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International Consensus Panel Recommendations for the Optimization of Traditional and Single-use Negative Pressure Wound Therapy in the Treatment of Acute and Chronic Wounds

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International Consensus Panel Recommendations for the Optimization of Traditional and Single-Use Negative Pressure Wound Therapy in the Treatment of Acute and Chronic Wounds

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ABSTRACT: *Introduction.* Currently, there are no international standardized guidelines or recommendations to guide the clinical decision-making process on when to initiate various negative pressure wound therapy (NPWT) systems for acute and chronic wounds. Specifically, no established recommendations or guidance exists regarding the type of NPWT system to use, traditional (tNPWT) or single-use (sNPWT), and how to transition between the 2 systems. *Methods.* An expert panel was convened to (1) provide recommendations to clinicians on when to consider NPWT use in acute and chronic wound management and (2) develop a practical decision-making tool to guide on the appropriateness of the different NPWT modalities (tNPWT or sNPWT) and when they should be utilized. *Results.* The panel made recommendations and designed a clinical decision-making tool to aid the consideration for initiating NPWT and the optimal system to be utilized based on (1) therapeutic goals, (2) wound-related factors, (3) patient satisfaction and quality of life, (4) care setting-related factors, (5) economic-related factors, and (6) NPWT system-related factors. *Conclusions.* The panel recommendations took into consideration the clinical, operational, and financial factors in the clinical decision-making process of NPWT use to enable optimal patient and health care system outcomes.

KEY WORDS: traditional negative pressure wound therapy, single-use negative pressure wound therapy, patient satisfaction, quality of life, operational efficiencies, financial efficiencies

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INTRODUCTION

In the late 20th century, the introduction of negative pressure wound therapy (NPWT; now referred to as traditional NPWT [tNPWT]) launched a new era in wound management. The tNPWT system entails the use of a pump that delivers subatmospheric pressure to the wound bed through tubing secured to a filler, typically gauze or foam, which is placed into the wound and sealed with an adhesive drape. The wound exudate then is collected in a canister. The mechanism of action of NPWT is now reasonably understood, resulting in improved wound homeostasis, wound bed appearance, granulation tissue formation, and improved tissue perfusion.[1,2]

Traditional NPWT has become a standard treatment modality for wounds of select etiologies, with several systems available on the market.[3] However, clinical, operational, and financial obstacles, examples of which are listed in **Table 1**, can limit its use. In attempts to overcome some of these barriers, an evolution in NPWT has occurred, including the advent of single-use NPWT (sNPWT) systems.[3] The sNPWT applies subatmospheric pressure to the wound through an integrated dressing and pump system, with or without an associated canister. Various sNPWT systems exist, each with specific instructions for use (IFU) in terms of wear time and requirement for dressing change frequency.

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While advances in NPWT delivery and systems have been made, there are currently no international or standardized guidelines or recommendations on when to initiate NPWT as a treatment modality for selected acute and chronic wounds.[4] Specifically, guidelines should consider the type of NPWT system (tNPWT or sNPWT) that would be appropriate. At present, health care professionals determine which NPWT treatment to use on a case-by-case basis or are driven by protocols that vary by institution. This can lead to inconsistency and wide variability in wound assessments and choices of when to use NPWT, how to use it, which system to use (tNPWT or sNPWT), and, if required, how to transition between the 2 systems. To address this issue, an expert panel was convened to (1) advise clinicians on when to consider NPWT use in acute and chronic wound management and (2) provide a practical decision-making tool to guide on NPWT modality (tNPWT or sNPWT) and when it should be utilized.

Recommendations of this panel focused on tNPWT and sNPWT, as these are the 2 most common modalities of NPWT available worldwide. Discussion focused on the treatment of acute and chronic wounds and not closed surgical incision management or temporary abdominal closure with NPWT, as sufficient literature and guidelines exist on the use of sNPWT in this setting.[5,6] Acute wounds are defined as those that proceed through the well-recognized and overlapping phases of wound healing—hemostasis, inflammatory, proliferative, and remodeling—for resolution in a timely fashion. Chronic wounds have delayed healing, often stalled in a dysregulated inflammatory phase, therefore making them unable to progress to the proliferative phase of healing.[7]

