A Retrospective Study: Clinical Experience Using Vacuum-Assisted Closure in the Treatment of Wounds

Suresh Antony, MD, FACP and Sandra Terrazas, PTCWS, CLT
El Paso, Texas

We report the results of our wound care experience using the wound vac as an adjunct therapy in the treatment of sternal, spinal, and lower-extremity wounds. This is a retrospective study in which 42 patients were evaluated between 1999 and 2002 for nonhealing sternal, spinal, and lower-extremity wounds. There were 12 patients with sternal wounds with a variety of pathogens who were treated with antimicrobials along with the wound VAC. The VAC was applied for an average of 12 days, and all 12 patients went onto complete closure by the end of four weeks. There were 14 patients in the lower-extremity wound group, again, with a variety of pathogens. The VAC was placed for an average of 29.3 days to achieve closure along with the wound VAC. There were 16 spinal wound patients with a variety of pathogens. All the patients received antimicrobial therapy, with the average duration of the VAC beings 27.6 days and closure taking about eight weeks. The wound VAC, along with appropriate antimicrobial therapy and surgery, appears to help reduce the number of days to healing, along with a reduction in the number hospital days and possibly costs to the health system.

Key words: wound VAC ■ wound healing

 From the Texas Tech University Health Sciences Center/U.S. Oncology PA, and Diamond Rehabilitation Center, El Paso, TX. Send correspondence and reprint requests for *J Natl Med Assoc.* 2004;96:1073–1077 to: Suresh Antony, 7848 Gateway E., El Paso, TX 79935; e-mail: santony@elp.rr.com

INTRODUCTION

Several million patients suffer from nonhealing wounds in a variety of anatomical sites, costing the health system millions of dollars. The cost and management of these wounds varies in different centers. For example, the cost of managing a diabetic foot infection for approximately two weeks in one center is between $20,000–$25,000 but may be quite different in another center.[1] Prior to the advent of the wound VAC, the treatment of nonhealing wounds consisted of traditional modalities, such as wet-to-dry dressings, debridement, and topical antibiotics, with closure of these wounds taking several weeks or months.[2] The process of wound healing is a complex one, consisting of cell migration leading to repair and closure of wounds. The process also needs removal of debris, control of infection, clearance of inflammation, angiogenesis, deposition of granulation tissue, contraction, remodeling of the connective tissue matrix, and maturation. If any of these steps fail, a chronic open wound without anatomical or functional integrity results. Chronic wounds may be associated with pressure, trauma, venous insufficiency, diabetes, arterial disease, or prolonged immobilization. These wounds result in prolonged hospitalization, high risk of infection, and result in billions of dollars in healthcare costs. The advent of the wound VAC has substantially increased wound closure rates and reduced morbidity and health costs for many patients.[3-6] We present the clinical features, isolated pathogens, and healing results of 42 patients seen in our institution with sternal, spinal, and lower-extremity wounds treated with antimicrobial therapy, debridement, and wound VAC placement.

MATERIALS AND METHODS

There were 42 patients obtained in this retrospective study with a variety of infections to wounds, including sternal, (Figure 1) spinal (Figure 2), and lower extremity (Figure 3). Data was collected for age, sex, predisposing factors, microorganisms, duration of wound VAC application, and wound heal-

ing rates. Appropriate wound cultures were obtained from the sites after which antimicrobial therapy was started, if needed. The patient underwent operative and nonoperative debridement until healthy bleeding tissue and/or bone were revealed. Pulse lavage irrigation was utilized as well in some of the wounds. The VAC was then applied to the wound. The wound was evaluated every two to three days. The wound VAC was initiated by placing a foam dressing in the open wound. The polyurethane foam has a noncollapsible evacuation tube embedded, a vacuum pump, and a transparent adhesive drape (KCI International, San Antonio, TX) (Figures 4 and 5).

The foam used is a medical grade reticulated polyurethane foam with a 400–600-μmL pore size. Side ports of the evacuation tube below communication of the lumen of the tube to spaces in the trabaculated foam and the open cell nature of the foam ensures equal distribution of the applied pressure to every surface of the wound that is in contact with the foam. The foam is then cut and contoured to fit the size of the defect. The foam is then connected through the evacuation tube with the VAC pump. The wound is then sealed with an adhesive drape. The suction generates enough vacuum in the wound, producing a high-contact zone in the wound foam interface, and a vacuum seal is then achieved.[5,7] The polyurethane foam is then changed every two-to-three days with the drainage tube. This makes it possible for the wound to be inspected and avoids ingrowths of tissue into the foam. A container on the side of the VAC collects the wound exudate, which is changed weekly or upon filling capacity. The pump pressure is set between 125–150 mmHg depending on patient's level of tolerance. Debridement with enzymatic compounds was occasionally used between dressing changes until good granulation tissue was present or until closure of the wound was achieved. Nonhealing wounds were defined as wounds that did not close two or more weeks after operative intervention or dehisced after closure.

