Negative Pressure Wound Therapy

by John H. Dirckx, M.D.

Most of the recent advances in medical science have involved creating things that never existed in nature, such as synthetic antibiotics and radiopharmaceuticals. But sometimes real progress is made simply by finding ways to aid and abet the natural healing power of living tissues or to exploit natural forces such as gravity and osmotic pressure. And occasionally what seems like a cutting-edge development turns out to be the reinvention or rediscovery of a principle or technique that is hundreds or thousands of years old.

The application of oral suction to snakebites and certain other superficial lesions must surely go back very far into human prehistory. The practice of cupping (creating a partial vacuum within a cup-shaped vessel of horn or metal placed over a lesion or incision to draw out blood or other material) was well established before the beginning of the Christian era. Rubber bulbs, syringes, aspirators, suction pumps, and vacuum drainage devices have been integral features of medicine and surgery for decades or centuries.

Negative pressure wound therapy (NPWT) is therefore not so much the exploitation of a newly discovered principle or property of nature as a refinement of existing knowledge and techniques. NPWT is the intermittent application of a partial vacuum to a wound, ulcer, or other surface lesion by means of a motorized pump, appropriate tubing, and a dressing of spongelike synthetic material held in place by an occlusive drape.

Within the past decade, NPWT has shown promise in promoting the healing of acute and chronic wounds, partial-thickness burns, diabetic and pressure ulcers, and skin grafts. An environment of controlled negative pressure increases local vascularity and oxygenation of tissues while evacuating edema fluid, exudate, extravasated blood, and bacteria.

The use of polyurethane foam with a mechanical vacuum pump was pioneered during the 1990s by Drs. Louis Argenta and Michael Morykwas of Wake Forest University School of Medicine. A line of products based on their research is marketed by Kinetic Concepts Inc. (KCI) of San Antonio, Texas, as the V.A.C. (Vacuum Assisted Closure) Therapy System. This system is patented and received approval by the U.S. Food and Drug Administration (FDA) in 1995.

In 2004 the FDA approved the V1 Versatile Wound Vacuum System manufactured by Blue Sky Medical Group of Carlsbad, California. This system, which uses a vacuum chamber rather than a foam dressing, is based on research performed in Russia during the 1980s. A suit brought by KCI against Blue Sky for patent infringement was rejected by a federal court in August, 2006.

The unique feature of the V.A.C. Therapy System is a sterile, resilient, open-cell polyurethane foam dressing material that can be trimmed to fit a surface lesion or to fill a wound or ulcer. The dressing is held in place and its margins sealed with a drape that has an acrylic adhesive coating.

The application of negative pressure to the occluded foam causes its cells to collapse and exert a continuous suction on the covered tissues. A manometer at the pump measures the degree of vacuum within the system. Drainage is collected in a canister. The use of a Y-connector makes it possible to treat more than one lesion simultaneously with a single pump.

NCWT removes interstitial fluid and infectious materials and maintains a closed, warm, moist environment for wound healing. Animal and limited human studies suggest that negative pressure assists in the development of granulation tissue, with wound contracture and neoepithelization, by mechanically stimulating cell proliferation and angiogenesis (capillary formation).

Negative pressure wound therapy can be applied in a hospital or nursing facility or in the patient's home. Selected patients can remain ambulatory and even resume employment with a battery-operated portable pump worn on a belt around the waist. Dressings are normally left in place for 48 hours between changes. More frequent changes may be appropriate in the presence of infection or when close monitoring of wound status is necessary. Foam is not bioabsorbable and must be completely removed at each dressing change.

Current treatment guidelines call for a negative pressure of 125 mmHg to be applied for 5-minute periods separated by 2-minute intervals of normal pressure. These recommendations are based on empirical observations that a stronger vacuum or a continuous vacuum is associated with reduced rather than increased blood flow.

Vacuum therapy has been applied successfully to a wide variety of lesions, including deep, complicated, nonhealing wounds of mixed etiology, dehiscent surgical wounds, neuropathic and ischemic ulcers, and pressure ulcers (bedsores). It has permitted the use of simple techniques for soft-tissue reconstruction and wound closure that formerly required complex pedicled or microsurgical free flaps.

