DISCLAIMER: These guidelines were prepared jointly by the Surgical Critical Care and Medical Critical Care Services at Orlando Regional Medical Center. They are intended to serve as a general statement regarding appropriate patient care practices based upon the available medical literature and clinical expertise at the time of development. They should not be considered to be accepted protocol or policy, nor are intended to replace clinical judgment or dictate care of individual patients.

NEGATIVE PRESSURE WOUND THERAPY

SUMMARY

Negative pressure wound therapy (NPWT) is the application of specialized sub-atmospheric pressure dressings to facilitate wound closure. NPWT is associated with variable benefits depending upon the patient population in which it is used. Appropriate consideration of the indications for NPWT is important given the cost of this therapy.

RECOMMENDATIONS

- **Level 1**
  - NPWT improves the rate of skin graft success in patients at high risk of graft loss.
  - NPWT improves patient comfort and decreases wound care requirements in patients with pressure (decubitus) ulcers.
  - NPWT should not be used in wounds with inadequate tissue perfusion.
- **Level 2**
  - NPWT reduces time to wound closure in acute open wounds.
  - NPWT should be considered when primary closure is not possible after or between wound debridements as a bridge to definitive closure.
  - NPWT reduces time to wound closure, length of hospitalization, complication rates, and cost in chronic diabetic foot wounds.
  - NPWT improves patient survival among patients who require an open abdomen.
  - NPWT should be stopped when delayed surgical closure is possible.
  - NPWT should not be used in patients with active bleeding or infection.
- **Level 3**
  - NPWT dressings simplify post-operative wound care especially in large, complex wounds that are difficult to dress.
  - If home NPWT is anticipated, home health care should be consulted early and arrangements made to facilitate timely discharge and delivery of dressing supplies to the patient's home.

INTRODUCTION

Negative pressure wound therapy (NPWT), also known as "vacuum-assisted wound closure", refers to the application of sub-atmospheric pressure to either an acute or chronic wound to remove exudate and debris, decrease edema, reduce bacterial colonization, and promote granulation tissue formation and perfusion (1,2). It is intended to create an environment that promotes wound healing by secondary or tertiary intention. NPWT has been widely adopted over the two decades and over 1,000 publications describe its use in a variety of wound types (3). While the beneficial effects of subatmospheric pressure on wound healing have been demonstrated in animal models, prospective randomized trials in humans are limited and the evidence supporting NPWT is primarily limited to retrospective reviews, small prospective clinical trials, and expert opinion.

EVIDENCE DEFINITIONS

- **Class I:** Prospective randomized controlled trial.
- **Class II:** Prospective clinical study or retrospective analysis of reliable data. Includes observational, cohort, prevalence, or case control studies.
- **Class III:** Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion.
- **Technology assessment:** A technology study which does not lend itself to classification in the above-mentioned format. Devices are evaluated in terms of their accuracy, reliability, therapeutic potential, or cost effectiveness.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

NPWT generally consists of open-pore polyurethrane foam sponge, a semi-occlusive adhesive sheet, a fluid collection system, and a suction pump capable of generating negative pressures of 50 to 175 mmHg. The foam sponge is cut to fit the size of the wound and covered with the adhesive sheet. A suction port and tubing is attached to the foam via a hole cut in the adhesive cover. The dressing is then connected to a portable suction pump. Any fluid, bacteria, debris, and pro-inflammatory cytokines within the wound are collected in a disposable collection canister attached to the suction pump. These dressings may be used in both the inpatient and outpatient setting.

The NPWT dressing maintains a warm, moist environment that is stable and more conducive to wound healing than traditional wet-to-dry dressings (2,3). The closed negative pressure system generates a pressure gradient between the wound and suction canister that promotes fluid transport from both the wound bed and interstitial space reducing wound edema. The open porous structure of the foam transmits the negative pressure to the wound surface. The wound deforms, drawing the edges of the wound together, decreasing wound size and volume, and firmly opposing any skin grafts or flaps that are present. Tissue deformation is an important stimulus for tissue remodeling at the cellular level. The degree of tissue deformation depends upon the stiffness of the tissue; scar tissue has less mobility and will have less of a response to NPWT. NPWT increases blood flow within the wound, reduces the pro-inflammatory cytokine and bacterial burden present, and stimulates fibroblast growth and migration into the wound accelerating the healing process (4,5).

