Wound Healing and Cost-Saving Benefits of Combining Negative-Pressure Wound Therapy with Silver

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ABSTRACT

A 20-patient case series is presented, demonstrating the incorporation of a silver antimicrobial negative-pressure dressing and a negative-pressure wound therapy device for improved healing outcomes, decreased nursing time expenditure, and decreased cost expenditure.

KEYWORDS: negative pressure wound therapy, wound healing and silver, cost savings

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INTRODUCTION

The vacuum-assisted closure (V.A.C.) negative-pressure wound therapy (NPWT) system (Kinetic Concepts, San Antonio, Texas) is approved for the management of chronic wounds, acute wounds, traumatic wounds, subacute and dehisced wounds, partial-thickness burns, ulcers (such as diabetic or pressure), and flaps and grafts in multiple settings. Negative-pressure wound therapy is intended to create an environment that promotes wound healing by preparing the wound bed for closure, reducing edema, promoting granulation tissue formation and perfusion, and by removing exudate and infectious material.

The V.A.C. is composed of 3 components that work together to help promote wound healing through granulation tissue formation.[1,2] It provides intermittent or continuous therapy and promotes wound healing under the negative pressure created. The V.A.C. GranuFoam dressing applies mechanical forces to the wound, which are known as macrostrain and microstrain force.[3,4] Macrostrain force is the visible stretch that occurs when negative pressure contracts the foam and draws the wound edges together, provides direct and complete wound bed contact, evenly distributes negative pressure, and removes exudate and infectious materials. Microstrain force is also the microdeformation at the cellular level, which leads to cell stretch.[3] Microstrain force also reduces edema, promotes perfusion, and promotes granulation tissue formation by facilitating cell migration and proliferation.

Silver is used in numerous medical products and has broad antimicrobial properties against gram-positive and gram-negative bacteria.[5] In a 30-patient prospective study, Silverlon (Argentum Medical, Geneva, Illinois) antimicrobial negative-pressure dressing (NPD), in combination with a dermal-engineered substitute, appeared to be efficacious in healing diabetic, ischemic, and lower-extremity chronic wounds.[6] The Silverlon NPD is designed to intimately make contact with the wound as a primary dressing and permits the passage of fluids (Figure 1). The Silverlon NPD is indicated for the local management of superficial to partial-thickness burns, partial- to full-thickness wounds, donor and graft sites, acute wounds, lacerations, abrasions, traumatic wounds, surgical wounds, dehisced wounds, Stage I-IV dermal ulcers, pressure ulcers, diabetic ulcers, and venous ulcers. The presence of silver in this dressing when used in combination with NPWT provides an effective protection against microbial contamination and may add to the macrostrain and microstrain force benefits of the promotion of granulation material and decreasing infectious materials, even

Figure 1.
SILVERLON DRESSING

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though the Silverlon NPD is between the wound and the NPWT device. This continuation of the benefits of the NPWT in the presence of the Silverlon NPD is because of the thinness and fenestration of the Silverlon NPD. This silver dressing provides broad-spectrum coverage, allowing dressing changes every 5 to 7 days.[5–9]

METHODS

Group 1 consisted of 10 patients with 10 wounds, which were located on the foot (7), leg (1), knee (1), and the back (1). Group 1 had weekly surgical excisional wound debridement with dressing changes consisting of application of NPWT and the Silverlon NPD dressing every 5 days with 4 patients and every 7 days with 6 patients. The combination-dressing changes were decreased from 7 days to every 5 days, based on clinical evaluation and discretion of the treating physician. The sequence of applying the Silverlon NPD with NPWT is illustrated in Figure 2 A-D. The Silverlon NPD is cut to overlap the wound margins by 1 cm and then applied to the wound and held in place as NPWT is applied per standard technique. Group 2 also consisted of 10 patients with 10 wounds, which were located on the foot (7), ankle (1), leg (1), and the knee (1). Group 2 patients experienced weekly surgical excisional wound debridement at dressing changes and application of NPWT every 2 days. For both groups, the time measured in days that the wound was open and the time to closure, patient age, patient A_{1c} when applicable, cost of wound care per patient, and the nursing time expended for wound care were recorded.

RESULTS

In group 1, the average patient age was 65 years, and 7 of the patients had diabetes, with an average A_{1c} of 9.41%. The wounds were open an average of 70.6 days before initiation of NPWT in combination of the Silverlon NPD. The wounds obtained closure

Figure 2.

