Inpatient and Outpatient Wound Treatment Recommendations:
Assessing Use of Negative Pressure Wound Therapy Systems or Oxidized Regenerated Cellulose (ORC)/Collagen/Silver-ORC Dressings

Andrew Applewhite, MD, CWSP; Saeed A. Chowdhry, MD; Michael Desvigne, MD, CWS, FACS; Allen Gabriel, MD, FACS; Rosemary Hill, RN, BSN, CWOCN COCC (C); Mary Anne Obst, RN, BSN, CCRN, CWOCN; Dawn Shepherd, BSN, RN, CWON, CFCN; Marcus Speyrer, RN, CWS; Terry Treadwell, MD, FACS; and Lindsey Waddell, RN, MSN, WHNP-BC

This supplement was subject to the WOUNDS® peer-review process. It is being provided as a courtesy to Ostomy Wound Management® readers and was not subject to their peer-review process.

Supported by Acelity.
From the 1Baylor University Medical Center, Comprehensive Wound Center, Dallas, TX; 2Advocate Christ Hospital, Chicago, IL; 3Integra Medical, Scottsdale, AZ; 4PeaceHealth Medical Group, Vancouver, WA; 5Lions Gate Hospital, North Vancouver, British Columbia, Canada; 6Regions Hospital, St Paul, MN; 7Parkland Memorial Hospital, Mansfield, TX; 8The Wound Treatment Center, LLC, Opelousas General Health System, Opelousas, LA; 9Institute for Advanced Wound Care, Baptist Medical Center South, Montgomery, AL; and 10Integumetrix, Nashville and Hendersonville, TN

Disclosure: All authors have consulting agreements with KCI, an Acelity Company, San Antonio, TX. Acelity sponsored the panel meeting.
Inpatient and Outpatient Wound Treatment Recommendations: Assessing Use of Negative Pressure Wound Therapy Systems or Oxidized Regenerated Cellulose (ORC)/Collagen/Silver-ORC Dressings

Andrew Applewhite, MD, CWSP1; Saeed A. Chowdhry, MD2; Michael Desvigne, MD, CWS, FACS3; Allen Gabriel, MD, FACS4; Rosemary Hill, RN, BSN, CWOCN COCC (C)5; Mary Anne Obst, RN, BSN, CCRN, CWOCN6; Dawn Shepherd, BSN, RN, CWON, CFCN7; Marcus Speyrer, RN, CWS8; Terry Treadwell, MD, FACS9; and Lindsey Waddell, RN, MSN, WHNP-BC10

Abstract: The increase in wound prevalence means more patients with wounds are being transferred through care settings than ever before. Although the goals of therapy may be the same in both settings, wound care therapies and dressings differ in availability and appropriateness for each setting. Negative pressure wound therapy (NPWT) modalities and oxidized regenerated cellulose (ORC)/collagen (C)/silver-ORC dressings are available in both inpatient and outpatient care settings, but (to-date) lack comprehensive information regarding best practices in transitioning use of these therapies between various care settings. A panel meeting was convened to provide literature- and experience-based recommendations in transitioning wound care patients between various care settings. The use of NPWT with instillation and dwell time was recommended in wounds contaminated with debris and/or infectious materials or heavy exudate. In addition, ORC/C/silver-ORC dressing application was recommended for surface bleeding and for placement into explored areas of undermining to help promote development of granulation tissue. When transitioning a patient from inpatient to outpatient care, overall health, access to services, severity and complexity of the wound, and equipment availability should be taken into consideration. Treatment modalities to bridge the gap during care transition should be used to help maintain continuous care. For outpatient care, NPWT use was recommended for removal of infectious materials and exudate management. The ORC/C/silver-ORC dressings also may be used to help manage exudate and promote granulation tissue development and moist wound healing. In addition, practice challenges and potential solutions for patient adherence, interrupted care during patient transition, and troubleshooting after hours and weekend device alarms were discussed.

Key Words: treatment guidelines, oxidized regenerated cellulose/collagen/silver dressings, negative pressure wound therapy, instillation therapy


The prevalence of acute and chronic wounds needing treatment is increasing across the globe, largely due to an aging population and a sharp worldwide increase in diabetes and obesity.1-5 Annual global wound care product expenditures are projected to reach $22 billion by 2022 from $18.4 billion in 2017, at a compound annual growth rate of 3.7%.6 To reduce health care system costs, the timely transfer of patients from acute care inpatient settings to less expensive post-acute care settings, such as the subacute, rehabilitation, skilled nursing, or home setting, has become a top priority, particularly in developed countries. As a result, there has been a major shift in
Inpatient and Outpatient Wound Treatment Recommendations

By nature of their various (and often multiple) comorbidities, wound care patients require multimodal treatment across the spectrum of health care settings. The increase in wound prevalence means that more patients with wounds and wound treatment products are being transferred through care settings than ever before. Meanwhile, wound care patient transfer networks and processes are intricate and can appear as complex as the wounds themselves, and in the current era of pay-for-performance health care with quality measures, there are high stakes for smooth patient transfers from acute care that avoid unnecessary readmissions. Numerous patient, wound, clinical, environmental, and economic factors must be considered for successful patient transfer from one care setting to another. While the goals of therapy may be the same in both settings, wound care therapies and dressings differ in availability and appropriateness for each setting. Although many wound care options are available for use, this manuscript will focus on negative pressure wound therapy (NPWT) modalities and oxidized regenerated cellulose (ORC)/collagen (C)/silver-ORC dressings, which are available in both inpatient and outpatient care settings and lack comprehensive information regarding best practices in transitioning use of these therapies between various care settings.