Figure 1a. Pre-VAC Sternal Wound

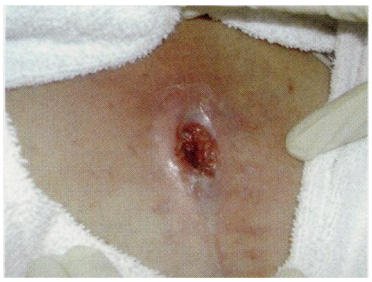
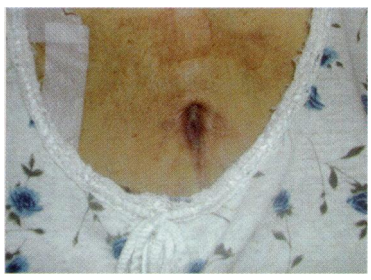


Figure 1b. Post-VAC Sternal Wound Showing Closure



RESULTS

Forty-two patients were evaluated between 1999 and 2002 for nonhealing sternal, spinal, and lower-extremity wounds. There were four patients on oral steroids, and none of the patients were on antigraft rejection drugs.

STERNAL WOUNDS

There were 12 patients with sternal wounds following coronary-artery-bypass grafting. The average age was 72 years. There were eight males and four females. All 12 patients had diabetes and coronary artery disease. Pathogens isolated included *Staphylococcus* (eight), *Pseudomonas* (two), mixed infection (one), and *Candida* (one). All 12 patients were treated with antimicrobials concomitantly with the wound care. No complications were observed. One patient had recurrence of the infection with the same pathogen and was retreated with success. The VAC was applied for an average of 12 days (range two-to-23 days). All 12 patients went onto complete wound closure by the end of four weeks.

LOWER-EXTREMITY WOUNDS

There were 14 patients in this group with an average age of 62 years. Eight of the patients had diabetes, coronary artery disease, and peripheral vascular disease. Isolated pathogens included *Staphylococcus* (four), gram-negative pathogens (one), and anaerobes (one), and no cultures were obtained in eight patients. All 14 patients received antimicrobial therapy; one patient did not respond to therapy and had to undergo an above-knee amputation, while another underwent surgical closure. The wound VAC was applied with an average of 29.3 days, range of four-to-186 days.

SPINAL WOUNDS

There were 16 patients in this group with an average age of 59 years, five males, and 11 females. Eight of the patients had diabetes in addition to other predisposing conditions, such as rheumatoid arthritis and spinal stenosis. Infecting pathogens included *Staphylococcus* (15), *Enterococcus* (two), *Candida* (two), *Pseudomonas aeruginosa* (one), and a mixed

infection (three). All 16 patients received antimicrobial therapy. One patient expired of unrelated causes. Recurrence of infections occurred in two patients who went onto successful healing once they were retreated. Eight patients went on to surgical closure, while the remaining eight patients went onto complete wound closure. Average length of VAC application was 27.6 days. (range two-to-178 days). The duration to wound closure was about eight weeks.

DISCUSSION

The first case, in which negative pressure was used in the treatment of pressure ulcers and chronic wounds, was described in 1993 by Argenta et al.[8] Since then, it has been used in a variety of wounds, including diabetic ulcers, abdominal wounds, sternal wounds, and spinal wounds.[5,7,9-11] The principle of negative pressure includes promotion of granulation tissue by arterial dilatation.[12] The device also has been shown to reduce edema, bacterial colonization, and reduce excess fluid.[13] These effects seem to shorten the duration of wound healing as noted in a previous report and suggested by this study. It has been suggested that successful healing correlates with less than 10^5 organisms per gram of tissue. The number achieved with wound VAC therapy is usually less than 10^3.[5]

Complications with the wound VAC are infrequent if the patient population is properly selected. These include bleeding from the wound at the time of sponge change due to excessive growth of granulation tissue into the sponge if it has been left in place longer than 48–72 hours. Pain has been associated with sponge changes but usually is short lived and can be controlled with oral narcotics. Occasionally, odor may be a problem, and one needs to ascertain that there is no active infection present. Allergic reactions to the drape have been reported as well, and these have been managed with topical steroids or antihistamines.[14]

Sternal wound infections have been quite a problem in terms of healing until the advent of the VAC. In one paper, 16 patients with sternal wound infections were treated with the combination of antimicrobials, debridement, and VAC therapy with good results.[15-17] None of these patients had any complications and had shorter hospitalization stays, earlier extubation, and better outcomes when compared to patients treated with normal saline dressing changes.