Table 1. Clinical, operational, and financial obstacles that can limit tNPWT use

Need for technical guidance and education to clinicians who are operating the systems within their own facilities
Patient pain
Tolerance and impact on quality of life
Human resources and time necessary to manage logistics for procurement and discharging a patient on tNPWT
Access to tNPWT system
tNPWT pump device losses
Billing disputes

tNPWT: traditional negative pressure wound therapy

Use of NPWT that incorporates fluid instillation (iNPWT), a newer modality of NPWT, is often touted to assist in wound bed preparation through removal of microorganisms and dilution of inflammatory and cytotoxic macromolecules in addition to the mechanisms of action of tNPWT.[8] However, a recent systematic review on its use identified only 5 (4%) level 1 randomized controlled trials (RCTs), 4 of which compared iNPWT with tNPWT.[9] None of these 4 studies demonstrated any statistically significant difference between iNPWT and tNPWT use in the number of surgeries required, length of hospital stay, readmission, duration of antibiotic therapy, bacteria concentration, reinfection, duration of NPWT use, time to wound healing, and proportion of wounds healed.

The results of this systematic review provide evidence that iNPWT use cannot replace the principles of good wound bed preparation, namely proper debridement, a key component in wound care.[10] Given these findings, iNPWT use was not included in the panel recommendations.

Process of Consensus Development

An international panel of clinicians from Canada, Spain, the United Kingdom, and the United States of America experienced in wound care and NPWT use was convened. Specialties of the panelists included dermatology, general surgery, nursing, orthopedic surgery, plastic surgery, podiatry, tissue viability, and wound care. Prior to the initial meeting, supplemental literature that further augmented current expertise and experience was provided for review. Panel meetings were performed virtually in compliance with guidelines and recommendations in place due to the COVID-19 pandemic. The entire panel met during the initial virtual meeting for introductions and to plan the consensus document, set objectives, and establish project timelines. Individual sessions were then held with panel members to gather information on personal experience with NPWT use and how therapeutic goals, alongside consideration of how factors relating to the wound, patient, care setting, economic, and device play a role in the process for deciding to initiate and discontinue NPWT and whether to implement therapy with a traditional or single-use system. A modified Delphi method[11] was employed to draft a consensus document based on these one-on-one sessions for review. Several rounds of group discussions and edits then were performed followed by approval of the final document by all panel members.

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CONSENSUS RESULTS

Overview

Consensus statements on the factors to consider for initiation and discontinuation of NPWT and the system to be utilized were grouped into 6 categories:

1. therapeutic goals,
2. wound-related factors,
3. patient satisfaction and quality of life,
4. care setting-related factors,
5. economic-related factors, and
6. NPWT system-related factors.

Therapeutic Goals

Consensus Statement 1: *Initiation of NPWT should be considered when there is a need to: (1) promote granulation tissue; (2) prepare a wound for closure—whether through use of an autograft, use of other advanced wound care modalities, delayed primary closure, or secondary intention; (3) control edema; (4) manage exudate; (5) achieve wound stabilization; and (6) assist in stabilization of patients with complex and traumatic wounds.*

A recent comprehensive review of NPWT suggests that therapeutic goals may be either short term or long term.[12] Short-term goals include providing a dressing solution; managing wound exudate, odor, and pain; and preventing infection. Possible long-term goals include reducing wound exudate volume, reducing the wound area, producing healthy granulation tissue, and preparing the wound bed for intended wound closure through secondary intention healing or by covering the wound with a skin graft or a flap.

Substantial evidence exists demonstrating that the application of NPWT expedites wound resolution and minimizes the potential for wound-related complications to occur. A systematic review and separate meta-analysis of RCTs comparing tNPWT with standard of care in the treatment of a variety of acute and chronic wounds found that NPWT resulted in greater reduction in wound size and reduced time in selected wound types to complete wound healing.[13,14] A systematic review and meta-analysis of tNPWT use in the treatment of diabetic foot ulcers (DFUs) found tNPWT use resulted in a significantly shorter time to healing; greater reduction in wound size, including depth; and significant increase in complete wound healing compared with standard of care alone. A significant reduction in amputation rates also was reported.[15] Use of a particular sNPWT system in an RCT specific to DFUs and venous leg ulcerations found a significantly greater reduction in wound area and closure rates compared with use of tNPWT, supporting its use as a first-line NPWT modality for these lower extremity wound types.[16]

In addition, tNPWT can be used for patients with complex and traumatic wounds, whereby it can assist in patient stabilization, allowing for step-down in care and enhanced patient mobility.[17] For these reasons, the panel determined that NPWT should be employed in the treatment of selected acute and chronic wounds to achieve the desired therapeutic goals.