Over the past 2 decades, NPWT (V.A.C. Therapy; KCI, an Acelity Company, San Antonio, TX) has been adopted for use in inpatient and outpatient care settings for nearly all wound types due to its ability to manage wounds through promoting costs from hospital inpatient to outpatient settings.

Figure 1. Inpatient versus outpatient treatment management. Therapy options are not simultaneous. Dashed line represents transition between inpatient and outpatient care. Arrows represent availability across care settings.

NPWTi-d: negative pressure wound therapy with instillation and dwell time; ROCF-CC: reticulated open-cell foam with through holes; ROCF-V: reticulated open-cell foam without through holes; NPWT: negative pressure wound therapy; ORC: oxidized regenerated cellulose; C: collagen
Assessing NPWT Systems or ORC/Collagen/Silver-ORC Dressings

granulation tissue development, reducing edema, promoting perfusion, and removing wound exudate and infectious materials. The NPWT devices and dressings have evolved to include instillation and dwelling of topical wound solutions in the wound bed (NPWTi-d; V.A.C. VERAFLÓ Therapy; KCI, an Acelity Company) and a new reticulated open-cell foam dressing with through holes (ROCF-CC; V.A.C. VERAFLÓ CLEANSE CHOICE Dressing; KCI, an Acelity Company), both of which are currently only available for inpatient use.

As early as 1960, ORC was used in hemostatic wound dressings.7 Since then, ORC dressings have continued to evolve. The addition of collagen, and more recently silver, provided a moist wound environment, promoted reepithelialization, and created an antimicrobial barrier. One collagen dressing, available in both the inpatient and outpatient care settings, contains 44% ORC, 55% bovine collagen, and 1% silver-ORC (ORC/C/silver-ORC; PROMOGRAN PRISMA Matrix; Systaugenix, an Acelity Company, Gargrave, UK). This ORC/C/silver-ORC dressing has been utilized in a variety of wound types, including diabetic foot ulcers (DFUs), venous leg ulcers, pressure injuries (PIs), and donor site wounds.8,9

To help guide the transition of wound care patients, a panel meeting of specialists experienced in inpatient and outpatient care convened to discuss challenges and recommendations for use of NPWT systems or ORC/C/silver-ORC dressings in different care settings. The purpose of this publication is to provide literature- and experience-based recommendations from the meeting to address challenges in transitioning wound care patients between various care settings and help optimize use of NPWT or ORC/C/silver-ORC dressings in inpatient versus outpatient settings.

Methods

Panel meeting. The meeting was held on January 18 to 19, 2018, in Dallas, Texas. Panel members were chosen based on their experience in wound care, trauma care, and plastic surgery.
Nine panel members attended the meeting, which was moderated by one of the panel members and recorded.

**Literature search.** Prior to the meeting, a preliminary literature search using MEDLINE (PubMed) and Google Scholar was conducted to provide background information on ORC/C/silver-ORC dressings, NPWT, NPWTi-d, and treatment consensus guidelines. The search included English language peer-reviewed articles published from January 2000 to January 2018. The following keywords were used: negative pressure wound therapy, negative pressure wound therapy with instillation and dwell time, oxidized regenerated cellulose/collagen/silver dressings, ORC/collagen/silver-ORC, treatment guidelines, treatment algorithms, and clinical pathways. From the search, 243 articles were identified; after duplicates were removed, 226 articles were assessed for relevance to the topic. The articles most relevant to the topic were selected for inclusion. A booklet containing 5 articles on ORC/C/silver-ORC dressings, NPWT, NPWTi-d, and treatment consensus guidelines was distributed to panel members for review prior to the panel meeting.

**Meeting objectives and panel presentations.** Panel members presented case studies and provided recommendations to develop treatment guidelines for use of NPWT, NPWTi-d, or ORC/C/silver-ORC dressings in inpatient, transition, and outpatient care based on the goal of therapy and the therapy’s mechanism of action. If a discrepancy in the development of the treatment guidelines occurred, the topic was discussed until an agreement was reached. Inpatient versus outpatient care, practice challenges, tips and pearls, and potential areas of cost savings also were examined. Follow-up communications occurred via e-mail and continued throughout manuscript development. All panel members approved the final manuscript.

