The Safe Use of Negative-Pressure Wound Therapy

Knowing how it works and how to solve problems are crucial.

Negative-pressure wound therapy (NPWT) is a widely used treatment for acute and chronic wounds. NPWT involves inserting a gauze or foam dressing into an open wound; sealing the area with an adhesive film; and connecting a tube embedded in the dressing to a vacuum pump, which creates negative pressure at the wound site. NPWT is used to reduce edema, promote granulation-tissue perfusion and formation, and remove exudate and infectious materials from the wound. NPWT has been shown to be a safe alternative to other therapies, although current clinical evidence is insufficient to say that NPWT is superior to other treatments. NPWT also has a higher material cost than conventional wound therapies, but that may be offset by reduced healing time, reduced nursing staff time and expense, shorter hospital stays, and NPWT’s facilitation of patient transfer to lower-cost care settings. Despite the potential benefits of NPWT as a component of a comprehensive wound-treatment program, nurses should be aware that serious complications have been associated with its use. Appropriate patient selection prior to initiation of NPWT, skillful device application, and frequent patient assessment and monitoring of the system are essential to minimizing patient safety risks associated with NPWT.

In November 2009 the U.S. Food and Drug Administration (FDA) issued a warning to health care professionals and consumers regarding serious complications, especially bleeding and infection, associated with NPWT. On February 24, 2011, the FDA updated the warning, reporting that there had been 12 deaths and 174 injuries since 2007. Bleeding continued to be the cause of most of the serious events and occurred in patients with blood-vessel grafts in the legs, those with breastbone and groin wounds, and those receiving anticoagulants, as well as during removal of dressing adherent to the tissues. Wound infection related to the retention of dressing material in the wound was another reported serious complication. The FDA also warned that the safety and effectiveness of NPWT systems in newborns, infants, and children hasn’t been established and that there are currently no NPWT systems approved for use in these populations.

From January 2008 to December 2009 the Pennsylvania Patient Safety Reporting System (PA-PSRS) received 419 reports of complications associated with NPWT. Almost half of the reports involved problems with the ongoing assessment and monitoring of NPWT after the initiation of therapy. In some instances, infrequent assessment and monitoring resulted in infection, maceration, or compromise of tissue surrounding the wound. Other reports involved a delay in the initiation of NPWT or incorrect application of the system. Reports also indicate that patients experience complications with NPWT after discharge. The event reports are summarized as follows:

- Reports associated with assessment (5%) describe events related to delayed or missing physician orders or the lack of patient assessment before initiation of treatment.
- Reports associated with the application of NPWT (21%) describe events related to a delay in application or incorrect application of NPWT.
- Reports associated with the monitoring of NPWT (47%) describe events related to the frequency or lack of monitoring of the functioning of the system.
device or the adequacy of ongoing assessment of the patient undergoing NPWT.
- Reports associated with NPWT issues after the patient’s discharge from the acute care setting (7%) suggest that patients or family caregivers may not have received adequate education on home-based NPWT.
- The remainder of the reports (20%) involved a combination of some or all of the above categories of events.

**Examples.** The following examples were taken from reports to PA-PSRS.

- **Patient on wound-vacuum therapy was taken to radiology for a procedure, and when the patient was returned to the room, the nurse did not reinitiate therapy.** Ninety minutes later, another nurse reapplied the wound vacuum and restarted the therapy. Nurses are encouraged to complete bedside reports and complete thorough assessments after returning a patient from treatment.
- **NPWT dressing was due to be changed; when the wound was examined the dressing was found to be applied incorrectly, with the tubing directly against the wound instead of on top of the sponge as directed.**
- **Black foam [used in NPWT] was placed directly on the skin; no barrier was placed first.** When the foam was pulled off, healthy skin was bleeding and had foam marks.
- **When changing the NPWT dressing, staff noted that the foam had been covering intact skin and was not just in the wound bed.** The skin surrounding the incision line was now very red and abraded.
- **Nurse went to the bedside for NPWT dressing change and noticed that the sponge was not compressed, the machine was off, and the suction tubing connector was not connected to the canister.** The nurse reconnected the machine and suction was established; it was not determined how long the machine had been left off.
- **The patient was seen for a routine visit at a local wound clinic.** A call was received that NPWT discharge was done poorly prior to patient’s discharge with black foam overlapping the intact skin, causing maceration of healthy tissue.
- **The patient noticed that NPWT suction was fluctuating while he was still an inpatient; pressure was not remaining constant at 120 mmHg as ordered by the physician.** The patient reported suction issue to staff prior to discharge; staff were unable to [solve the problem] and did not contact physician. Per patient, staff stated visiting nurse would rectify the problem. When wound and skin graft were assessed by visiting nurse, [the patient’s tissue was] found to be macerated from the amount of drainage that had built up under the dressing. The patient was instructed in troubleshooting the unit and measures to employ if needed.