A. WOUND AFTER SHARP EXCISIONAL DEBRIDEMENT IN PREPARATION FOR SILVERLON NPD APPLICATION. B. SILVERLON NPD APPLICATION WITH OVERLAPPING THE WOUND MARGINS BY 1 CM. C. V.A.C. NPWT GRANUFOAM DRESSING APPLICATION. D. COMPLETED V.A.C. NPWT APPLICATION

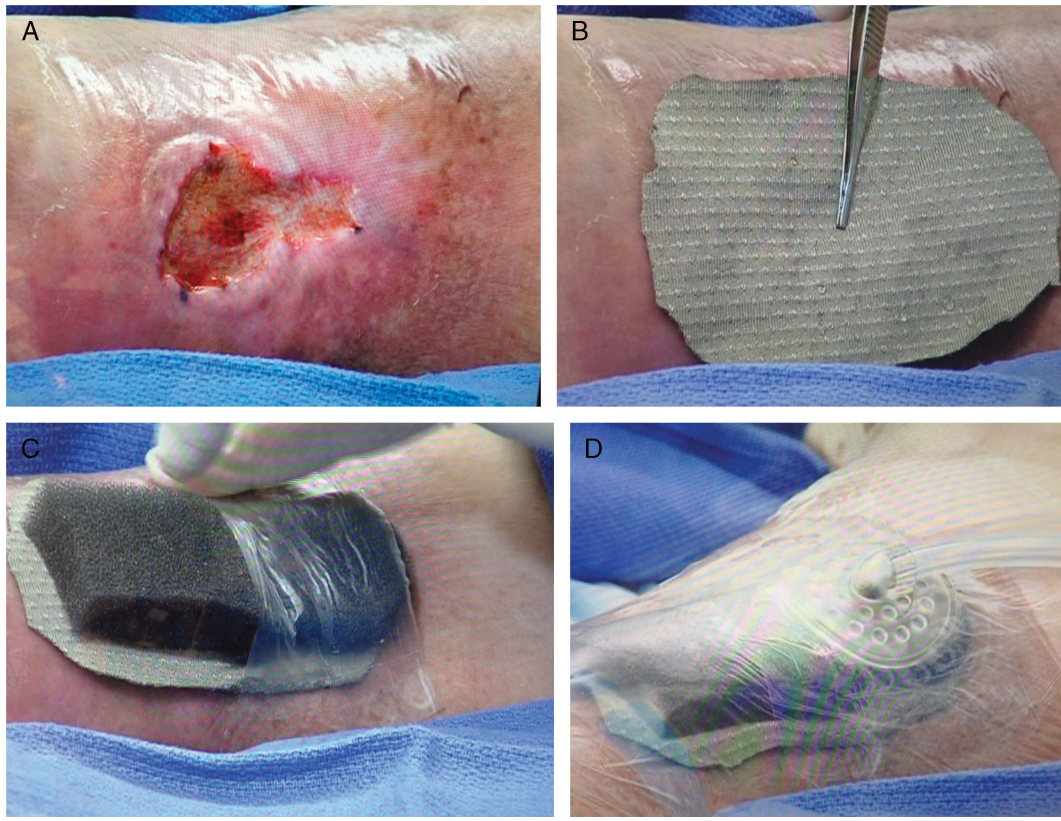

Table 1.

DATA SUMMARY

Treatment	Average Patient Age, y	$A_{1c\%}$	Days the Wound Is Open Before Treatment	Days to Wound Closure	Wound Treatment Cost Per Patient	Total Nursing Time Per Patient, h
Silverlon NPD and V.A.C NPWT	65	9.4	70.6	50.5	$826	4.3
V.A.C NPWT alone	64	10.3	75	61.7	$5181	15.4
Difference for cost, wound closure, and time				11.2	$4355	11.1

on an average of 50.5 days. The average cost associated with wound care for this group was $826 per patient, and the nursing time expenditure per patient for wound dressing changes was 4.3 hours. This information is summarized in Table 1. Patient 2 received this therapy in conjunction with hyperbaric oxygen therapy, demonstrating safety for Silverlon NPD in a hyperbaric oxygen chamber (Figure 2).