Wound-Related Factors

Consensus Statement 2: *Wounds appropriate for consideration of sNPWT are those that meet device IFU, based on wound size, depth, and exudate amount. The clinician must be familiar with the IFU of the sNPWT system utilized, as these factors can considerably vary between sNPWT devices.*

Consensus Statement 3: *Wounds appropriate for consideration of tNPWT are those in which the size, depth, and volume of exudate are beyond the management capacity of a sNPWT system.*

Once the therapeutic goals and need for NPWT have been identified, wound-related factors—size, depth, and exudate amount—are the first considerations in the clinical decision-making process of determining the optimal NPWT modality to employ for the end goal desired.[3] The aforementioned wound aspects, while often difficult to quantify, vary by wound and patient. The tNPWT and sNPWT systems vary in capability of use, based on wound area, wound depth, and volume of exudate, and require consideration before use. For use in large, highly exuding wounds, tNPWT is the best option as those wounds require a powerful pump to deliver the appropriate NPWT and the capacity to manage large volumes of exudate. Depending on the tNPWT system utilized, the canister for fluid collection can hold between 300 mL to 1000 mL of exudate.[18-20] The tNPWT dressing changes are typically performed every 48 hours to 72 hours, at least 2 to 3 times per week. However, dressing change frequency can vary based on clinical assessment, patient acuity, and wound characteristics.

The sNPWT systems can be used to manage a variety of wounds, where the associated dressing conforms and covers the entire wound. In addition, sNPWT can be used with or without a filler, depending on the sNPWT system and depth of the wound, as long as intimate contact between the wound bed and the NPWT dressing or filler is achieved. It is a common misconception that the use of these systems is limited to smaller wounds with low amounts of exudate as this is often the focus of published reports.[21-24] For example, one sNPWT device (PICO; Smith+Nephew) can accommodate moderate volumes of exudate due to the construct of the associated dressing having a superabsorbent core and top film layer with a high moisture vapor transmission rate.[25] A retrospective analysis of 409 patients with wounds greater than or equal to 2 cm in depth found that those treated with this particular sNPWT sys-