**Results**

Over the course of the 2-day panel meeting, panel members developed inpatient and outpatient treatment

---

**Figure 3.** Patient and wound evaluation determines therapy goals. Adapted from Kim et al.15

---

**Therapy Goals**

- Patient optimization for wound healing
- Remove thick exudate, such as fibrinous material and slough
- Cleanse wound
- Removal of infectious material
- Exudate management
- Promote granulation tissue formation
- Moist wound healing
- Wound closure

---

**Patient Evaluation**

- Age
- Nutrition
- Comorbidities
- Nicotine use
- Alcohol use
- Illegal substance use
- Medication use
- Social support network

**Wound Evaluation**

- Perfusion
- Exposed structures
- Contamination/Infection
- Necrotic/devitalized tissue
- Wound duration
- Etiology
- Location and size
- Drainage
- Odor
- Pain
- Edema
Assessing NPWT Systems or ORC/Collagen/Silver-ORC Dressings

Table 2. Mechanisms of action for NPWT, NPWTi-d, and ORC/C/silver-ORC dressings

<table>
<thead>
<tr>
<th>Therapy</th>
<th>Mechanism of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPWT</td>
<td>• Draw wound edges together(^\text{24})</td>
</tr>
<tr>
<td></td>
<td>• Promotes perfusion and reduces edema(^\text{24})</td>
</tr>
<tr>
<td></td>
<td>• Removes exudate and infectious materials(^\text{25})</td>
</tr>
<tr>
<td></td>
<td>• Dressing interaction with tissue creates microdeformation that leads to cell stretch(^\text{26})</td>
</tr>
<tr>
<td></td>
<td>• Cell stretch under negative pressure stimulates cellular activity that promotes granulation tissue formation(^\text{26})</td>
</tr>
<tr>
<td>NPWTi-d</td>
<td>• NPWT mechanisms of action</td>
</tr>
<tr>
<td></td>
<td>• Cleanses wound with cyclic delivery, dwell, and removal of topical solutions(^\text{27})</td>
</tr>
<tr>
<td></td>
<td>• Provides thorough wound coverage with topical solutions during selected dwell time(^\text{27})</td>
</tr>
<tr>
<td></td>
<td>• Dilutes and solubilizes infectious materials and wound debris(^\text{27,28})</td>
</tr>
<tr>
<td>ORC/C/silver-ORC dressing</td>
<td>• ORC component reduces surface bleeding(^\text{29})</td>
</tr>
<tr>
<td></td>
<td>• ORC/C component promotes a physiologically moist microenvironment at the wound surface(^\text{11,30,31})</td>
</tr>
<tr>
<td></td>
<td>• Reduces bioburden within the silver-ORC component(^\text{23})</td>
</tr>
<tr>
<td></td>
<td>• Collagen is a major component of the dermis and is degraded by MMPs. Collagen acts as a sacrificial substrate if an excess of MMPs are present(^\text{33})</td>
</tr>
</tbody>
</table>

NPWT: negative pressure wound therapy; NPWTi-d: negative pressure wound therapy with instillation and dwell time; ORC: oxidized regenerated cellulose; C: collagen; MMPs: matrix metalloproteinases

recommendations for use of NPWT, NPWTi-d, or ORC/C/silver-ORC dressings (Figure 1). This was the first comprehensive review of these products in these care settings compared with the goal of therapy. Figure 1 shows where the handoff to other treatment options exist as goals of therapy are met. In developing these recommendations, panel members discussed the patient and wound assessments necessary to determine appropriate plans of care, followed by creation of inpatient, transition, and outpatient recommendations. Practice challenges and areas to improve therapy efficiency also were examined and are presented below.

**Patient and wound assessment.** Prior to developing a treatment plan, the patient should be assessed for risk factors that may hinder optimal wound healing (Figure 2). Patient risk factors for stalled wound healing include diabetes, obesity, peripheral vascular disease, infection, immunosuppression, nicotine use, malnutrition, and social situation (Table 1\(^\text{21}\)). When providing wound care, a thorough wound evaluation also should be performed to aid in selecting wound- and patient-appropriate treatment. The wound evaluation should encompass wound characteristics: wound age, size, etiology, presence of infection, presence of necrotic/devitalized tissue, and pain (Figure 3; Table 1\(^\text{21}\)). Blood flow and presence and type of infection should be assessed using diagnostic laboratory and imaging techniques (eg, ankle-brachial index, wound culture swabs, magnetic resonance imaging, etc).

**Product mechanisms of action.** The NPWT, NPWTi-d, and ORC/C/silver-ORC dressings have mechanisms of action that may not be optimal in all treatment settings. It is important to keep the indications for use of the therapies in mind when developing a treatment plan because use of an inappropriate therapy may delay wound healing.\(^\text{22,23}\) Mechanisms of action for NPWT, NPWTi-d, and ORC/C/silver-ORC dressings are described in Table 2.\(^\text{11,24-33}\)

Macrostrain and microstrain also occur during NPWTi-d.\(^\text{26,34,35}\) However, NPWTi-d provides the additional benefits of wound cleansing through the cyclic delivery, dwell, and removal of topical wound solutions.\(^\text{36}\) This instillation of topical wound solutions into the wound bed may help dilute and solubilize infectious materials and wound debris.

In the presence of exudate, ORC/C/silver-ORC dressings transform into a soft, conformable, biodegradable gel allowing for contact with all areas of the wound. The dressing maintains a physiologically moist microenvironment at the wound surface, which is conducive to epithelialization, granulation
Inpatient and Outpatient Wound Treatment Recommendations

Inpatient treatment recommendations.

The patient’s treatment plan should be based on the care setting and goals of therapy, with regular reassessment of goals and wound status (Figure 4). Common goals of therapy identified by the panel members include management of wound bioburden, removal of wound debris, wound bed preparation, moist wound healing, and wound closure (Figure 1; Table 3). Importantly, if wound infection is present, treatment for the infection must be initiated.