**HOW DOES NPWT WORK?**

When NPWT is ordered for a patient, there are a number of strategies to ensure the safe use of the system; the most basic is an understanding of the principles of NPWT. NPWT facilitates wound healing through the following mechanisms:
- **Stimulation of wound-edge retraction.** Negative pressure draws the edges of the wound together.
- **Stimulation of granulation tissue formation.** Application of mechanical force slowly stretches the skin and stimulates new cell growth and the formation of granulation tissue.
- **Increased local blood flow.** Increased blood flow decreases inflammation and edema and also helps to remove bacteria and exudate from the wound. The reduction in fluid around the wound margins also increases capillary blood flow to the wound bed.
- **Reduced bacterial load in the wound.** The reduction in the number of dressing changes decreases damage to delicate new tissue and decreases exposure of the wound to nosocomial infection.

A number of NPWT systems are available, and a nurse caring for a patient using NPWT must be familiar with the manufacturer’s instructions. Notably, indications for use and application methods aren’t the same for all devices. The basic components of NPWT are the dressing, sealing mechanism, tubing, and suction pump. The details of application are beyond the scope of this article. Typically, though, foam or gauze dressing is sized to fit into the wound and applied to the wound base. A transparent film that covers the wound and dressing is applied, providing a closed environment. Tubing attached to the dressing and a suction pump remove excess fluid and exudate from the wound. Suction may be set between 60 and 125 mmHg and can be intermittent or continuous.

**WHICH PATIENTS ARE CANDIDATES?**

Appropriate patient selection is important to prevent complications and help ensure the success of NPWT. As with any wound care regimen, optimizing the patient’s ability to heal is essential and requires assessment and management of underlying diseases, such as diabetes mellitus, and monitoring of anticoagulation and immunosuppressive therapy. Other factors affecting wound healing are hemodynamic stability, nutritional status, blood glucose, fluid balance, and...
the presence of infection. Nurses can help ensure the safe use of NPWT by assessing a patient prior to the initiation of therapy for factors that place a patient at risk for complications:

- anticoagulant use
- friable vessels and infected blood vessels
- vascular anastomosis
- infected wounds
- malignancy in the wound margins
- untreated osteomyelitis
- exposed vessels, nerves, tendons, and ligaments
- exposed vital organs
- sharp edges in the wound
- spinal cord injury
- nonsutured hemostatic agents (such as bone wax, absorbable gelatin sponge, and spray wound sealant) applied at the wound site, which may, if dislodged, increase the risk of bleeding
- magnetic resonance imaging
- hyperbaric chamber treatment
- defibrillation
- application near the vagus nerve (because of the risk of bradycardia)
- circumferential dressing application

PROMOTING THE SAFE USE OF NPWT
Before initiating NPWT, refer to facility policy and be knowledgeable about the manufacturer’s instructions on use of the device. Regular in-servicing and competency updates are essential to ensure safe and successful use of NPWT. Education of patients and caregivers is also required to ensure safe use of NPWT after discharge. Although a number of NPWT devices are available, the basic steps involved in NPWT are similar: accurate assessment of the patient and wound before initiation of NPWT; appropriate wound-bed preparation; application of the NPWT unit; and monitoring of progress during NPWT, which includes dressing changes and wound reassessment. In each step of the implementation and management of NPWT, risk-reduction strategies can promote the safe use of the device and facilitate wound healing.

Patient assessment.
- Review the physician’s order for NPWT. Orders should include the wound-cleansing agent, the type of vacuum and dressing (foam or gauze), therapy settings (intermittent or continuous suction and a negative-pressure setting, for example), and the frequency of dressing changes.
- Assess the patient for the risk factors for complications (listed above), especially the risk of bleeding, including preexisting bleeding disorders and the use of anticoagulants or other medications or herbs that prolong bleeding times (such as nonsteroidal antiinflammatory drugs, including aspirin, and gingko biloba). Bleeding associated with the use of NPWT has caused patient deaths.
- Assess the periwound (the area surrounding the wound) for signs of compromise, such as breakdown or maceration; address these conditions before initiating NPWT.

Wound preparation.
- Cleanse the wound according to the physician’s order and facility policy before each dressing application.
- Apply minimal mechanical force during each cleaning.
- Consider using 0.9% sodium chloride solution instead of antiseptic or antibacterial preparations.
- Clean the periwound, protecting intact skin to prevent breakdown. Skin-preparation products provide a protective barrier between the skin and the adhesive dressing, remove skin oils to promote a better seal, and help minimize trauma when the dressing is removed.