In lower-extremity wounds, such as graft site infections, there appears to be a reduction in exudates and bacteria with rapid formation of granulation tissue especially when compared to traditional methods of treatment.[4] Complications with this method are negligible and compares with our experience as well.

In spinal wounds, the occurrence of serious complications is around 4% but can be as high as 20% in some series.[18,19] These wounds may be associated with exposure of vertebral canal, spinal sac, and

Figure 2a. Pre-VAC Spinal Wound

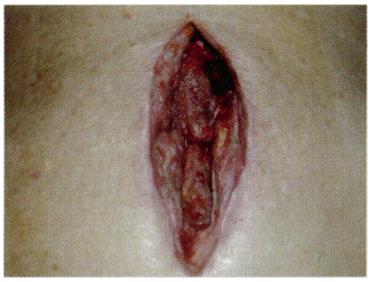


Figure 2b. Post-VAC Treatment of Spinal Wound

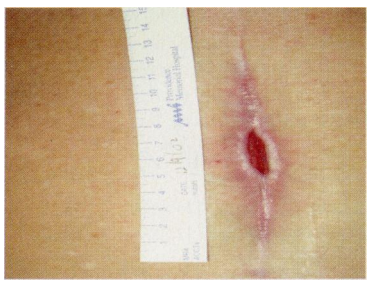


Figure 3a. Pre VAC Treatment Lower

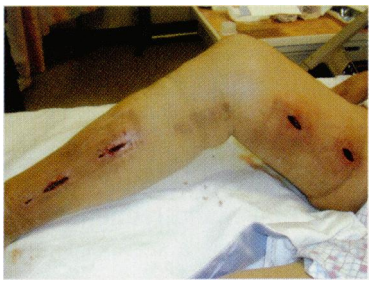


Figure 3b. Post-VAC Treatment Lower-Extremity Wounds Extremity Wounds

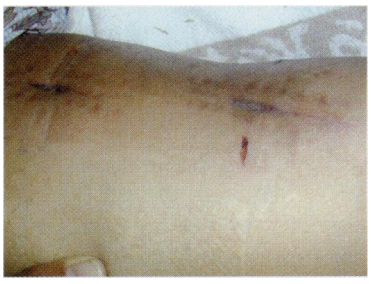


Figure 4. Wound VAC in Place with Sponge

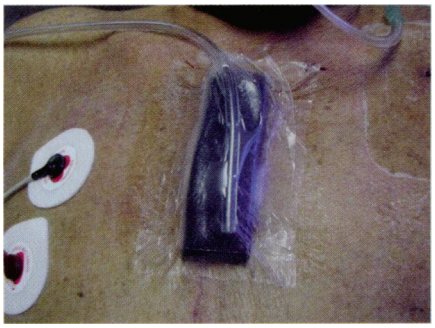
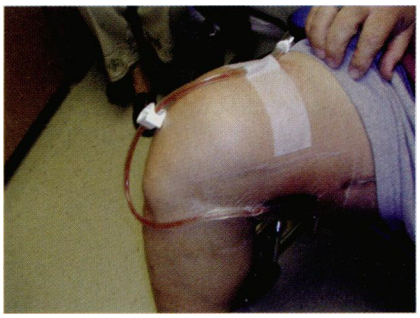


Figure 5. Wound VAC Showing Active and Drainage Tube Drainage of Fluid



hardware. Significant morbidity and mortality exists with these wounds, and the average cost for treating these patients is approximately $100,000 per patient. Some investigators have found successful closure of spinal wounds can be achieved much more rapidly than traditional methods in patients being able to tolerate the device. Animal studies using pigs with wounds were studied to validate the efficacy of the wound VAC. These animal models were studied to document the rate of wound healing using subatmosphere pressure and by laser doppler probes to measure blood perfusion. Bacterial clearance studies were conducted by infecting wounds with *s. aureus* and *s. epidermis*, the results of which showed reduction in the bacterial load, longer flap survival, and increased rate of granulation.[20]

Nonhealing wounds can be associated with diabetes; venous stasis ulcers; prolonged nonmobilization; and postoperative wounds, such as deep, persistently infected spinal wounds, etc. The treatment of these wounds is costly, demanding lengthy hospital stays and incurring both psychological and emotional stress to patients. The advent of the VAC appears to have helped such wounds achieve faster healing, shorter hospital stays, and reduction in the overall cost. Our study presents a series of patients with a variety of infections in which the wound VAC was successfully used. In our experience, it appears that most of these wounds occurred in the elderly with a history of diabetes mellitus, coronary artery disease, and peripheral vascular disease with the predominant pathogen isolated being *Staphylococcus*. Patients who did not receive antimicrobials but were treated with the VAC and debridement alone also healed without any adverse outcomes. The optimum duration of application of the VAC has not been well-established but seems to vary depending on the site where the wound occurred, vascularity, and infection. The wound VAC in combination with antimicrobial therapy and surgical debridement should be standard-of-care soon in the treatment of difficult to heal wounds such as sternal, spinal, and lower-extremity or graft sites. Further studies need to be done to evaluate the efficacy of the wound VAC with these types of wounds, and to access the safety and clinical efficacy of this modality of treatment.