Negative pressure wound therapy with instillation and dwell time with ROCF-CC dressing use is recommended in wounds that are contaminated with debris and/or infectious materials, or display heavy exudate.15-17 For patients in the inpatient setting, part of the initial assessment should determine whether the patient is a candidate for surgical debridement. In a subset of patients, surgical debridement is not appropriate or is declined by the patients. If the wounds in this subset display viscous exudate, NPWTi-d with ROCF-CC use may be considered.15-17 Based on their experiences, the panel members report that the NPWTi-d with ROCF-CC dressings allowed for a more accurate assessment of the dimensions and status of the wound bed, demarcating viable tissue and isolating areas of nonviable tissue. Panel members described that using the NPWTi-d with ROCF-CC dressings did not promote granulation tissue development in areas of devitalized tissue. Once the nonviable tissue was removed and NPWTi-d with ROCF-CC dressings were restarted, granulation tissue development was observed in these areas. In addition, these dressings can be utilized for immediate wound cleansing when surgical debridement is delayed or complete surgical debridement is not appropriate or possible. Once debris, slough, and/or devitalized tissue is decreased, therapy can be switched to NPWTi-d with a reticulated open-cell foam without through holes dressing (ROCF-V; V.A.C. VERAFLOR Dressing, KCI, an Acelity Company).

Figure 4. Inpatient treatment selection algorithm.
NPWTi-d: negative pressure wound therapy with instillation and dwell time; ROCF-CC: reticulated open-cell foam with through holes; ROCF-V: reticulated open-cell foam without through holes; NPWT: negative pressure wound therapy; ORC: oxidized regenerated cellulose; C: collagen

When an excess of MMPs are present, collagen acts as a sacrificial substrate.33 In the presence of collagen and ORC, Cullen et al11 demonstrated that components of wound exudate, such as proteases, were reduced.

Inpatient treatment recommendations.

When an excess of MMPs are present, collagen acts as a sacrificial substrate.33 In the presence of collagen and ORC, Cullen et al11 demonstrated that components of wound exudate, such as proteases, were reduced.

Tissue formation, and optimal wound healing. Different components of the dressing have unique properties. The ionically bound silver in the dressing provides an antimicrobial barrier. Reduction of bioburden has been observed within the silver-ORC dressing component,32 and in vitro testing has shown no detrimental effect on host cells.37 The ORC component has demonstrated a reduction in surface bleeding.29 Collagen is a major component of the dermis and is readily degraded by matrix metalloproteinases (MMPs) during wound healing.
or NPWT to achieve therapy goals and allow patient discharge if appropriate.\textsuperscript{28,38-40}

Negative pressure wound therapy with instillation and dwell time with ROCF-V dressings, NPWT, or ORC/C/silver-ORC dressings also may be used as a tool in the management of infection and wound exudate and to promote granulation tissue development and moist wound healing. Therapy selection should be based on a combination of patient and wound characteristics. Negative pressure wound therapy and NPWTi-d with ROCF-V dressings may be considered for wounds with moderate to heavy exudate. As the amount of wound exudate reduces, therapy can be switched to standard NPWT because instillation of topical wound solutions may no longer be needed. If light to moderate wound exudate is present and the therapy goal is granulation tissue development, NPWT or ORC/C/silver-ORC dressings should be considered. In addition, when wound bed preparation for skin grafting is required, NPWT or ORC/C/silver-ORC dressings may be utilized.\textsuperscript{41}

An ORC/C/silver-ORC dressing application was recommended if surface bleeding is present, because the ORC component can help reduce surface bleeding.\textsuperscript{29} Further, panel members recommended the application of ORC/C/silver-ORC dressings in explored areas of undermining to help promote the development of granulation tissue in these areas.

Table 4 displays a complete list of the various wound types that panel members recommended for the use of NPWTi-d, NPWT, and ORC/C/silver-ORC dressings, such as DFUs, PIIs, and traumatic wounds, in the inpatient setting.

Surgical versus nonsurgical closure. Depending on the clinical strategy, treatment with NPWT and NPWTi-d may lead to a surgical closure (Figure 5). Therefore, the transition to the home setting may include care for a surgical incision or a split-thickness skin graft (STSG). For patients with chronic wounds, the care strategy typically focuses on promoting a healthy wound

| Table 3. Wound characteristics, goals of therapy, and recommended therapies |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| **Wound Characteristics**   | **Goal of Therapy**          | **Recommended Therapy**      | **Inpatient Availability**  | **Outpatient Availability** |
| Surface bleeding            | Reduce surface bleeding     | ORC/C/silver-ORC             | ✓                           | ✓                           |
| Large amount of viscous exudate | Removal of thick exudate, such as fibrinous material and slough | NPWTi-d + ROCF-CC           | ✓                           |
| Wound debris                | Cleanse (inpatient)         | NPWTi-d + ROCF-V             | ✓                           |
| High microbial bioburden     | Removal of infectious materials | NPWTi-d + ROCF-CC           | ✓                           |
|                             |                             | NPWTi-d + ROCF-V             | ✓                           |
|                             |                             | NPWT                        | ✓                           |
|                             |                             | ORC/C/silver-ORC             | ✓                           |
| Moderate to heavy exudate   | Exudate management          | NPWTi-d + ROCF-V             | ✓                           |
|                             |                             | NPWT                        | ✓                           |
|                             |                             | ORC/C/silver-ORC             | ✓                           |
| Desiccated wound            | Moist wound healing         | NPWTi-d + ROCF-V             | ✓                           |
|                             |                             | NPWT                        | ✓                           |
|                             |                             | ORC/C/silver-ORC             | ✓                           |
| Stalled or delayed development of granulation tissue | Promote granulation tissue formation | NPWT | ✓     |
|                             | Rebalance moist wound environment | ORC/C/silver-ORC | ✓     |

