How I do it

Negative pressure wound therapy with off-the-shelf components

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Abstract

\textbf{Background:} The KCI Wound VAC system (Kinetic Concepts, Inc, San Antonio, TX) for providing negative-pressure therapy for wounds is expensive and may not be available for patients without insurance. We have examined the feasibility of using off-the-shelf components to provide comparable negative pressure therapy at less cost.

\textbf{Methods:} Adhesive iodine-impregnated drape, a flat Jackson-Pratt drain (Cardinal Health, McGaw Park, IL), and foam prep sponges stapled together are used to assemble a dressing connected to wall suction (negative 75–100 mm Hg) to create negative pressure wound therapy that is relatively inexpensive ($60 component cost).

\textbf{Results:} We have used this system in more than 40 cases with results that seem comparable to the commercial system and have not seen bleeding or other complications.

\textbf{Conclusion:} Off-the-shelf components can be safely employed to provide effective negative pressure therapy for wounds and skin grafts.

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\textbf{Keywords:} Negative pressure therapy; Wound, Skin graft; Vacuum assisted closure; Off-the-shelf system

The application of negative pressure to promote wound healing first was described in the Russian medical literature for patients with infected breast wounds. These original reports described the topical application of a suction-cup–type apparatus to the wound surface to create negative pressures of 80 mm Hg [1,2]. Subsequent reports have described the successful management of enterocutaneous fistulae and open abdominal wounds using flat drains delivering negative pressure under compliant plastic films [3–5]. In these early reports surgical gauze was used to create an interface between the wound surface and the vacuum source.

\textbf{Kinetic Concepts, Inc. (KCI; San Antonio, TX)} markets a modular negative pressure system (Wound VAC) that is based on the system developed by Argenta and Morykwas [6] and Morykwas et al [7] by using foam sponges connected to suction tubing and a vacuum pump containing a small canister. Other commercial vendors market similar systems. The KCI system has been used very successfully to treat a large variety of wound problems such as dehisced incisions, leg ulcers, and skin grafts, and has been adopted very rapidly into surgical practice across many disciplines [8–13]. The advantages of negative pressure therapy appear to include better control of wound secretions, reduction of wound edema, promotion of granulation, improved patient comfort, and, based on some clinical trial data, more rapid healing [8–13]. The foam sponges used in the commercial system provide a good, possibly optimal, interface between the wound and the vacuum source because of the even distribution of suction exerted by the porous foams and their ability to capture secretions.

We have been using the KCI Wound VAC system with good results, but because of financial considerations we have tried to develop a method of providing patients with similar negative-pressure therapy without the significant costs of purchasing or renting the KCI system, which can cost more than $100 per day. We have developed a method of creating negative pressure in wounds by using widely available off-the-shelf components that is easy to construct and apply and, based on our experience in more than 40 cases, appears to provide nearly equivalent effects on wound healing. We use this system whenever negative-pressure therapy is indicated and the KCI system is not available.

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Techniques

As shown in Fig. 1, the construction of our off-the-shelf system requires materials commonly used in the operating room: (1) a surgical stapler (model PXW35; Ethicon, Cincinnati, OH); (2) foam sponges used for dressings or for surgical preparation (model 4463; Cardinal Health, McGaw Park, IL); (3) a 10-mm Jackson Pratt (JP) drain (model SU130-1311; Cardinal Health); (4) Ioban adhesive film and Ioban iodine-impregnated transparent surgical drape (model 6651EZ; 3M, St. Paul, MN), and (5) a wall suction connector (model P361; Cardinal Health) for the JP drain to adapt into standard suction tubing. The system, once constructed, routinely is connected to a 1-L suction canister and to standard wall suction at 75 to 100 mm Hg negative pressure. We use the lower pressure for skin grafts and higher pressures when wound drainage is indicated.

