

Initial Experience Using a Novel Reticulated Open Cell Foam Dressing with Through Holes during Negative Pressure Wound Therapy with Instillation for Management of Pressure Ulcers

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Abstract

Several published reviews and recommendations exist for the use of negative pressure wound therapy (NPWT) with instillation and a dwell time (NPWTi-d) in acute and chronic wounds. Specific dressings for use with NPWTi-d have also been developed, including a reticulated open cell foam dressing with through holes (ROCF-CC) that assists in removing thick wound exudate and infectious materials. ROCF-CC is especially helpful for wound cleansing when debridement is not possible or appropriate in patients.

We report our initial experiences in using NPWTi-d with ROCF-CC in patients with pressure ulcers. An algorithmic approach was used to determine appropriate treatment to reach the goals of therapy (i.e., wound bed preparation, granulation tissue formation, and removal of infectious materials). Previous therapies included honey and gauze soaked in Dakin's solution. All patients received antibiotics and debridement when possible.

Five patients (3 females and 2 males) received NPWTi-d with ROCF-CC (instillation of saline or a hypochlorous solution with a dwell time of 10 minutes, followed by 2-3 hours of -125 mmHg NPWT). Patient comorbidities included obesity, diabetes mellitus, hypertension, and peripheral artery disease. Mean age of patients was 65.2 years (range: 50-82 years). After an average of 6 days of therapy (range 2-9 days), all wounds treated with NPWTi-d with ROCF-CC showed rapid granulation tissue formation.

We also noted improved removal of devitalized tissue and subsequent granulation tissue formation in patients receiving hypochlorous solution compared to patients receiving saline during NPWTi-d with ROCF-CC. All patients were eventually transferred to a skilled nursing facility. In our clinical practice, NPWTi-d with ROCF-CC provided effective and rapid removal of the thick exudate and infectious materials and promoted excellent development of underlying granulation tissue.

Keywords: Negative pressure wound therapy; Instillation; Thick exudate; Devitalized tissue; Wound cleansing

Introduction

Pressure ulcers (PrUs) are challenging complex wounds that develop due to localized injuries to the skin, particularly over bony prominences, because of pressure or when pressure is combined with shear and/or friction [1]. Although the definition and staging of PrUs was recently redefined by the National Pressure Ulcer Advisory Panel (NPUAP) in 2016 [2], there is still much debate regarding these changes among the healthcare community.

In our institution, high-risk operative patients with complex chronic wounds, such as PrUs, have been treated with a variety of dressings. Traditional dry/moist gauze wound dressings, low adherent dressings, and semipermeable films mitigate against fluid and environmental microbial penetration but allow the egress of air and water vapor. Moist occlusive dressing have been utilized, as these dressings support the inflammatory phase by creating a low oxygen tension environment (thereby increasing angiogenesis, iron metabolism, glucose metabolism, cell proliferation/survival and activating factors such as

hypoxia-inducible factor-1), which has also been shown to increase the rate of re-epithelialization [3-5].

Hydrocolloids and hydrogels have also been used in our institution. Under the appropriate setting, these dressings absorb a certain amount of exudate but keep a moist environment; hydrocolloids are impermeable to air and are long-lasting but do not function well in exudative wounds. In a dry wound environment, hydrogels may be used to help promote moisture in the wound.

For highly exudative wounds, alginate dressings (a seaweed-derived non-woven fiber dressing) are typically used because of their ability to absorb copious amounts of fluid. We have also used autolytic debridement in wounds with a moist wound environment; however, this form of therapy is not capable of removing devitalized tissue as well as surgical debridement and is not an adequate replacement for sharp surgical debridement [6-8].

Negative pressure wound therapy (NPWT) is commonly used for the management of both acute and chronic complex wounds at our institution. This therapy has typically been associated with higher costs; however, several studies have shown an overall savings in direct and indirect costs, in a large part due to decreases in operating room

(OR) visits, early wound closure for treated patients, reduced hospital stay, fewer required dressing changes (which potentially translates into lower material/manpower cost and care delivery efficiency), as well as improved limb preservation rates [9-14].