ORC: oxidized regenerated cellulose; C: collagen; NPWTi-d: negative pressure wound therapy with instillation and dwell time; ROCF-CC: reticulated open-cell foam with through holes; ROCF-V: reticulated open-cell foam without through holes; NPWT: negative pressure wound therapy
Inpatient and Outpatient Wound Treatment Recommendations

Table 4. Available NPWT-i-d, NPWT, or ORC/C/silver-ORC therapy options by wound type

<table>
<thead>
<tr>
<th>Wound Type</th>
<th>Inpatient Availability Only</th>
<th>Inpatient and Outpatient Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NPWTi-d a</td>
<td>NPWT</td>
</tr>
<tr>
<td>DFU</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>VLU</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PI</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Traumatic</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Surgical</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Skin Tear</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Skin graft donor site</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>NPWTi-d: negative pressure wound therapy with instillation and dwell time; NPWT: negative pressure wound therapy; ORC: oxidized regenerated cellulose; C: collagen; DFU: diabetic foot ulcer; VLU: venous leg ulcer; PI: pressure injury</td>
<td></td>
</tr>
<tr>
<td>a Grey shaded column indicates inpatient availability only.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

bed and then allowing the wound to close by reepithelialization or delayed primary closure. In this scenario, the transition to home care will focus on therapies that promote granulation tissue formation and reepithelialization.

Transition from inpatient to outpatient treatment recommendations. When transitioning a patient from inpatient to outpatient care, multiple discharge factors should be considered. Patient factors such as overall health, cognitive and function status, home environment, preferences and concerns, and access to services are important and may alter treatment plans following patient discharge. Other factors that should be taken into account are the severity and complexity of the wound, treatment goals, equipment availability, insurer requirements, and access to follow-up care.

As patients transition from inpatient to outpatient care, it can be difficult to maintain uninterrupted care. Off-the-shelf NPWT (SNAP Therapy System; V.A.C.VIA Therapy System; V.A.C. FREEDOM Therapy System; ACTIV.A.C. Therapy System; KCI, an Acelity Company) or ORC/C/silver-ORC dressings may be utilized in outpatient care and can help bridge the gap between inpatient and outpatient care (Figures 1, 6; Table 3), because dressing changes should occur every 2 to 3 days as per the manufacturer’s instructions.

For NPWT, a 2013 study by Gabriel et al examined the use of off-the-shelf NPWT over skin grafts in the outpatient setting. Here, patients who received the outpatient NPWT units were discharged on the same day as graft placement without the need for inpatient admittance and an average 6-day length of stay (LOS) seen in the historical cohort. In addition to helping improve ease of discharge, 1 off-the-shelf NPWT system (ACTIV.A.C. Therapy) comes equipped with remote therapy monitoring (RTM; iON PROGRESS Remote Therapy Monitoring; KCI, an Acelity Company). The RTM allows for a network of trained professionals to contact patients using NPWT in the home care setting and may help ensure continuous usage of NPWT. Thus, the application of an off-the-shelf NPWT system may help maintain uninterrupted wound care as the patient transitions from inpatient to outpatient care settings.

Outpatient treatment recommendations. Similar to inpatient treatment recommendations, therapy selection should be based on patient characteristics, wound assessments, and goals of therapy. If infection is present, infection treatment should be initiated. Negative pressure wound therapy or ORC/C/silver-ORC dressings are treatment options available for outpatient usage (Figure 1; Table 3). In wounds needing removal of infectious materials, NPWT can be utilized after appropriate infection management care has been initiated. Also, ORC/C/silver-ORC dressings may be applied over contaminated wounds; they have been reported to show a reduction of bioburden within the silver-ORC component. Negative pressure wound therapy or ORC/C/silver-ORC dressings also may be used to help manage exudate and promote granulation tissue development and moist wound healing. Moreover, panel members recommended the application of ORC/C/silver-ORC dressings into explored areas of undermining to help promote the development of granulation tissue. If assistance with surface bleeding is required, ORC/C/silver-ORC dressings should be applied.

Similar to the inpatient treatment recommendations, the panel members advised the use of NPWT and ORC/C/silver-ORC dressings in a variety of wound types, including DFUs, PIs, and traumatic wounds, in the outpatient setting (Table 4).
**Practice tips and pearls.** Panel members described their practice tips and pearls for use of each product (Table 5). One important tip the panel members emphasized, independent of care setting, was to ensure the wound is free from debris and has a healthy granulation bed prior to starting wound closure measures. If the wound closure methods were attempted too early, panel members noted stalled wound healing and failed wound closure efforts.