In general, the wound to be treated is debrided to remove necrotic or infected tissue before the application of negative-pressure dressings (Fig. 2A). To ensure an adequate seal with the overlying adhesive film, the surrounding skin must be as dry as possible. In many cases, particularly with split-thickness skin grafts, we place a porous silver mesh between the wound and the sponges (Fig. 2B). We have used either multilayer 7-day release silver mesh (7-day Acticoat; Smith & Nephew, Largo, FL) or several layers of the silver mesh from the standard 1-layer Acticoat (Smith & Nephew). Such silver mesh barriers provide a sustained antimicrobial environment and seem particularly apt for use with negative-pressure dressings over skin grafts [14]. We have used a variety of other topical products between the sponge and the wound tissue including antibiotic ointments, papain preparations, and growth factor gel, all of which seem to be compatible with negative-pressure therapy [15].

Foam sponges are stapled together to form a raft larger than the wound to be treated using 3 to 4 staples to connect each sponge (Fig. 2C). The assembled foam then is cut to match the wound and secured with 1 or 2 staples to the adjacent skin (Fig. 2D). A layer of Ioban adhesive then is wrapped tightly to seal the entire wound. The Ioban adhesive is cut in the center with a scalpel or scissors to create an approximately 1-cm diameter defect. The JP drain, with most of the perforated portion removed, is placed over the defect and secured with another layer of Ioban adhesive (Fig. 3A). Additional layers of Ioban adhesive are wrapped around the JP to seal the wound completely. A wall suction connector then is used to establish continuity between the JP and wall suction. A negative pressure of 75 mm Hg induces...
the characteristic collapse of foam sponges seen in other systems (Fig. 3B). Skin graft dressings usually are left in place for 5 days. Our practice with open wounds is to replace the dressing every 2 or 3 days.

Comments

We have used the off-the-shelf system for management of leg ulcers, diabetic foot infections, dehisced extremity and abdominal incisions, and split-thickness skin grafts in 40 patients in the past 2 years. In general, we have seen very similar local wound responses as observed with the KCI Wound VAC. We have found the off-the-shelf system to be particularly good for skin graft dressings, and we now routinely use either the KCI or the off-the-shelf system without seeing any difference in results.

Based on our hospital purchase expenses, the overall cost required to assemble 1 off-the-shelf system using 1 stapler, 1 box of foam sponges, 1 large sheet of Ioban, 1 JP drain, and 1 connector is less than $60. This estimate does not take into account charges for using the wall suction apparatus, which also is low.

We believe that only a minor difference in distribution of vacuum suction to the wound results from substituting multiple sponges stapled together versus a single sponge. Our methods allow the foam layer to be tailored easily to match the wound dimensions; in deep wounds the sponges can be piled in layers. The application of the vacuum should be used to test the system in the operating room or at bedside, and rapid compression of the sponge raft when vacuum is applied reliably indicates that no significant leak is present.

Although we have not observed any problems with hemorrhage with this method (eg, discontinuing therapy because of bleeding), there is some concern that large wounds or those oozing at the time of dressing application could bleed excessively into the suction canister, which unlike commercial systems does not have a volume cut-off level. Because of this limitation, we urge caution in using this method for pediatric wounds in which drainage volumes should be monitored carefully, and for very large wounds or those likely to bleed excessively.

Other limitations of the off-the-shelf system include the inability to modify the pressure cycle (eg, intermittent suction) and to treat patients on an outpatient basis because our device uses simple wall suction for negative pressure. Despite these limitations, our system is invaluable for patients who would benefit greatly from negative-pressure therapy but who are unable to obtain access to commercial systems as a result of funding, cost considerations, or unavailability.

A recent clinical trial indicated that negative-pressure therapy is more cost effective than traditional saline-soaked gauze dressings [16]. Unfortunately, in the current health care environment, commercial technology is not always available as a result of cost or insurance authorization issues. The components required in this off-the-shelf system are available in most community hospitals and are easy to apply to manage inpatient wound problems, and based on our experiences it provides results similar to more complex commercial systems.

References