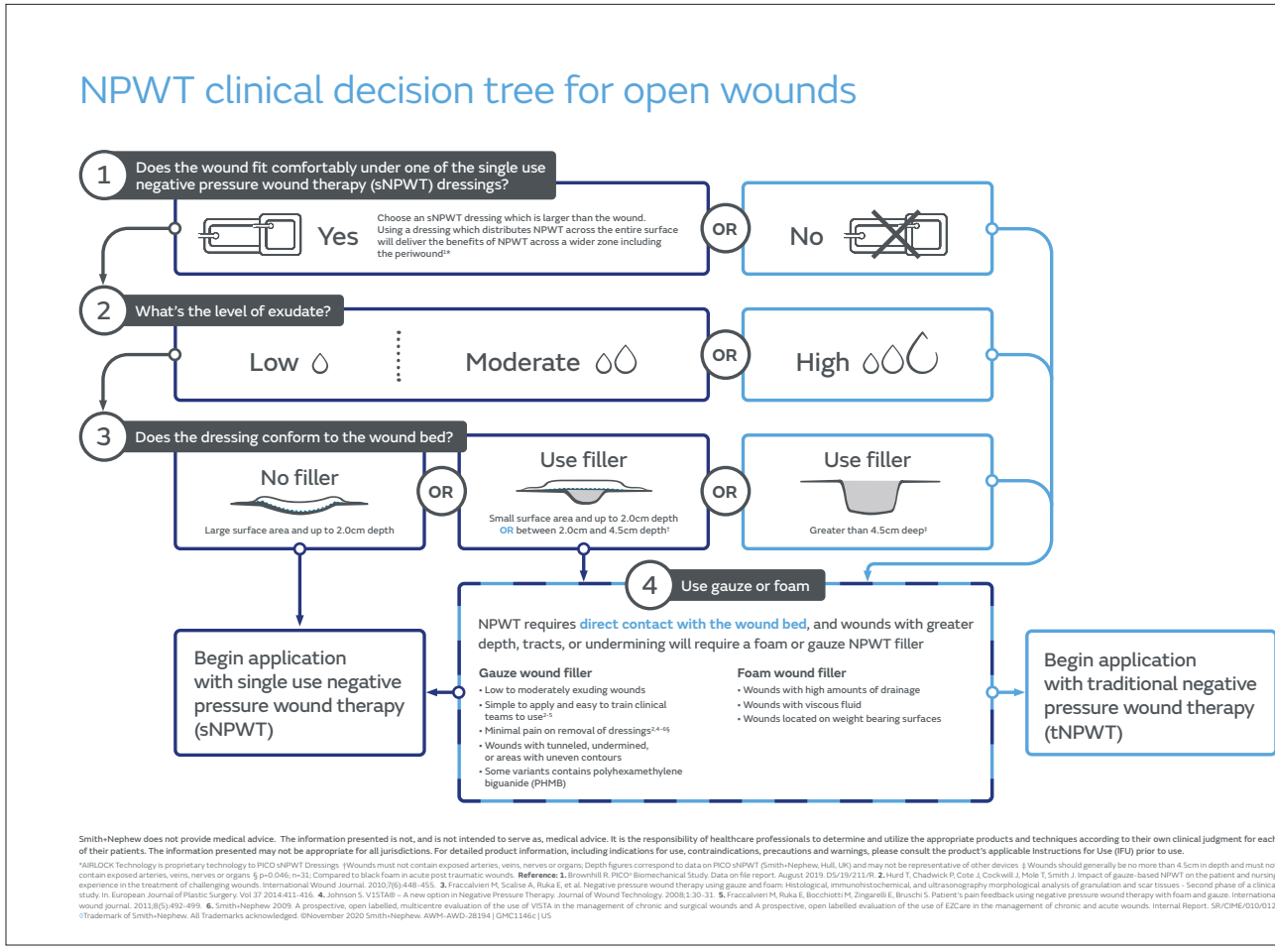

Figure. A clinical decision-making tool for determination of initiation of traditional negative pressure wound therapy or single-use negative pressure wound therapy in the management of open wounds.

tem required fewer dressing changes and had a substantially shorter time to healing, compared with those treated with standard of care.[24] However, clinicians need to be familiar with the labelling and IFU of the sNPWT system chosen, as exceptions exist. To provide guidance to health care professionals, a clinical decision-making tool to determine if an acute or chronic wound is suitable for tNPWT or sNPWT use has been designed and shown in the **Figure**.

Consensus Statement 4: *sNPWT can be considered as a bolster dressing for wounds in which closure is being obtained via a split-thickness skin graft (STSG) or application of a skin substitute.*

Intimate contact between a STSG and the wound bed for the first 5 to 7 days following application is critical to ensure the graft receives necessary vascular and nutrient supplies for successful take.[26-30] Similar principles exist for application of skin substitutes, despite the fact they do not take.[30] To facilitate intimate contact between the STSG or skin substitute and the wound bed, a bolster dressing such as an NPWT dressing is recommended to minimize shear, traction, and fluid accumulation between the wound bed and graft. The optimal wound bed for STSG or skin substitute placement is one that is well-vascularized with a healthy, noninfected granular base flush with the surrounding skin, no exposed structures, and low amounts of exudate. Furthermore, the use of tNPWT or sNPWT can facilitate both wound bed preparation, as outlined in the aforementioned therapeutic goals, and serve as a bolster dressing after graft placement. Several studies have demonstrated the use of tNPWT as a bolster dressing over STSG (range, 4–7 days), thereby allowing for greater patient mobility, increased graft take rates, shorter healing times, reduced need for repeat procedures, and improved long-term wound resolution rates.[27-30] These findings were consistent with tNPWT use for bolstering of artificial dermal skin substitutes.[30]

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The use of sNPWT in this setting is optimal due to the dynamics of the shallow wound bed, the recommendation that the bolster dressing remain in place as long as appropriate (typically 4–7 days), minimal impact on patient mobility, and the potential for early discharge home.[29]

