC pad with a drainage tube. The foam dressing is applied onto the ulcer and sealed over with the adhesive drape. A small annular hole is created to expose the foam, the TRAC pad is placed over this hole and attached, sealing the foam dressing. The proximal end of the drainage tube is then connected...
up with the tube emitting from the canister. When the therapy unit is switched on, the foam dressing shrinks as the suction takes effect (Figure 1).

The VAC unit contains an alarm system which can become triggered by a malfunction such as: leakage; tube blockage; a full or partially-connected canister; low battery; and insufficient pressure/suction. Depending on the type of ulcer being managed and the general medical status of the patient, the device can be left for 48 hours in the first treatment, and 12 to 24 hours thereafter.

Challenges of using VAC therapy on foot ulcers

The size and location of a wound determines the type of VAC unit and accessories that will be employed. Most diabetic patients with plantar foot ulcers are ambulatory and tend not to require hospital admission. As a result, they can be treated in an out-patient facility and are able to take the ‘mobile’ VAC unit home. This however poses several issues:

- It is assumed patients will respect and return the VAC unit in an undamaged and untampered state. In our experience most units have been returned undamaged, however some level of tampering has been witnessed, even with the ‘lock’ mechanism engaged. Despite scrupulous patient selection and carefully explained instructions, the risk of potential tampering of the unit by patients or their carers cannot be ignored.
- Non-compliance: The patient treated with VAC therapy in Figure 2 was requested to return to clinic in 24 hours, but did not attend until 74 hours later. During this period the unit was disconnected

by the patient and a heavy presence of exudate accumulated around the wound. Despite prior careful patient selection, education and instruction, patient compliance remains a difficult hurdle to overcome.
- The alarm system is often triggered by a leakage which occurs when the drape becomes detached from the skin. This can be due to several reasons:
  - The drape is applied whilst the patient is not weight-bearing. When the patient ambulates, expansion of the plantar tissues of the foot can aggravate and weaken the drape, increasing the risk of leakage. Furthermore, the dynamic structure of the foot is subjected to intrinsic and extrinsic forces which emit considerable amounts of stress on the drape. If the patient’s foot, for example, has a biomechanical anomaly such as a rocker-bottom (as seen in Charcot’s arthropathy), or splaying of the metatarsals due to forefoot hyperpronation, the drape can overstretch and become detached from the skin surface.
  - By virtue of the anatomy of the foot, unlike in abdominal wounds where the area of application is more uniform, it is difficult to place the drape on a foot ulcer, especially the plantar aspect without forming creases. Such creasing creates ‘tunnelling’, allowing the leaked exudate to spread (Figure 3).

- Excessive leakage of exudate around the wound periphery and beyond leads to a significant amount of macerated tissue. Accumulation of such fluid which contains, amongst others, proteases, will further delay wound healing and lead to bacterial infection, most often *Pseudomonas* (Figure 4).

Figure 1: Shrinkage of the foam dressing with suction from the TRAC pad

Figure 2: Accumulation of exudate after the VAC unit was disconnected by the patient due to non compliance

Figure 3: Creasing causing a “tunnelling” effect of the transparent drape

Figure 4: Plantar neuropathic ulcer depicting necrotic tissue with a greenish tinge characteristic of a *Pseudomonas* infection. Surrounding macerated tissue is also evident.
• The position of some wounds on the foot can make it difficult to apply VAC therapy (Figure 5).
• Application of VAC therapy in patients with renal failure creates another challenge. The case in Figure 6 depicts a type II diabetic patient with renal failure on dialysis, receiving anticoagulant medication and presenting with a chronic foot ulcer. Application of negative pressure on such ulcers can damage local blood vessels, and lead to excessive suction, with the accumulation of a blood saturated dressing. This may occur at a time when the patient is at home and totally unaware of such a scenario, often during the hours of sleep.

• Armstrong and Lavery24 emphasised the importance of offloading while implementing VAC therapy. Offloading a foot ulcer combined with VAC therapy has posed yet another practical challenge. It has been somewhat technically demanding to apply an effective offloading mechanism that incorporates a VAC unit without interference of the drape’s ability to allow vapour exchange or permit evaporation of sweat, or squashing of the drainage tube, or detaching the drape from the skin. There are no best practice guidelines for this and so in our experience it remains an art to be mastered. In an attempt to offload, direct placement of the TRAC pad on the plantar ulcer has been implemented in an attempt to discourage the patient to bear weight on the ulcer (Figure 7).

