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Treatment Options

5 Questions—and Answers—about Negative Pressure Wound Therapy

Luther C. Kloth, MS, PT, CWS, FAPTA

Q: What is negative pressure wound therapy?

A: Negative pressure wound therapy (NPWT) is an adjunctive wound treatment that involves the application of a controlled level of subatmospheric pressure to a wound at 50 mm Hg to 175 mm Hg.¹ Generated by a portable programmable pump, the suction effect is applied to the entire interior surface of a clean wound through open-cell polyurethane or polyvinyl alcohol (PVA) foam.² The polyurethane foam is black and has a pore size of 400 μm to 600 μm , and the PVA foam is white and has a pore size of 200 μm to 300 μm .

The foam dressing must be packed in the wound cavity so that it has contact with the entire base, sidewalls, and undermined and tunneled surfaces. If more than 1 piece of foam is needed, each additional piece must make contact with another piece to ensure that the suction effect is distributed to all wound surfaces. The dressing is then secured in the wound by covering it with a semioclusive polyurethane film drape supplied with the device. The film drape should also cover at least 4 cm of surrounding intact skin.

The suction effect of the device is exerted on the foam dressing via a polyvinyl tube that is inserted into the foam through a slit made in the vapor-permeable film drape. Care must be taken to create an airtight seal where the tube passes through the slit in the drape by pinching an additional strip of semipermeable film around the tube. The opposite end of the polyvinyl tube is then connected to a tube that leads to a 300 cc canister that is inserted into a recess in the vacuum pump. The disposable canister serves as a collection depot for edema fluid that is suctioned from the wound tissue.

Q: NPWT is indicated for what types of wounds?

A: In 1995, the Food and Drug Administration (FDA) approved NPWT for the treatment of nonhealing wounds. In January 2000, the FDA expanded the indications for NPWT to include chronic, acute, traumatic, subacute, and dehiscent wounds; diabetic ulcers; pressure ulcers; flaps; and grafts. Table 1 lists examples of patients with wound types for which NPWT may be appropriate.

Q: When would NPWT be contraindicated?

A: NPWT is contraindicated³ when:

- wounds contain necrotic tissue
- osteomyelitis is untreated
- fistulas to body cavities or organs are present
- malignancy is present in the wound
- treatment would place the foam dressing directly over arteries and veins that are exposed in the wound.

NPWT should be used with caution³ on patients when there is active bleeding in the wound, when hemostasis is difficult following debridement, or when anticoagulant therapy is used.

Q: Why is NPWT thought to be effective in managing wounds?

A: Several research studies and clinical trials have demonstrated positive effects of NPWT on wound healing. Three experimental studies—2 on porcine models^{4,5} and 1 on humans⁶—have provided evidence that NPWT enhances granulation tissue formation, clears edema fluid and bacteria from wounds, and increases cutaneous perfusion and oxygen tension. Other experimental studies have provided evidence that mechanical stress—in the form of stretching or expansion applied to tissues and cells (which likely occurs with NPWT)—induces a wide variety of cells to proliferate in vivo (nerve, blood vessels, skin) and in vitro (endothelial and vascular smooth muscle cells and fibroblasts).⁷⁻¹¹ In addition, 9 studies involving human subjects have reported favorable outcomes following the use of NPWT to promote closure of a variety of wounds. Of these 9 studies, 4 were noncontrolled case series,^{6,12-14} 3 were individual case studies,¹⁵⁻¹⁷ and 2 were small randomized controlled trials.^{17,18} Four of these studies reported significant increases in granulation tissue formation,^{1,12,14,18} while other studies reported significantly faster progress toward wound closure or improved skin grafting outcomes.^{6,15,16} One study of 10 diabetic foot wounds reported a clinically significant decrease in the size of wounds treated with NPWT compared with wounds treated with saline-moistened gauze.¹⁹

Q: Are different wounds managed differently with NPWT?