Consensus Statement 5: *The wound should be reassessed at regular intervals (ideally every 2 weeks) to determine if NPWT treatment should be continued or discontinued and for the appropriateness of transition from tNPWT to sNPWT. Consideration should be made for reassessment of NPWT use if therapeutic goals have not been met or there is minimal or no change in wound size, amount of granulation tissue, or reduction in edema and exudate volume. Transition from tNPWT to sNPWT should be considered when the wound size, depth, and exudate amount are within the management capacity of the sNPWT system that is being considered for use.*

A focused, regular, wound assessment every few weeks provides an appropriate time frame to assess a wound for changes, therefore, enabling a clinical decision to be made on whether to continue or discontinue therapy or to use adjunct/alternative pertinent interventions.[4] As wound size, depth, and exudate amount decrease, the transition from tNPWT to sNPWT should be considered as a means to enhance patient satisfaction, increase quality of life through improved mobility, and ease of discharge from care facilities. Other institutional and cost-related benefits of transitioning a patient from tNPWT to sNPWT are addressed in the economic-related factors section of this consensus document. The panel agreed that NPWT should be discontinued once therapeutic goals are met or when the wound has not progressed towards resolution. Wounds that have not progressed towards resolution should be reassessed for causative factors and further appropriate interventions.

Table 2. Factors contributing to patient anxiety and stress with tNPWT use

Lack of understanding on the benefits of tNPWT
Patient perception that the clinician performing the dressing change is unfamiliar with proper application techniques
The need to reorganize their lives around frequent follow-up appointments
A decreased positive self-image and self-esteem due to being self-conscious of the noise and visual appearance of the tNPWT pump device when in public

tNPWT: traditional negative pressure wound therapy

Patient Satisfaction and Quality of Life

Consensus Statement 6: *When NPWT is deemed an appropriate treatment modality for acute and chronic wounds, sNPWT should be the first-line modality utilized to increase patient satisfaction and quality of life. Patient education on NPWT as a treatment modality, the benefits of its use, and the advantages of sNPWT over tNPWT can improve patient satisfaction and treatment compliance.*

Some patients have expressed optimism with NPWT treatment due to use of an advanced treatment modality on their wound that has the potential to expedite resolution.[26-28] However, patient quality of life has been shown to be reduced with tNPWT use.[29,30] A systematic review of the effects of tNPWT use on patient quality of life demonstrated a significant increase in patient anxiety, thought to be related to frequent painful dressing changes and restrictions on activities of daily living.[31] Pain during tNPWT dressing changes has been reported to occur in up to 67% of patients.[32] This pain is thought to be related to tissue damage that occurs during dressing changes because of tissue growth into the foam filler.[32] Use of a silicone-based NPWT dressing, a gauze wound filler, or a nonadherent wound contact layer between the wound bed and the foam filler may help reduce pain and tissue trauma during dressing changes.[33-38] Patients in a retrospective cohort study of sNPWT on complex dehisced abdominal wounds did not complain of pain or discomfort with application or removal of the associated silicone adhesive dressing.[35] An increased concentration of vascular endothelial growth factor, improved granulation tissue quality, and reduced scar tissue formation has been demonstrated with use of a gauze as opposed to a foam filler, theorized to be due to reduced tissue in-growth within the gauze filler.[36-38] This improved granulation tissue quality has been demonstrated to reduce the need for wound bed debridement prior to skin graft application. Reduced tissue in-growth with use of a gauze filler also has been found to result in significantly less patient-reported pain during dressing changes compared with a foam filler.[37] When a clinician determines that NPWT will help attain the therapeutic goals outlined for the treatment of an acute or chronic wound, use of a sNPWT system when clinically appropriate should be first considered to allow for improved patient experience and quality of life.

Minimizing the pain related to tNPWT dressing changes should positively impact patient quality of life; however, patient anxiety and stress with tNPWT use can still exist due to other factors (**Table 2**). Patients may therefore benefit from education on tNPWT, including benefits of its use and what its use entails. Patient education has been demonstrated to increase patient confidence and their ability to adapt to treatment with positivity, such as finding creative ways to dress and carry the tNPWT pump device in order

to conceal it and the associated tubing connection.[39-42] If the wound is suitable, many of these patient-related concerns can be addressed with sNPWT use.