• Armstrong and Lavery24 emphasised the importance of offloading while implementing VAC therapy. Offloading a foot ulcer combined with VAC therapy has posed yet another practical challenge. It has been somewhat technically demanding to apply an effective offloading mechanism that incorporates a VAC unit without interference of the drape’s ability to allow vapour exchange or permit evaporation of sweat, or squashing of the drainage tube, or detaching the drape from the skin. There are no best practice guidelines for this and so in our experience it remains an art to be mastered. In an attempt to offload, direct placement of the TRAC pad on the plantar ulcer has been implemented in an attempt to discourage the patient to bear weight on the ulcer (Figure 7).

• Application of VAC therapy is time consuming for the clinicians involved. Duration can easily double if the drape is applied incorrectly, or if the alarm sounds due to air pockets, unsealed areas, or leakage. The associated expense of equipment is also significant.

Facing the challenges of VAC therapy

Difficulties of using VAC therapy have been documented in the literature.25, 26 In selecting suitable patients for the ambulatory VAC unit, the clinician needs to consider individuals according to their level of understanding, safety and demonstrated ability to follow instructions. Adequate patient education is paramount to emphasise the potential problems or malfunctions that can arise with the unit and how best to deal with them in the home environment. Visits as part of a home care plan by a health practitioner or district nurse to monitor progress of the patient and machine, would be the ideal situation.

Good blood supply is of paramount importance in the success of VAC Therapy. Arterial assessment profile, including transcutaneous oximetry (TcPO2) should be done before implementing VAC therapy. If TcPO2 is between 20 and 30 mmHg, particularly in the presence of peripheral neuropathy, the pressure intensity of VAC therapy should be lowered accordingly.27,28

Managing leakage will always pose some difficulty in treating plantar foot ulcers. Caution should be taken not to overstretch the drape, or pull the patient’s skin too tightly to form wrinkles, as this can contribute towards damage of the drape on weight bearing. Soft tissue expansion during ambulation is inevitable with potential for ‘tunnelling’ or wrinkling of the drape to develop. Slow application and ironing out of crease lines in the drape as they arise can aid in a more efficient application technique, however this is still a difficult process, especially when the drape is applied around the heel area. In our experience applying tincture of benzoin on to the surrounding skin and allowing it to dry, creates enhanced adhesion of the drape. To reduce the chances of fluid leakage, application of single layered strips of drape around the wound edges is recommended. These aim to isolate and protect the immediate surrounding skin, similar to the technique of drape application used in surgical preparation. Care is taken not to occlude the skin too intensely as this can lead to maceration.

Necrotic ulcers should first be thoroughly debrided before using VAC therapy23 and any ‘undermining’ or ‘roofing over’ removed by appropriate measures with minimal risk to the patient.
Application of VAC therapy on an ulcerated weight bearing foot without offloading is a futile exercise. The transparent drape is subjected to compressive and shearing stresses that will delay healing. In order to overcome this danger, simple felt padding in the form of ‘boot’ padding can be applied to lessen ambulatory forces (See Figure 8(a) and (b)). Modifications around total contact casting could also be incorporated in order to accommodate the VAC unit.

The choice of using VAC therapy should be weighed against the availability of resources in each wound care setting. As long as advanced wound care technology devices are safe, effective, affordable, and evidence based, there is no reason why they cannot be employed as an adjunct to wound care.

Conclusion

Continuity of wound care in diabetic patients requires patient cooperation as well as a multi-disciplinary approach to management. Patients who are always ambulatory, or have an inadequate level of understanding instructions, or have poor control of their diabetes and general health (often due to depression), are in our experience poor candidates for VAC therapy. Patient compliance is a problem for VAC therapy and allocation requires careful consideration by clinicians. Despite the practical challenges associated with VAC therapy in pedal diabetic wounds, it remains an effective and useful adjunct to administer as part of a wound management plan, assuming that good control of diabetes exists, infection levels are controlled, contraindications of therapy are adhered to (especially arterial insufficiency) and a good level of patient compliance and understanding is evident.

References