Over the years, NPWT has evolved to include the ability to instill topical wound solutions, which are then allowed to dwell directly onto the wound bed [15,16]. Allowing an instilled solution to dwell in the wound bed helps to cleanse the wound and the NPWT cycle helps remove solubilized contaminants, devitalized tissue, and slough [16]. Hypochlorite-based solutions [17,18] and 0.9% normal saline [19-21] as topical instillation solutions have shown positive clinical outcomes.

A growing body of literature supports the use of NPWT with instillation and dwell time (NPWTi-d) with positive clinical outcomes and potential cost savings being reported [19-23]. Additionally, several published reviews and recommendations exist for the use of NPWTi-d in acute and chronic wounds [15,16,24]. Specific dressings for use with NPWTi-d have also been developed, including a reticulated open cell foam dressing with through holes (ROCF-CC) that assists in removing thick wound exudate and infectious materials [25]. ROCF-CC may be especially helpful for wound cleansing when surgical debridement must be delayed or is not possible or appropriate.

The aim of this 5-patient case series was to present our initial experience using NPWTi-d with ROCF-CC to manage large complex pressure ulcers that contained substantial areas of devitalized tissue, thick exudates, and/or yellow fibrinous slough.

Methods

An algorithm approach (Figure 1) was used to determine appropriate treatment to reach the goals of therapy (ie, wound bed preparation, granulation tissue formation, and removal of infectious materials) [26].

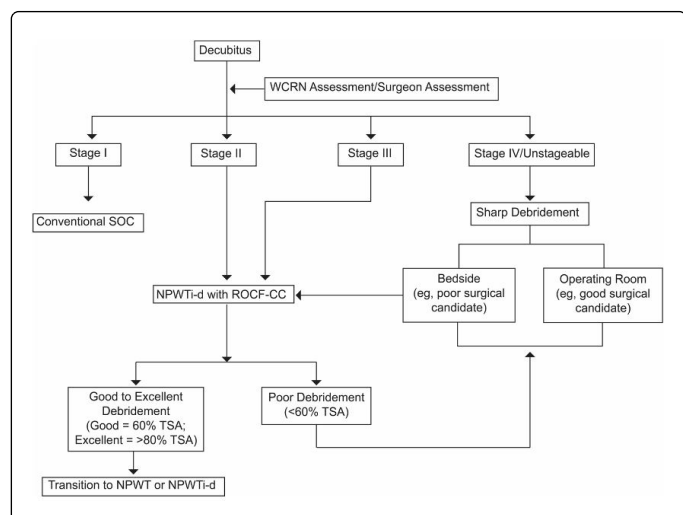


Figure 1: Prospective algorithm (NPWTi-d: negative pressure wound therapy with instillation and a dwell time; ROCF-CC: reticulated open cell foam with through holes; TSA: Total Surface Area; NPWT: Negative Pressure Wound Therapy).

Debridement was performed, when possible, prior to use of NPWTi-d with ROCF-CC, and the periwound area was protected, as needed. The ROCF-CC wound contact layer with 1.0 cm diameter

through holes was cut to size and placed in the wound bed. The 8 mm or 16 mm thick cover layer was cut and placed over the wound contact layer to fill the wound depth, explored tunnels, and undermined areas. NPWTi-d was initiated to instill saline or a hypochlorous solution with a dwell time of 10 minutes, followed by 2-3 hours of -125 mmHg negative pressure. Dressings were changed every 2-3 days.

Results

Five patients (3 females, 2 males) with a mean age of 65.2 years (range: 50-82 years) were treated (Table 1). Patient comorbidities included obesity, diabetes mellitus, hypertension, and peripheral artery disease. After an average of 6 days of therapy (range: 2-9 days), all wounds showed rapid granulation tissue formation. We also observed improved removal of devitalized tissue and subsequent granulation tissue formation in patients receiving hypochlorous solution compared to patients receiving saline during NPWTi-d with ROCF-CC. All patients were transferred to a skilled nursing facility.