**Practice challenges.** In trauma and inpatient settings, one practice challenge is the sense that patients are discharged too early (ie, before an optimum/stable wound care plan is evaluated fully). This most often occurs when wound care is secondary to initial clinical presentation. Maintaining good communication with the attending physician and all specialists and outlining the plan for wound care in the progress notes (eg, “dressing to be changed on Wednesday, if looks good, OK to go home”; “wound continues to have necrotic tissue, would benefit from further debridement”; or “patient would benefit from placement in a skilled nursing facility for further wound care and antibiotics”) may help improve continuity of the patient’s wound care. In addition, panel members recommended continued wound assessment and intervention with clinically appropriate therapies.

A number of challenges exist in the transition between inpatient and outpatient care settings. A common vulnerable point in transition care is communication difficulties between hospitals and outpatient care settings at discharge, which can cause a significant delay in care.42,46,47 Providing detailed
Inpatient and Outpatient Wound Treatment Recommendations

With the increased use of advanced wound care modalities, overnight and weekend device alarms can be difficult for health care providers to manage. After hours, device alarms may be a problem in trauma and inpatient settings. In the outpatient setting, especially home care, device and leakage alarms may be turned off and therapy stopped due to difficulty resolving the alerts. Improved training may help mitigate these difficulties.

Patient adherence to the care plan is an increasing challenge in clinical practice, and education may help increase adherence to treatment. In home care, a NPWT device may be turned off and therapy stopped. The RTM developed for NPWT allows for a network of trained professionals to contact patients when therapy usage is low and provide patient education to improve therapy adherence. Early results have indicated an increase in patient adherence to therapy usage following the patient call. This RTM ability has the potential to help patients maintain continuous wound care during the transition from inpatient to outpatient care.

Practice challenges are reported in Table 6.

Economic considerations. Cost of treatment can affect treatment plan implementation. There can be difficulty in obtaining prescribed wound care products in the practice/hospital/home health setting. For example, in the acute care setting, the cost of advanced wound care and dressings need to be covered under the diagnosis-related group rate for that patient. In outpatient care in a wound care center, some product use is available immediately (ORC/C/silver-ORC dressings), while others (NPWT) will only be reimbursed after 30 days of failed standard of care.

Inpatient and Outpatient Wound Treatment Recommendations

44

Figure 6. Transition to outpatient care treatment selection algorithm.
NPWT: negative pressure wound therapy; ORC: oxidized regenerated cellulose; C: collagen

NPWT: negative pressure wound therapy; ORC: oxidized regenerated cellulose; C: collagen

Patient and Wound Evaluation

No

Patient Ready for Discharge?

Yes

Large Wound?

No

Yes

NPWT

Moderate Exudate?

No

Yes

ORC/C/Silver-ORC Dressings

Mechanical NPWT

NPWT

Patient and Wound Evaluation

treatment notes in discharge documents and a point-of-care contact may help improve these communication issues. Also, as patients transition from inpatient to outpatient care, it can be difficult for patients to maintain uninterrupted care. Off-the-shelf NPWT, RTM, or ORC/C/silver-ORC dressings can be utilized to bridge the gap between inpatient and outpatient care.
care treatment. In contrast, when a patient is initially treated with NPWT in an inpatient care setting and transitions to outpatient care, application of outpatient-approved NPWT prior to discharge may be allowed if wound improvement during inpatient care is well documented. This challenge affects the types of products prescribed and the wound care treatment plan. An increase in published evidence along with health economic studies may help address this challenge.

Several studies have been published that explore the health economics of NPWT use. Authors have reported reduced total cost, wound-related readmission rates, and resource utilization with adjunctive use of NPWT. Gabriel et al demonstrated a reduced number of surgical debridements, hospital LOS, therapy usage length, and time to wound closure, resulting in a potential reduction of average therapy cost in patients who received NPWTi-d compared with standard NPWT. Similarly, increased rates of wound healing and reduced time to wound healing also have been reported. There is a paucity of published literature examining the health economics of ORC/C/silver-ORC dressing usage; however, Snyder et al reported improved wound healing rates and estimated reduced costs in patients that received ORC/C/silver-ORC dressings compared with gauze dressings.

The timing of advanced wound therapy usage also can impact the economics of wound healing. An inpatient study compared the early and late use of NPWT in trauma patients. A significant decrease \( P < .05 \) in LOS, intensive care unit stays, treatment days, and total and variable costs was observed in the group that received NPWT early in treatment compared with the group receiving late NPWT use. Similarly, the impact of LOS in home health care in patients with PIs (N = 98) or surgical wounds (N = 464) that received NPWT early (< 30 days for PIs and < 7 days for surgical wounds after start of home care) compared with later in the treatment plan was examined. Patients that received NPWT early showed a significantly reduced LOS in home health care \( P < .0001 \).

The panel members developed a list of practices that could enhance therapy/product use efficiencies, including patient education and the adoption of appropriate therapies at the appropriate time within the clinical treatment pathway, which is reported in Table 7.