Both systemic and local wound factors can contribute to delays in wound healing. Systemic factors (e.g., poor nutrition, wound ischemia, etc…) should be identified and corrected to the extent that is possible. Local wound factors that interfere with normal healing include desiccation, tissue edema, excessive exudate, poor tissue apposition (e.g., grafts and flaps), and wound infection. Stagnant fluid is associated with pro-inflammatory cytokines that impede wound healing. The purpose of NPWT is to overcome many of these local wound factors.

NPWT systems may be placed only under the order of a physician. The order must specify negative pressure limits, continuous or intermittent mode, and the frequency of dressing changes. The dressings may be applied by either a trained physician or nurse.

INDICATIONS & CONTRAINDICATIONS

NPWT is intended for use in the following clinical situations:

- Chronic open wounds [diabetic ulcers and pressure ulcers (Stage III or IV)]
- Acute and traumatic wounds especially as a bridge to definitive closure
- Skin grafts
- Sub-acute wounds (such as dehisced incisions)
- Post-operative flaps or grafts
- The “open abdomen”

NPWT is contraindicated in the setting of:

- Exposed organs, blood vessels, vascular grafts, or unexplored enteric fistulas
- Active, untreated infection
- Necrotic tissue
- Malignancy tissue (within the wound)
- Fragile skin
- Active hemorrhage / coagulopathy / anticoagulation
- Adhesive allergy

LITERATURE REVIEW

Numerous clinical trials and systematic reviews of NPWT have been performed. Due to the broad range of patient populations to which this therapy can be applied, specific indications and patient groups should be considered rather than the efficacy of NPWT as a whole.

- Acute Wounds
  Acute wounds are commonly traumatic in nature, but may also occur after surgical debridement of infected / necrotic tissue or following surgical reconstruction. Such wounds commonly require serial debridement and dressing changes over a prolonged period of time. NPWT has been demonstrated to significantly reduce the time to wound closure (5,6). NPWT has also been demonstrated to facilitate the management of complex wounds, simplifying postoperative wound care, decreasing the number of dressing changes, and reducing the complexity of subsequent reconstructive procedures (3,7). NPWT is especially useful when primary closure is not possible after or between wound debridements and can serve as a bridge to definitive closure (3). Due to its cost, NPWT should be stopped as soon as delayed surgical closure is possible.

- Chronic Wounds
  Compared with conventional dressing changes, NPWT reduces the time to closure of diabetic foot ulcers. NPWT is also associated with shorter length of hospitalization, decreased complication rates, and reduced cost in such patients. Among patients with pressure (decubitus) ulcers, NPWT improves patient comfort and is less labor-intensive (8,9).

- Skin graft / flap fixation
  NPWT has been used instead of traditional bolstering methods to provide skin graft fixation in patients at high risk for skin graft loss (10). NPWT distributes negative pressure uniformly over the surface of the fresh graft, immobilizing the graft with less chance of shearing (11). Improved qualitative skin graft take and skin graft success have been demonstrated in both observational and randomized trials (12,13).

- Open abdomen
  The abdomen of a critically ill patient is frequently left open to avoid the detrimental effects of elevated intra-abdominal pressure (intra-abdominal hypertension and abdominal compartment syndrome) and to facilitate second look operations. Compared to traditional temporary abdominal closure dressings, NPWT has been demonstrated to significantly improve patient survival and facilitate earlier closure of the open abdomen (14).

- Open sternum
  Post-sternotomy mediastinitis is a devastating complication of cardiac surgery with high morbidity and mortality (10). NPWT has been demonstrated to significantly decrease bacterial load, decrease hospital length of stay, and reduce overall mortality (15,16).

COMPLICATIONS

NPWT is generally safe and well-tolerated. Significant complications can usually be avoided through appropriate patient selection. Bleeding is the most common significant complication associated with NPWT. Minor hemorrhage from granulation tissue during dressing changes is common and easily controlled using direct pressure. Severe hemorrhage may occur in patients who are anticoagulated or in patients with exposed blood vessels or grafts. Infection is most commonly due to inadequate debridement and control of the initial wound infection. Adequate source control is therefore essential to successful subsequent NPWT. If active infection is suspected, NPWT should be discontinued, the wound debrided, and appropriate antibiotics initiated. Control and closure of enteric fistulas can be expedited through the use of NPWT, but fistula formation has been reported with the use of incorrectly placed NPWT dressings.

DRESSING CHANGES

NPWT dressings are typically changed every 48-72 hours based upon the patient's clinical situation. The following procedure describes appropriate removal and replacement of a NPWT dressing.