Case Studies

The following are three cases demonstrating the successful use of NPWTi-d with the ROCF-CC dressing.

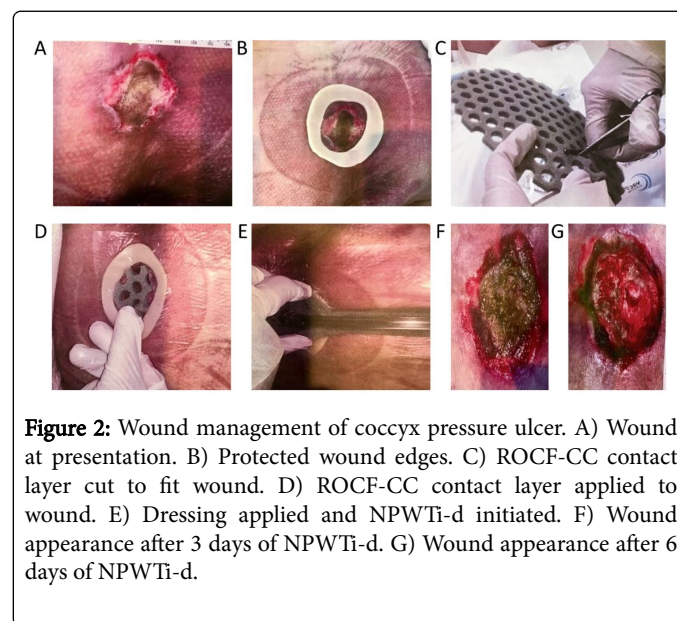


Figure 2: Wound management of coccyx pressure ulcer. A) Wound at presentation. B) Protected wound edges. C) ROCF-CC contact layer cut to fit wound. D) ROCF-CC contact layer applied to wound. E) Dressing applied and NPWTi-d initiated. F) Wound appearance after 3 days of NPWTi-d. G) Wound appearance after 6 days of NPWTi-d.

Case 1

An 82-year-old female presented with an unstageable coccyx pressure ulcer with >90% surface area covered with nonviable tissue (Figure 2A). Medical history included previous small bowel obstruction, Clostridium difficile colitis, incarcerated umbilical hernia, chronic obstructive pulmonary disease, Churg-Strauss syndrome with lung involvement, transverse myelitis, and moderate malnutrition. The wound edges were protected using ostomy paste (Figure 2B), and the ROCF-CC contact layer was cut to fit the wound (Figure 2C). The ROCF-CC contact layer was applied gently to the wound (Figure 2D). The dressing was applied (Figure 2E) and NPWTi-d was initiated (30 cc of hypochlorous solution instilled with a 10-minute dwell time, followed by 2 hours of NPWT at -125 mmHg). After 3 days of NPWTi-d, the devitalized tissue was semi-liquid (Figure 2F). After 6 days of NPWTi-d, the wound displayed >90% viable tissue and the wound

depth decreased (Figure 2G). Standard NPWT was initiated, and the patient was discharged to a long-term acute care facility.

Case	Age	Sex	Wound etiology	Medical history
1	82	Female	Unstageable coccyx pressure ulcer; >90% surface area covered nonviable tissue	Small bowel obstruction; Clostridium difficile colitis; incarcerated umbilical hernia; chronic obstructive pulmonary disease; Churg-Strauss syndrome with lung involvement; transverse myelitis; moderate malnutrition
2	72	Male	Unstageable sacral pressure ulcer	Essential hypertension; cerebrovascular accident
3	59	Female	Stage 3 pannicular ulcer; 80% devitalized tissue with foul, purulent drainage	Panniculitis; obesity, diabetes mellitus; stomach stapling
4	50	Male	Sacral pressure ulcer with 90% devitalized tissue	Motor vehicle accident; acute respiratory failure; C6/C7 fracture/spinal cord injury; paralysis
5	63	Female	Thigh pressure ulcer with erythematous border and 100% devitalized tissue	Active smoker; diabetes mellitus; peripheral artery disease

Table 1: Patient demographics and wound etiology.