The sNPWT systems are generally easy to apply, small, and quiet, making them easier to conceal and less of a hindrance on mobility and activities of daily living. For example, more than 80% of nurses in a study of 326 home care patients were pleased with the sNPWT system, with 96% finding it easy to apply,[21] resulting in easier application and less frequent dressing changes, since the dressing can be left in place for up to 7 days. A prospective RCT comparing sNPWT with tNPWT use on the treatment of lower extremity ulcerations found an overall increase in patient satisfaction in the sNPWT group, with willingness to use the system again due to comfort and reduced negative impact on activities of daily living and sleep.[16] This positive impact on patient satisfaction and quality of life supports sNPWT as a first-line modality in wounds eligible for its use.

Consensus Statement 7: *sNPWT use may be an optimal choice for ambulatory patients with wounds eligible for sNPWT use who must return to work or face barriers to access follow-up medical appointments.*

Restriction of movement, decreased self-esteem, increased dependency on others, perception of the loss of control, and increased anxiety have been implicated as reasons patients desire to discontinue tNPWT, particularly with patients of a younger age.[33,37,39,40,42] With age and additional factors included herein, sNPWT may be an excellent alternative. Being on the whole smaller and quieter, sNPWT makes it easy to secure and conceal compared with tNPWT, facilitating discreet treatment and allowing patients greater independence and quality of life.[16,21,40,41] A study of 326 home care patients found that with use of sNPWT, more than 90% were able to shower/bathe and perform daily activities on their own (when disconnecting the sNPWT pump from the dressing during washing).[21] Over 97% of these patients reported no discomfort with wearing the system and were pleased with its treatment. For patients who may have difficulty in being concordant with follow-up appointments due to their living environment or other medical conditions, such as patients who are homeless or have other social barriers, specific sNPWT systems are optimal due to ease of its removal, minimal risk for retained dressings, and ability to use without a filler (if appropriate).[17,21]

Care Setting-Related Factors

Consensus Statement 8: *tNPWT is a valuable treatment option for patients with acute or chronic wounds that are large and complex. Benefits of tNPWT include stabilization of the wound and patient, patient mobility, more rapid transition from critical care units to step-down units, and reduced hospital length of stay. Initial use of sNPWT or early conversion to sNPWT from tNPWT in eligible wounds should be considered to assist in transitioning patients from inpatient to outpatient care.*

Clinical evidence exists to support using NPWT to expedite patient and wound stabilization and wound management. This has resulted in the wide adoption of NPWT for the management of complex wounds, and the trend is for NPWT to be deployed in the home as well as in hospitals.[43] Initiation of NPWT within the first 2 days of care as opposed to day 3 or later in patients with large traumatic or open surgical wounds has been shown to reduce the risk for infection and delayed healing, is associated with more rapid weaning of patients off ventilator support, and encourages patient mobility, potentially resulting in less time spent in critical care and a reduced length of hospital stay.[17,29,38,44] Availability of necessary tNPWT supplies and access to nurses specialized in tNPWT application have been factors cited in delayed discharge and prolonging hospital length of stay. Single-use NPWT may further facilitate transition of patient care from the inpatient to outpatient setting or may negate the need for hospitalization altogether.[4,21,29,45] Use of an sNPWT system in 21 patients (8 retrospectively reviewed and 13 prospectively evaluated) with varying surgical and traumatic wounds, facilitated earlier patient discharge and subsequent outpatient management that enhanced patient quality of life and reduced associated hospital costs.[24] Use of this same system at a major trauma center over a 5-year period of time also demonstrated greater ability of transition from or negated the need for inpatient care.[44] Of 213 wounds studied, 93.4% of which were open, more than 50% were able to be managed in the outpatient setting, thereby increasing hospital inpatient throughput.[44] For the remainder of the patients, the sNPWT device was applied in the operating room or inpatient setting, with subsequent ability for earlier discharge and reduced length of stay. Similarly, this was associated with reduced health care costs and enhanced patient flow due to bed availability for other non-surgical and surgical patients requiring hospital admission.