REFERENCES

1. Hibbs P. The economics of pressure ulcer prevention. *Decubitus.* 1989;2: 32-38.

2. Lazarus GS, Cooper DM, Knighton DR, et al. Definitions and guidelines for assessment of wounds and evaluation of healing. *Arch Dermatol.* 1994; 130:489-493.

3. Joseph E, Hamori CA, Bergman S, et al. A prospective randomized trial of vacuum-assisted closure versus standard therapy of chronic nonhealing wounds. *Wounds.* 2000;12:60-67.

4. Demaria R, Giovannini UM, Teot L, et al. Using VAC to treat a vascular bypass site infection. *Journal of Wound Care.* 2001;10:12-13.

5. Argenta LC. Vacuum device can speed healing. *Wound Care.* 1997;29.

6. Argenta LC. Vacuum-assisted closure case. *Wound Care.* 1997;30-31.

7. Mullner T, Mrkonjic L, Kwasny O, et al. The use of negative pressure to promote the healing of tissue defects: a clinical trial using the vacuum-sealing technique. *Br J Plast Surg.* 1997;50:194-199.

8. Argenta LC, Morykwas M, Rouchard R. The use of negative pressure to promote healing of pressure ulcers and chronic wounds in 75 consecutive patients. Presented at the Joint Meeting of the Wound Healing Society and European Tissue Repair Society, Amsterdam. August 1993.

9. Blackburn JH, Boemi L, Hall W, et al. Negative pressure dressings as a bolster for skin grafts. *Ann Plast Surg.* 1998;40;453-457.

10. Jones G, Jurkiewicz, MJ, Bostwick J, et al. Management of the infected median sternotomy wound with muscle flaps: the Emory 20-year experience. *Ann Surg.* 1997;225:766-778.

11. Obdeign MC, De Lange MY, Lichtendahl DH, et al. Vacuum-assisted closure in the treatment of poststernotomy mediastinitis. *Ann Thorac Surg.* 1999;68:2358-2360.

12. Argenta LC, Morykwas M. Vacuum-assisted closure: new method for healing chronic wounds. Presented at the 73rd annual meeting of the American Association of Plastic Surgeons, St. Louis, MO, May 1994.

13. Morykwas MJ, Faler BJ, Pearce DJ, et al. Effects of varying levels of subatmospheric pressure on the rate of granulation tissue formation in experimental wounds in swine. *Ann Plast Surg.* 2001;47:547-551.

14. De Franzo AJ, Marks MW, Argenta LC, et al. Vacuum-assisted closure for the treatment of degloving injuries. *Plast Reconstr Surg.* 1999;104;2145-2148.

15. Hersh RE, Dahman JM, Dahman MI, et al. The vacuum-assisted closure device as a bridge to sternal wound closure. *Ann Plast Surg.* 2001;46:250-254.

16. Tang AT, Ohri SK, Haw MP. Novel application of vacuum-assisted closure technique to the treatment of sternotomy wound infection. *Eur J Cardiothorac Surg.* 2000;17:482-484.

17. Obdeijn MC, De Lange MY, Lichtendahl DH, et al. Vacuum-assisted clo-

sure in the treatment of poststernotomy mediastinitis. *Ann Thorac Surg.* 1999;68:2358-2360.

18. Yuan-Innes MJ, Temple CL, Lacey MS. Vacuum-assisted wound closure: a new approach to spinal wounds with exposed hardware. *Spine.* 2001;26:E1-E4.

19. Klink BK, Thurman RT, Witpenn GP, et al. Muscle-flap closure for salvage of complex back wounds. *Spine.* 1994;19:1467-1470.

20. Morykwas MJ, Argenta LC, Shelton-Brown EI, et al. Vacuum-Assisted Closure: a new method for wound control and treatment: animal studies and basic foundation. *Ann Plast Surg.* 1997;38:553-562. ■

We Welcome Your Comments

The *Journal of the National Medical Association* welcomes your Letters to the Editor about articles that appear in the *JNMA* or issues relevant to minority healthcare. Address correspondence to ktaylor@nmanet.org.