A: The NPWT protocol for management of a wound depends

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Table 1. EXAMPLES OF INDICATIONS FOR NPWT

Types of Wounds/Patient History	Rationale for Use
A 37-year-old woman is a type 1 brittle diabetic with digits of both hands (except left thumb) auto-amputated secondary to gangrene and both legs surgically amputated below the knee secondary to gangrene. She is totally dependent on her husband for mobility. A clean sacral pressure ulcer has deteriorated from 6.5 x 5.3 x 2.2 cm to 13.2 x 6.4 x 3.3 cm during 8 weeks of standard care. The wound is undermined 2 to 5 cm along both margins of the wound's long axis.	Eight weeks of standard care failed to promote healing of a wound that has become life-threatening. NPWT has been documented to increase the rate of granulation tissue formation ^{1,2,3} and epithelialization ⁴ secondary to increasing perfusion to the wound bed. ¹ For this wound, NPWT would be applied via a polyurethane sponge in continuous mode at 125 mm Hg for the first 48 hours, after which NPWT would be applied in the intermittent mode at 125 mm Hg. The sponge dressing is changed every 48 hours. ⁴
A 56-year-old man has bilateral lower extremity arterial occlusive disease and a chronic wound secondary to arterial insufficiency on the lateral, middle third of his right leg. Ankle-brachial indexes are 0.5 on the right and 0.6 on the left lower extremity. Transcutaneous oxygen level of the hypoxic periwound skin is 28 mm Hg. The wound has failed to show evidence of healing after 4 weeks of standard moist wound care plus HBO therapy. The wound measures 8.3 x 5.5 x 3.7 cm (2.2 cm of fibula exposed). Twenty-five percent of the wound bed is covered with yellow adherent necrotic tissue.	Four weeks of standard moist wound care plus HBO failed to promote measurable evidence of healing in this wound. NPWT has been shown to maintain a moist wound environment, ¹ produce a 4-fold increase in blood flow, ¹ and increase the rate of granulation tissue formation. ^{1,2,3} Following debridement and hemostasis, the exposed bone would be covered with a nonadherent dressing. NPWT would then be applied via a polyurethane sponge in the continuous mode at 50 to 75 mm Hg, with sponge dressing changes every 48 hours. ⁴
A 29-year-old man suffered traumatic amputation of his right upper extremity at midforearm in a farm accident. Five weeks following surgical closure of the amputation stump, the wound dehiscence and became infected and edematous. The infection was treated with antibiotic therapy, and the patient's physician recommended concurrent adjunctive treatment with NPWT to facilitate healing by edema removal and reduction of the bacterial burden.	NPWT has been shown to evacuate the localized edema fluid ¹ that typically accumulates in the interstices surrounding a wound. It is thought that the stagnated edema fluid compresses microvascular and lymphatic vessels that, respectively, obstruct arterial delivery of oxygen and the removal of bacteria. ⁴ The edema fluid harbors bacteria and matrix metalloproteinase, ⁵ releasing enzymes that break down collagen secreted by fibroblasts. By evacuating the edema fluid, circulation is restored and the bacterial burden is significantly reduced, allowing healing to advance. ¹

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on several factors. Some factors are related to the type of wound and whether it needs removal of edema fluid containing a high bacterial burden, facilitation of granulation tissue growth and/or contraction, or promotion of flap or graft adherence to the wound base. Given the FDA's indications for NPWT, the exclusive manufacturer of the only NPWT device in the United States (Vacuum-Assisted Closure, [V.A.C.]; Kinetic Concepts, Inc [KCI], San Antonio, TX) further delineates recommended guidelines for 7 wound categories to be managed with their NPWT device, including acute/traumatic wounds, surgical wound dehiscence, pressure ulcers, chronic ulcers (diabetic, arterial, vascular), meshed grafts, fresh flaps, and compromised flaps.² The recommended guidelines encompass the selection of

the initial and subsequent operation mode (whether it be continuous or intermittent), selection of the target suction pressure for polyurethane and PVA foams, and the time interval between foam dressing changes.

For more information about NPWT treatment parameters in the management of wounds, see "Guidelines for Using Negative Pressure Wound Therapy" by Susan Mendez-Eastman, RN, CWCN, CPSN, published in the November/December 2001 issue of *Advances in Skin & Wound Care*.² ●

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