### Case Studies

**Use of NPWTi-d with ROCF-V in a Sacral PI**

An 83-year-old man presented with a PI resulting from an ependymoma sacral tumor (Figure 7A). Patient medical history included hypothyroidism, hypertension, mild cognitive impairment, neurogenic bladder, and a seizure disorder. Intravenous antibiotics were initiated upon admission. Wound cultures were positive for *Morganella morganii*, *Escherichia coli*, and *Enterococcus faecalis*. Bedside sharp debridement was performed on the wound by a plastic surgeon (Figures 7B). The NPWTi-d with ROCF-V was initiated by instilling normal saline with a 5-minute dwell time followed by 2 hours of continuous negative pressure at -125 mm Hg. Ostomy paste, ostomy ring, gel sheet, and adhesive gel patch

<table>
<thead>
<tr>
<th>Setting</th>
<th>Product</th>
<th>Practice Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient Only</td>
<td>NPWTi-d + ROCF-CC</td>
<td>• Use of NPWTi-d with ROCF-CC may help remove infectious material and thick exudate such as fibrinous material and slough.</td>
</tr>
<tr>
<td></td>
<td>NPWTi-d + ROCF-V</td>
<td>• Application of hydrocolloid dressings, ostomy rings/ strips, and not over stretching the drape can help optimize the NPWT drape seal and protect peri-wound skin.</td>
</tr>
<tr>
<td></td>
<td>NPWT</td>
<td>• Application of hydrocolloid dressings, ostomy rings/ strips, and not over stretching the drape can help optimize the NPWT drape seal and protect peri-wound skin.</td>
</tr>
<tr>
<td></td>
<td>ORC/C/ Silver-ORC</td>
<td>• Place ORC/C/silver-ORC dressing on wounds prior to application to a total contact cast.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Layering ORC/C/silver-ORC dressings can help manage moderate to heavy exuding wounds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weekly wound debridement after application of ORC/C/silver-ORC dressing should be avoided unless wound healing has stalled and devitalized tissue is observed in the wound bed.</td>
</tr>
</tbody>
</table>

### Table 5. Panel member practice tips

<table>
<thead>
<tr>
<th>Setting</th>
<th>Product</th>
<th>Practice Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient Only</td>
<td>NPWTi-d + ROCF-CC</td>
<td>• Use of NPWTi-d with ROCF-CC may help remove infectious material and thick exudate such as fibrinous material and slough.</td>
</tr>
<tr>
<td></td>
<td>NPWTi-d + ROCF-V</td>
<td>• Application of hydrocolloid dressings, ostomy rings/ strips, and not over stretching the drape can help optimize the NPWT drape seal and protect peri-wound skin.</td>
</tr>
<tr>
<td></td>
<td>NPWT</td>
<td>• Application of hydrocolloid dressings, ostomy rings/ strips, and not over stretching the drape can help optimize the NPWT drape seal and protect peri-wound skin.</td>
</tr>
<tr>
<td></td>
<td>ORC/C/ Silver-ORC</td>
<td>• Place ORC/C/silver-ORC dressing on wounds prior to application to a total contact cast.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Layering ORC/C/silver-ORC dressings can help manage moderate to heavy exuding wounds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weekly wound debridement after application of ORC/C/silver-ORC dressing should be avoided unless wound healing has stalled and devitalized tissue is observed in the wound bed.</td>
</tr>
</tbody>
</table>

**NPWTi-d: negative pressure wound therapy with instillation and dwell time; ROCF-CC: reticulated open-cell foam with through holes; ROCF-V: reticulated open-cell foam without through holes; NPWT: negative pressure wound therapy; ORC: oxidized regenerated cellulose; C: collagen**
Inpatient and Outpatient Wound Treatment Recommendations

Table 6. Practice challenges

<table>
<thead>
<tr>
<th>Setting</th>
<th>Challenges</th>
<th>Suggested Resolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient</td>
<td>Patient adherence</td>
<td>• Increase patient education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Educate caregivers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Behavioral intervention⁴⁴</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Affective intervention⁴⁴</td>
</tr>
<tr>
<td></td>
<td>After hour device alarms that require troubleshooting</td>
<td>• Provide in-depth product use training</td>
</tr>
<tr>
<td></td>
<td>Balanced inpatient LOS with optimal outcomes</td>
<td>• Discussion of individual patient needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Communication with all specialists involved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Treatment plan notes in the patient’s chart</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• More involvement in primary team with wound care providers and bedside evaluation</td>
</tr>
<tr>
<td></td>
<td>Difficulty stocking wound therapy products</td>
<td>• Increase evidence for use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Publish cost-effectiveness studies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Educate material managers</td>
</tr>
<tr>
<td></td>
<td>Difficulty performing dressing changes</td>
<td>• Provide in-depth product use training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Utilize published literature as reference for complicated dressing placements and changes</td>
</tr>
<tr>
<td>Transition From</td>
<td>Lack of communication</td>
<td>• Provide detailed notes for treatment plan in discharge documents</td>
</tr>
<tr>
<td>Inpatient to</td>
<td></td>
<td>• Give point-of-care contact information in discharge documents</td>
</tr>
<tr>
<td>Outpatient</td>
<td></td>
<td>• Develop receipt of orders documentation to ensure orders have been received</td>
</tr>
<tr>
<td></td>
<td>Delay in treatment</td>
<td>• List symptoms or health problems to be cautious of after discharge</td>
</tr>
<tr>
<td></td>
<td>Patient adherence</td>
<td>• Increase patient education</td>
</tr>
<tr>
<td></td>
<td>Troubleshooting for device alarms</td>
<td>• Educate caregivers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remote therapy monitoring⁴⁴</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Affective intervention⁴⁴</td>
</tr>
<tr>
<td></td>
<td>Stocking wound therapy products</td>
<td>• Increase evidence for use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Publish cost-effectiveness studies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Educate material managers</td>
</tr>
</tbody>
</table>

LOS: length of stay; NPWT: negative pressure wound therapy; ORC: oxidized regenerated cellulose; C: collagen

were utilized to help maintain a seal. Dressing changes occurred every 2 to 3 days as per the manufacturer’s instructions for use.