Economic-Related Factors

Consensus Statement 9: *The application of sNPWT as the initial NPWT modality or as conversion from tNPWT can reduce overall health care costs as well as assist in the transition of patients from inpatient to outpatient care.*

It has been argued that one barrier to the implementation of newer

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Table 3. Consensus statements by category	
THERAPEUTIC GOALS	
Consensus Statement 1	Initiation of NPWT should be considered when there is a need to: 1) promote granulation tissue, 2) prepare a wound for closure—whether through use of an autograft, use of other advanced wound care modalities, delayed primary closure, or secondary intention, 3) control edema, 4) manage exudate, 5) achieve wound stabilization, and 6) assist in stabilization of patients with complex, traumatic, open wounds.
WOUND-RELATED FACTORS	
Consensus Statement 2	Wounds appropriate for consideration of sNPWT are those that meet device IFU, based on wound size, depth, and exudate amount. The clinician must be familiar with the IFU of the sNPWT system utilized, as these factors can considerably vary between sNPWT devices.
Consensus Statement 3	Wounds appropriate for consideration of tNPWT are those in which the size, depth, and volume of exudate are beyond the management capacity of a sNPWT system.
Consensus Statement 4	The sNPWT system can be considered as a bolster dressing for wounds in which closure is being obtained via a split-thickness skin graft or application of a skin substitute.
Consensus Statement 5	The wound should be reassessed at regular intervals (ideally every 2 weeks) to determine if NPWT treatment should be continued or discontinued and for the appropriateness of transition from tNPWT to sNPWT. Consideration should be made for reassessment of NPWT use if therapeutic goals have not been met or there is minimal or no change in wound size, amount of granulation tissue, or reduction in edema and exudate volume. Transition from tNPWT to sNPWT should be considered when the wound size, depth, and exudate amount are within the management capacity of the sNPWT system that is being considered for use.
PATIENT SATISFACTION AND QUALITY OF LIFE	
Consensus Statement 6	When NPWT is deemed an appropriate treatment modality for acute and chronic wounds, sNPWT should be the first-line modality utilized to increase patient satisfaction and quality of life. Patient education on NPWT as a treatment modality, the benefits of its use, and the advantages of sNPWT over tNPWT can improve patient satisfaction and treatment compliance.
Consensus Statement 7	sNPWT use may be an optimal choice for ambulatory patients with wounds eligible for sNPWT use who must return to work or face barriers to access follow-up medical appointments.
CARE SETTING-RELATED FACTORS	
Consensus Statement 8	tNPWT is a valuable treatment option for patients with acute or chronic wounds that are large and complex. Benefits of tNPWT include stabilization of the wound and patient, patient mobility, more rapid transition from critical care units to step-down units, and reduced hospital length of stay. Initial use of sNPWT or early conversion to sNPWT from tNPWT in eligible wounds should be considered to assist in transitioning patients from inpatient to outpatient care.
ECONOMIC-RELATED FACTORS	
Consensus Statement 9	The application of sNPWT as the initial NPWT modality or as conversion from tNPWT can reduce overall health care costs as well as assist in the transition of patients from inpatient to outpatient care.
NPWT DEVICE-RELATED FACTORS	
Consensus Statement 10	The decision on which NPWT system to utilize should be based on factors such as: 1) published evidence demonstrating the effect on wound management and healing, 2) system ease of use, 3) ease of system device and supply procurement, 4) logistical and technical support provided, 5) cost effectiveness of individual systems, and 6) user/patient acceptability.

NPWT: negative pressure wound therapy; sNPWT: single-use negative pressure wound therapy; IFU: instructions for use; tNPWT: traditional negative pressure wound therapy

technologies in wound management is a perception that they are too expensive.[46] While it is true that the unit price of a NPWT device is more than that of a simple dressing (eg, foam or non-woven), this fails to take into consideration evidence that early intervention with NPWT results in an improvement in overall healing rates with consequent cost savings, especially in labor costs, as well as an earlier improvement in patient quality of life, with earlier discharge, and the ability to manage the wound in the community.[4,29,45,47]

The effect of these benefits may be further enhanced by the choice of device. One retrospective, cost-minimization analysis of Medicare paid claims found a considerable economic benefit of using sNPWT rather than tNPWT for several wound types.[48] In an economic analysis of a previously published study,[16] the authors found that sNPWT provided an expected cost saving of $7756 per patient and an expected reduction of 1.67 open ulcer weeks per patient over 12 weeks and a cost reduction of $15 749 and 5.31 open ulcer weeks over 26 weeks.[49]