Some surgeons routinely employ NPWT both before and after skin grafting. Application of negative pressure to a thoroughly debrided wound promotes formation of a richly vascularized bed of granulation tissue for grafting. After

graft placement, a vacuum foam dressing serves as a bolster, conforming to the contours of the graft and keeping it in contact with its bed, and further enhances the probability of a successful take by continuously removing edema fluid or exudate from beneath the graft and reducing the microbial population. Foam that has been impregnated with ionic silver may be preferred for treating colonized or infected lesions or to reduce the risk of infection in skin grafts.

Contraindications to the use of NPWT include the presence within the treatment zone of severely ischemic, necrotic, or malignant tissue; uncontrolled infection; exposed organs, bone, or blood vessels; and a non-enteric fistula or sinus tract. All devitalized or necrotic tissue must be debrided, necessary surgical revascularization must be performed, and infection must be controlled with antibiotic therapy or by excision of osteomyelitic bone before application of negative pressure therapy. Grafting over exposed organs, blood vessels, tendons, nerves, bone, or implanted hardware requires the surgical interposition of natural tissues or the creation of a complete barrier with fine-meshed collagen or synthetic material.

The potential for significant hemorrhage with vacuum therapy must be considered in the immediate postoperative period, in patients with fresh vascular grafts, and in those on anticoagulants. Poor patient compliance, such as may occur in dementia, negates the benefits of the treatment and contraindicates it.

Although employed with increasing frequency and supported by favorable anecdotal reports, NPWT has not been extensively studied in randomized clinical trials, and compelling evidence of its effectiveness in some applications is lacking. Large and rigorously controlled trials are or soon will be under way, and may eventually provide strong endorsement of NPWT. Meanwhile, health insurance carriers including Medicare have recognized it as medically necessary and reimbursable for certain conditions.

John H. Dirckx, M.D., is the author of *Laboratory Tests and Diagnostic Procedures in Medicine* (2004), *Human Diseases*, 2nd ed. (2003), *H&P: A Nonphysician's Guide to the Medical History and Physical Examination*, 3rd ed. (2001), published by Health Professions Institute. He is medical editor of all HPI publications.

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SMASH (simultaneous acquisition of spatial harmonics) method—used in MRI procedures.

anvil dunk—a procedure used in laparoscopically performed gastric bypass to construct a gastrojejunostomy. The head of a stapling anvil is used to invaginate the stomach wall in order to bring the surgically created openings in the stomach and jejunum into apposition and stabilize them while they are being sutured together. See also *dunked end-to-end anastomosis.*

bird-beak sign (Radiol)—abrupt, smooth tapering of the distal esophagus on barium swallow, an indication of achalasia.

black knee prosthesis—a femoral component consisting of zirconium metal that has been heated and cooled in oxygen. This oxidizes the surface 5 microns of the metal and turns it into a black ceramic finish.

capillary isotachophoresis (cITP)—a modification of electrophoresis in which the use of two electrolytes with different chemical properties permits more rapid and more complete separation of analytes. It is a more sensitive means of measuring LDL subfractions in plasma.

8-to-S-plasty—a modified technique for closing a skin defect shaped like an 8 (two adjoining round lesions). The traditional method of repair by creating a single elliptical defect sacrifices healthy skin. In the Burow 8-to-S plasty, one triangle of skin with its apex at the constriction in the figure 8 is advanced to close one of the circular defects, and the other triangle of skin is advanced to close the other. No incisions are required and no skin is sacrificed. The suture line after closing resembles an "S".

odd facet of the patella—the 7th facet of the articular surface of the patella, being the most medial portion. Only at 135 degrees of flexion does the odd facet contact the medial femoral condyles. Therefore, in most patients, it is a very underused part of the articular surface. Underuse has been incriminated as a cause of damage to the articular surface, an example being chondromalacia.

rendezvous laparoendoscopic technique—a technique used in endoscopic sphincterotomy to facilitate the identification and cannulation of the papilla. Using this technique, a guidewire is inserted through the cystic duct, caught with an endoscopic polypectomy loop, extracted from the operative channel and cannulized with a sphincterotome. This is then pulled through the papilla in the common bile duct, thus completing the