Case 2

A 72-year-old male with a history of essential hypertension, cerebrovascular accident, and moderate to severe malnutrition presented with an unstageable sacral pressure ulcer. At presentation, the wound measured 15.0 cm × 11.0 cm with >60% adherent nonviable tissue on the wound surface (Figure 3A). After 24 hours of NPWTi-d (70 cc hypochlorous solution instilled with a 10-minute dwell time, followed by 3 hours of NPWT at -125 mmHg), the wound surface filled with >90% viable tissue (Figure 3B).

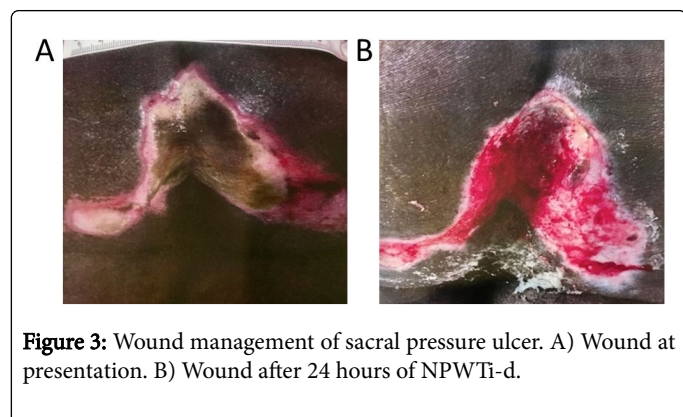


Figure 3: Wound management of sacral pressure ulcer. A) Wound at presentation. B) Wound after 24 hours of NPWTi-d.

Case 3

A 59-year-old female with a medical history of obesity, diabetes mellitus, and previous stomach stapling presented with panniculitis and a stage 3 panniculus ulcer. The ulcer measured 4 cm × 8.5 cm × 3 cm with 80% devitalized tissue and foul-smelling, purulent discharge (Figure 4A). After 9 days of NPWTi-d (38 cc hypochlorous solution instilled with a 10-minute dwell time, followed by 2 hours of NPWT at -125 mmHg), the wound displayed >90% viable tissue (Figure 4B).

Discussion

Pressure ulcers are a serious and costly healthcare issue that can often lead to reduced quality of life for patients [27,28]. Interventions to manage pressure ulcers include wound debridement, advanced

wound dressings, and advanced wound therapies such as NPWT. However, the advent of NPWTi-d has provided an alternative option for managing these difficult to heal wounds. In our 5 cases, NPWTi-d with ROCF-CC provided effective and rapid removal of the thick exudate and infectious materials and promoted granulation tissue formation in complex wounds.

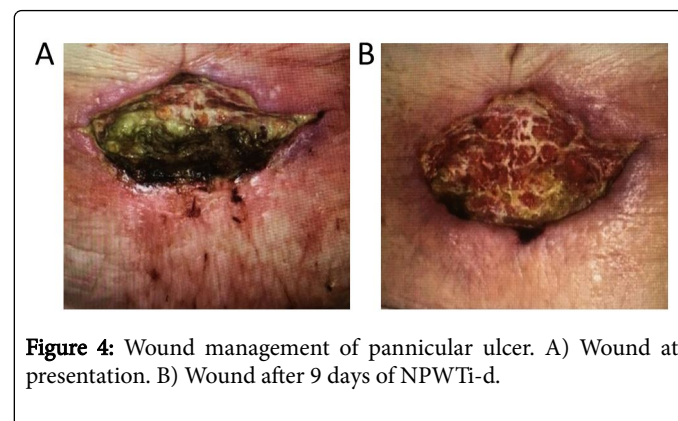


Figure 4: Wound management of pannicular ulcer. A) Wound at presentation. B) Wound after 9 days of NPWTi-d.