Procedure:

1. Schedule the dressing change so that the patient's physician or Wound Management Team member can be present (if desired).
2. Gather all necessary supplies at the patient's bedside.
   - Suction machine
   - Appropriately-sized NPWT dressing (including foam, semi-occlusive dressing, suction tubing, and collection canister)
   - Normal saline
   - Scissors
   - 4 x 4 gauze
   - Wound measuring guide
   - Skin prep barrier wipe
3. Explain the procedure to the patient and family.
4. Turn off the negative pressure 30 minutes before the dressing change.
5. Provide appropriate pain medication and/or anxiolytics to the patient 30 minutes before the procedure as ordered by the physician. Pain is controlled more effectively when administered prior to the dressing change.
6. Perform a timeout to ensure the right patient, right procedure, right site, and right equipment.
7. Remove the existing semi-occlusive dressing. Carefully remove the foam from the wound ensuring that all foam has been cleared from the wound prior to reapplication. Adherent foam should be soaked with normal saline and allowed to sit for 15-30 minutes before reattempting removal. If pain is excessive during foam dressing removal, the sponge can be soaked with topical Xylocaine without epinephrine (requires physician's order) prior to its removal either directly or via the suction tubing (with suction off).
8. Wounds treated with NPWT may become malodorous, but this does not necessarily confirm that infection is present. Wash the wound with sterile normal saline (if necessary). Thoroughly dry the skin surrounding the wound.
9. Determine the length, width, and depth of the wound. Note any tunnels or sinus tracts that are present.
10. Using clean technique (unless the physician specifies sterile technique), cut the new foam dressing slightly smaller than the size of the wound. Place the sponge lightly in the wound filling the entire area and eliminating all dead space. Ensure that the foam does not lie on any intact skin. Foam should not be placed over exposed arteries, veins, or intestine. If the depth of the wound requires using more than one piece of foam, ensure that the foam edges are in contact with each other. When fragile tissues are present within the wound, an interposition layer (such as petrolatum gauze) should be placed between the wound tissue and the foam sponge.
11. Prepare the peri-wound skin using a skin prep barrier wipe.
12. Cover the foam dressing with a new semi-occlusive adherent sheet. The sheet should extend at least 3-5 cm beyond the edge of the wound to achieve an occlusive seal. Vi-Drape spray, Mastisol, or skin glue can be used to help achieve a seal in complex or difficult wounds.
13. Cut a hole in the occlusive sheet and attach the suction tubing pad to the dressing.
14. Attach a new suction canister to the suction device. Connect the suction tubing to the suction canister.
15. Turn on the suction device, setting the therapy (suction level, continuous vs. intermittent) as prescribed by the physician. Ensure that an adequate occlusive seal has been obtained and that there is no leak. The foam under the occlusive dressing should compress and become firm to the touch. If this does not occur, examine the dressing and patch any leaks present as necessary.
16. Complete the NPWT procedure note in the electronic medical record. Carefully document the dimensions of the wound.
17. Complete the NPWT physician's orderset in the electronic medical record.

DOCUMENTATION

Confirm and document each shift that the dressing is intact, suction device is functioning properly, the prescribed level of suction is being used, the integrity of the surrounding skin, presence of rashes, volume/amount of drainage, and color of drainage.

PATIENT DISCHARGE / OUTPATIENT NPWT

Patients who will require outpatient NPWT following hospital discharge should ideally be identified early in their hospital course. This will allow sufficient time to ensure that the necessary insurance paperwork is processed and dressing supplies delivered prior to patient discharge. The patient should receive training on how to use the suction pump and be comfortable managing the device at home. The patient should be informed of the potential complications associated with the device and the need to seek medical assistance immediately if bleeding is observed. NPWT should be closely monitored by either a home health care nurse or the patient's physician.

The following patient populations will be placed on a home NPWT suction device prior to discharge from the hospital:

- Dressing changes that may induce pain or cannot be performed outside the hospital
- Patients who have undergone recent split thickness skin grafting
- Patients where a physician writes an order for uninterrupted therapy from hospital to home

Patients not meeting the above criteria should have their inpatient NPWT dressing removed and a wet-to-dry dressing applied at the time of discharge. A home health care nurse will meet the patient at home and place a new NPWT dressing in the wound using supplies delivered to the patient's home.

The NPWT vendor will provide the patient with a clear process for reordering dressing supplies as well as access to knowledgeable staff for 24/7 product consultation and technical support / equipment problems.

DISCONTINUATION OF THERAPY

Widespread clinical practice would support the closure of soft tissue wounds by surgical methods rather than healing by secondary intention. Once the wound bed is clean and granulating, and no other contraindications are present, delayed surgical closure should be performed, reducing cost, speeding recovery, and minimizing inconvenience for the patient (3).

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