Specifically, for tNPWT, it may be associated with operational issues related to the fact that the pump is reusable, must be decontaminated between patients, and various consumables must be purchased to enable it to function. An international quantitative survey of providers in the acute care setting determined that lost and/or misplaced pumps (due to patient transfer/discharge to other wards or facilities); low pump device fleet utilization when pumps were not promptly returned, not properly stored, or went unused; and lack of visibility of the therapy provision (ie, lack of patient monitoring systems) were the 3 main operational and financial issues associated with tNPWT use.[47]

NPWT System-Related Factors

Consensus Statement 10: *The decision on which NPWT system to utilize should be based on factors such as: (1) the published evidence demonstrating the effect on wound management and healing, (2) system ease of use, (3) ease of system device and supply procurement, (4) logistical and technical support provided, (4) cost effectiveness of individual systems, and (5) user/patient acceptability.*

Once the decision is made that a patient's wound could benefit from NPWT, the following objectives should be considered: the desired therapeutic goal(s); patient satisfaction and quality of life; and care setting-related and economic-related factors. The last component of NPWT initiation is the decision regarding the type of NPWT system (tNPWT or sNPWT) to utilize, as several different devices are currently available. The NPWT system-related factors that require consideration include treatment objectives, patient activities of daily living, ease of dressing application, supply procurement, logistical and technical support provision, cost effectiveness to both the patient and health care system, and user/patient acceptability.

Regarding tNPWT, a retrospective analysis of the 2 most commonly used tNPWT systems found no difference in healing rates, length of therapy, and rate of complications between the 2 systems.[50] A systematic review of the literature also found comparable clinical outcomes in a broad range of chronic and acute wounds (n = 1107) between tNPWT systems.[12] Thus, the decision on which tNPWT device to use should be based on that which best mitigates the operational and financial burdens associated with tNPWT use. Ease of access to the system, associated supplies, and immediate pump device availability can enhance optimal patient outcomes and reduced patient and health care system costs.

Although clinical outcomes are similar across tNPWT systems, differences in how sNPWT systems function may ultimately influence clinical outcomes and therefore selection. As mentioned in *Consensus Statement 2*, wound depth and exudate handling capability of sNPWT systems can vary. The mechanism of action and impact on the wound itself may also vary across the available systems. Reduced inflammation, greater quality and maturation of granulation tissue, collagen deposition, and rates of reepithelization were reported in a recent preclinical study comparing sNPWT to tNPWT.[51] The authors postulated that these results as well as differences in clinical outcomes seen in a recent study on lower extremity wounds are attributed to the unique dressing construction, which allows simultaneous delivery of negative pressure and fluid management within the dressing itself. This results in the application of NPWT not only to the wound but to the entire area of tissue under the dressing, while also negating the need for a wound filler if so desired. The absence of a wound filler, along with a low trauma wound contact layer, reduces the frequency of dressing change requirements and minimizes tissue disruption to the wound and surrounding skin that is associated with NPWT dressing changes. This results in less wound bed inflammation, greater quality and maturation of the granulation tissue forming, and greater rates of reepithelization.[51] The aforementioned considerations, coupled with cost effectiveness of treatment to the patient and facility, should assist in provider selection of the optimal tNPWT and sNPWT system for patient treatment.

CONCLUSIONS

The use of pathways designed to determine if sNPWT use would be an optimal first-line modality for NPWT have demonstrated significant reduction in wound

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size, time to healing, and complete wound closure.[4,47] However, these pathways only focused on wound-related factors to determine if sNPWT use was appropriate. The panel guidelines produced in this consensus document were developed to help guide the clinical decision-making process on when to initiate, change, or discontinue NPWT use in acute and chronic wounds; whether to initiate treatment with a tNPWT or sNPWT system; and when to transition between the 2 systems based on (1) therapeutic goals, (2) wound-related factors, (3) patient satisfaction and quality of life, (4) care setting-related factors, (5) economic-related factors, and (6) NPWT system-related factors.

These guidelines extend beyond clinical outcomes with inclusion of operational and financial factors to consider, as summarized in **Table 3**. Minimization of patient and health care system expenditures, while providing optimal patient care, including enhanced patient satisfaction and quality of life, should be an unstated and accepted standard in today's health care environment.

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