Application.
- Depending on facility policy, a certified wound-care specialist may perform the majority of NPWT applications. All nursing staff should undergo regular in-servicing and competency updates to address current practice in troubleshooting alarms, repairing leaks, and observing for complications.
- Select and prepare the dressing type and size appropriate for the wound as directed by the physician’s order, facility policy, and manufacturers’ instructions. Two types of sponges are typically available: black polyurethane and white soft foam. Gauze dressing may also be used with some NPWT systems. The dressing is used to fill all open areas of the wound, but practitioners should avoid overpacking the wound.
- Document the type of dressing that’s applied and the number of dressing pieces, as well as any additional measures used to create an adequate seal. Document the number of dressing pieces on the outside of the adhesive film and in the patient’s medical record to prevent any gauze or sponge from being left in the wound.
- Avoid pulling or stretching the transparent adhesive dressing used to seal the wound to prevent trauma to the periwound.
- Implement and document the ordered amount of negative pressure and the suction cycle. Continuous therapy provides sustained tension on the cells of the wound, causing mechanical...
stretching and removal of fluids. Intermittent therapy applies greater mechanical stretching throughout the treatment as the unit is cycled on and off.\textsuperscript{9, 10, 12}

**Ongoing monitoring and assessment.**

- Dressing changes are typically performed every 48 hours. At each dressing change, assess for wound deterioration, erythema, pain, purulent drainage, tissue necrosis, and an increase in wound size. The dressing may need to be changed more frequently when a wound is infected; the dressing change will be based on continuing evaluation of the wound and the patient’s clinical status.\textsuperscript{9, 10, 12, 14, 15}

- During each shift or in keeping with facility policy, ensure that the sponge is collapsed in the wound and the unit is on and functioning appropriately. A sponge that isn’t compressed may indicate a break in the seal.\textsuperscript{9-12}

- If NPWT use is interrupted for more than two hours, remove the old dressing and irrigate the wound. Disconnection from NPWT for more than two hours places patients at risk for the development of deep-vein thrombosis, compromised pulmonary function, and infection or sepsis (or both).\textsuperscript{10, 12, 16, 17}

- Avoid creating any new areas of pressure by ensuring that the tubing isn’t pressing against the patient’s skin.\textsuperscript{9, 10, 12, 14}

- Closely monitor patients with highly exudating wounds for fluid loss and dehydration.\textsuperscript{14}

- Troubleshoot and resolve NPWT alarms according to manufacturer’s recommendations.\textsuperscript{14, 16}

**WHEN TO STOP NPWT**

In the absence of complications, the duration of NPWT is based on regular evaluation of wound progress, the achievement of a predetermined treatment goal, or both.\textsuperscript{15, 18} Accurate and reproducible measurement of the wound should be performed weekly and the results recorded. Generally NPWT is used until the wound is filled with granulation tissue and ready for skin grafting, a flap, or standard wound care, but in some cases it’s used until wound closure.\textsuperscript{16} NPWT may be discontinued because of poor patient compliance or if the patient cannot tolerate NPWT.\textsuperscript{12} Stop NPWT and notify the physician or wound-care practitioner if any of the complications described above occurs or if signs of deterioration of the wound appear, such as erythema, pain, discharge or infection, tissue necrosis, or increased wound size.\textsuperscript{13}

**PATIENT AND FAMILY CAREGIVER EDUCATION**

Reports to the FDA indicate that patients have experienced serious complications related to NPWT after discharge.\textsuperscript{7} Similarly, reports to PA-PSRS suggest that the education of patients and caregivers (or the lack thereof) regarding NPWT use may have been a factor in the development of complications that resulted in re-admission. Consideration should first be given to whether the use of NPWT is appropriate for the patient in the home setting; patients and their caregivers need to be able to understand discharge instructions on the management of NPWT, especially if the availability of home care or accessibility of a wound-care clinic is limited.\textsuperscript{13} The education of patients who will be discharged with an NPWT device and the patients’ caregivers ideally should begin upon initiation of therapy and continue throughout the patients’ hospitalization. Return demonstrations are a good way to assess their understanding and skills.\textsuperscript{19} Ongoing education and discharge instructions regarding NPWT use for patients and caregivers include the following\textsuperscript{19}:

- the safe operation of the device (provide printed patient instructions either from the device manufacturer or specific to the device)

- troubleshooting of audio and visual alarms

- applying or reinforcing dressing application

- recognizing signs and symptoms of complications to report

- contacting appropriate health care providers, especially in an emergency situation

- responding to emergency situations, such as observing the bright red blood in the tubing or collection canister

Teach patients and caregivers that, in an emergency situation, they should stop NPWT immediately, apply direct manual pressure to the dressing, and activate emergency medical services.\textsuperscript{11}

**IN A NUTSHELL**

By following the general principles of wound care and implementing best practices related to NPWT, health care providers can safely facilitate wound healing. Widespread use of NPWT suggests that a health care provider is very likely to encounter a patient undergoing NPWT. Safe and effective implementation of NPWT requires regular staff servicing and competency evaluation. Clinical staff must be prepared to appropriately apply, monitor, and effectively troubleshoot problems with the device. Staff must be able to recognize and respond to complications related to NPWT. Patients and family caregivers must also be prepared to apply the unit, monitor therapy, and respond appropriately to issues that arise if the patient continues NPWT at home. ▼
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REFERENCES