In group 2, the average patient age was 64 years, and 8 of the patients had diabetes, with an average A_{1c} of 10.3%. The wounds were open an average of 75 days before initiation of NPWT. Following this therapy, the wounds obtained closure an average of 61.7 days. The average cost associated with wound care in this group was $5181 per patient, and the nursing time expenditure per patient for wound dressing changes was 15.4 hours. Table 1 illustrates these data.

The following were found when comparing group 1 with group 2:

- wounds showing improved healing—70.6 versus 75 days
- fewer NPWT kit changes—on average 1.16 vs 3.5 kits per week
- overall total cost $8260 ($826 per patient) versus $51,814 ($5184 per patient)
- less nursing time—43.46 hours (4.3 hours per patient) versus 154.5 hours (15.4 hours per patient) of NPWT in combination of the Silverlon NPD versus NPWT alone

These statistics are presented in Table 1.

DISCUSSION

The protocol for the NPWT at this hospital-based wound care center is application and change every 2 days. When the Silverlon NPD was used in conjunction with the NPWT dressing, the changes decreased to every 5 or 7 days, based on clinical evaluation and discretion of the treating physician. In a 2-week period when the Silverlon NPD with NPWT dressing was changed every 5 days instead of every 2 days for the NPWT alone, there was a decreased frequency of dressing changes of 2.5 from 7. When the Silverlon NPD and NPWT dressing was changed every 7 days at the physician's office or wound care center, this allowed home healthcare visits for wound care to be suspended. Regardless if the dressing was changed every 5 or 7 days, there were no issues with maintaining the seal and no incidence of significant maceration around the wound bed. In the case presentation that follows, because of these decreased visits in 2 weeks, the patient required 12 home healthcare visits from an estimated 35 nurse visits if NPWT was used alone if the dressing changes were being done every 7 days. This reflects a 66% reduction in home healthcare visits by adding a silver antimicrobial NPD. The total cost expenditure of NPWT in combination with Silverlon NPD compared with NPWT alone demonstrated an 84% reduction in total cost and a 72% decrease in total time expenditure.

In groups 1 and 2, there was no incidence of infection during the treatment. Changing the NPWT dressing every 5 to 7 days did not have any additional noticeable odor than would be expected. Pain was not assessed as 15 of the 20 patients had diabetes, and all had a significant neuropathy and some differing degree of pain sensation loss. Using the Silverlon NPD with NPWT in conjunction with hyperbaric oxygen therapy did not increase the time

Figure 3.

INITIAL KNEE WOUND WITH INFECTED KNEE PROSTHESIS PRESENTATION

needed to dive the patient, as no additional steps were required to place the patient in the hyperbaric chamber.

CASE PRESENTATION

A 91-year-old woman (group 1, patient 10), who did not have diabetes, presented with a painful, chronic infected knee prosthesis with 2 ulcers to deep facial tissue, episodically open for 3 years' duration, and now open for 97 days (Figure 3). To date, the patient had undergone multiple incision and drainage procedures, as well as debridements. The patient was not a candidate to return to the operating room for revision surgery.

Long-term osteomyelitis management had included oral doxycycline, rifampin, and fluconazole. Cultures revealed yeast and *Enterococcus faecium*. Wound management was initiated with ulcer surgical excisional debridement and application of the NPWT device in combination with the Silverlon NPD, which was placed in apposition to the wounds covered by the NPWT. The addition of the Silverlon NPD decreased NPWT dressing changes from 3 times a week to once a week. This decrease in dressing changes significantly decreased the patient's pain and cost of the wound care.

This patient progressed very well. The 2 ulcers were healed at 70 days after initiation of wound treatment. This patient has had no recurrence of the osteomyelitis or wounds in 2 years (Figure 4). She is functioning well and bearing weight without restrictions.

Figure 4.
HEALED KNEE WOUND

CONCLUSIONS

This retrospective case series presentation demonstrates the successful management, ease of application, decreased nursing time, and cost savings utilizing NPWT in combination with the Silverlon NPD versus NPWT alone. The Silverlon NPD was easy to apply and well tolerated by the patient. The Silverlon NPD was safe and effective when used with NPWT in the management of diabetic foot ulcers, venous stasis ulcers, ulcers in the presence of osteomyelitis, and upper torso ulcers. In addition, NPWT combined with Silverlon NPD may be used safely with hyperbaric oxygen therapy. ●

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