At our institution, we developed a preliminary algorithmic approach to managing patients with PrUs (Figure 1) that starts with a patient assessment. Whereas Stage I PrUs are typically treated with conventional standard of care, Stage II and III PrUs may benefit from the use of NPWTi-d with the ROCF-CC dressing, although sharp debridement is required for all Stage IV/Unstageable PrUs. Once there is sufficient debridement with 60%-80% total surface area, then the patients can be transitioned to standard NPWT, which previous studies have demonstrated successful use [29-32], or to NPWTi-d with the standard instillation dressing. As the use of NPWTi-d with ROCF-CC dressing continues, our algorithm can be expanded to include other complex patient populations.

The outcomes from our 5 patients are similar to the only other study published on the use of NPWTi-d with the novel ROCF-CC dressing. Teot et al. [25] described their experience with NPWTi-d ROCF-CC in patients with large complex chronic wounds, including PrUs, that contained viscous wound exudate and areas of devitalized tissue. They reported that the ROCF-CC dressing “assisted in loosening,

solubilizing, and detaching viscous exudate, dry fibrin, wet slough, and other infectious materials [25].”

There are still approximately 2.5 million PrUs treated annually in the United States with healthcare costs between \$9.1 to \$11.6 billion per year [27]. These costs can be further exacerbated by the elderly population, which is not only the fastest growing segment of the population but also account for the majority of PrUs [33]. The cost of the care for those individuals older than age of 65 contribute a large and growing component of healthcare expenditures. It is estimated that over 40% of all surgical procedures conducted annually in the United States involve this population group [28,34-36].

Macario [37] has posed the question, “How much does one minute of operating room (OR) time cost?” Recent clinical studies of U.S. hospitals have demonstrated that the average cost per minute of operating room time was \$62 [38,39]. This issue often arises in cases that take more time to complete than usual, or intraoperative delays (more commonly due to personnel, equipment needs/failures), or in surgical procedures conducted in patients with multiple comorbidities, thereby having a higher anesthetic risk and requiring more extensive monitoring and resources in order to conduct the procedure safely.

Therefore, any time trips to the OR can be minimized, healthcare costs of our patients may be potentially impacted. This is especially true for patients, such as ours, that can be described using the term “frailty,” a multifactorial state of general physical weakness, often under recognized patient vulnerability and decreased physiologic reserve. Perioperative risk is heterogeneous in this group, as age and comorbidities may fail to accurately predict functional deficits and often cannot adequately predict operative and perioperative morbidity and mortality in this population group [35,40-46].

A recent systematic study by Lin et al. [47] reported that “in patients over 75 years of age, frailty was associated with increased mortality, post-operative complications, prolonged length of stay and discharge to long term care facility.” These findings were noted, “irrespective of the type of surgery conducted “and were consistent across different frailty measurement techniques [47]. Currently, the literature investigating frailty and surgery has defined ‘geriatric’ as those above 60 or 65 years old, and studies in this patient population have recognized frailty being more prevalent with increasing age.

A recent systematic review incorporating 31 studies of frailty in persons 65 years or older found a prevalence from 4.0% to 17.0% (mean 9.9%) of physical frailty, with a higher prevalence when psychosocial frailty was also included [47,48]. In our patients, NPWTi-d using the ROCF-CC dressing was selected, as our patients were not candidates for surgical debridement due to their underlying comorbidities contributing to their perceived frailty risk.

Conclusion

We acknowledge the limitations of our case series, such as the small number of patients, lack of a control group, and selection bias. However, our early experience suggests that the ROCF-CC dressing has unique properties that allowed effective and rapid removal of thick exudate in large complex wounds with substantial areas of devitalized tissue. Also, the dressing was used safely in severely debilitated and frail patients. The use of NPWTi-d with ROCF-CC may potentially decrease cost of care by assisting in bedside wound cleansing and reducing the need for debridement in the OR as well as potentially

decreasing morbidity and mortality associated with formal operative surgical intervention. In our clinical practice, NPWTi-d with ROCF-CC promoted excellent development of underlying granulation tissue in our 5 patients. Further study is warranted in the use of this novel treatment modality, which will help to more clearly define and inform best evidence-based practice guidelines for its clinical application in the care of patients with chronic complex wounds.

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