After 10 days of therapy, the wound showed signs of an improved wound bed (Figure 7C). The NPWTi-d was continued for a total of 14 days to allow for further improvement of the wound bed (Figure 7D). On day 14, therapy was switched to NPWT (ACTIVA.C. Therapy System) and the patient continued to be managed on the medical floor (Figure 7E–7H).

Use of NPWTi-d with a ROCF-CC dressing in a large abdominal wound

A 70-year-old woman presented with a large abdominal wound (60 cm x 12 cm) open for 5 months in an area of previous radiation therapy (Figure 8A). Medical history included stage 4 chronic kidney disease, type II diabetes mellitus, atrial fibrillation/atrial flutter, obstructive sleep apnea, morbid obesity, chronic abdominal wounds, vitamin B12 deficiency, grade 2 endometrioid endometrial adenocarcinoma, adenocarcinoma of the uterus, and adenocarcinoma of the liver. Previous treatment included
NPWT, alginate-silver dressings, gauze, washing with antibiotics, and Dakin’s solution. Despite previous treatments, the wound bed showed a large amount of devitalized tissue and thick wound exudate. Negative pressure with instillation and dwell time with ROCF-CC dressing was initiated with 150 mL of normal saline and dwell time of 3 minutes, followed by continuous negative pressure at -100 mm Hg for 2 hours. Dressings were changed every 2 to 3 days.

After 4 days of therapy (Figure 8B), the amount of solution was changed to 300 mL and the dwell time remained at 3 minutes, followed by 2 hours of continuous negative pressure at -125 mm Hg. The short dwell time with an increased amount of topical wound solution instilled into the wound bed was utilized to increase wound cleansing provided by NPWTi-d with the ROCF-CC dressings.

After 11 days of therapy (Figure 8C), the dwell time was changed to 10 minutes, followed by 3.5 hours of continuous negative pressure at -125 mm Hg. Therapy was changed after 13 days to standard NPWT with continuous negative pressure at -100 mm Hg as per hospital protocol. However, after 3 days, the wound regressed, indicating therapy had been switched too early. The NPWTi-d with ROCF-CC dressing was restarted by instilling 300 mL of Dakin’s solution (quarter strength) with a dwell time of 10 minutes, followed by 3.5 hours of continuous negative pressure at -125 mm Hg.

After 24 hours of therapy, the instillation solution was switched to normal saline as the wound contamination had been significantly reduced. No other therapy parameters were altered.

After 28 days of NPWTi-d with the ROCF-CC dressing (Figure 8D), slough removal was ongoing; however, the wound bed showed signs of healthy granulation tissue formation. Negative pressure with instillation and dwell time with ROCF-CC dressing therapy setting was switched to instill 250 mL of Dakin’s solution (quarter strength) with a dwell time of 5 minutes, followed by

**Table 7. Recommendations for maximizing therapy/product use efficiencies**

- Use appropriate therapies
- Use the appropriate therapies with the appropriate protocol/clinical pathway
- Adopt appropriate therapies at the appropriate time
- Improve patient adherence
- Educate the patient
- Conduct clinician training
- Monitor and reassess etiology, comorbidities, and goal of therapy
- Communicate with caregivers, patients, and patient family members

**Figure 7.** Negative pressure wound therapy with instillation and dwell time (NPWTi-d) use in a sacral pressure injury. (A) Wound at presentation; (B) wound after sharp debridement; (C) wound after 10 days of NPWTi-d; (D) wound after 14 days of NPWTi-d prior to switching therapy to negative pressure wound therapy (NPWT); (E) wound after 3 days of NPWT; (F) wound after 8 days of NPWT; (G) wound after 16 days of NPWT; and (H) wound after 27 days of NPWT. Photos courtesy of Rosemary Hill.
2 hours of continuous negative pressure at -125 mm Hg.

After 33 days of treatment with NPWTi-d with the ROCF-CC dressing, the patient underwent sharp debridement in the operating room to remove remaining slough (Figure 8E). Following removal of all slough and devitalized tissue with appearance of a healthy wound bed, she was discharged to a long-term acute care facility with standard NPWT at -125 mm Hg.

**Use of ORC/collagen/silver-ORC dressing over STSG donor site**

A 56-year-old man presented with an infected right total knee arthroplasty (TKA). The patient underwent surgery to remove the infected implant. An antibiotic spacer was then placed into the joint. Following application of the spacer to TKA, the subsequent wound developed. A right gastric flap followed by STSG reconstruction was performed. The ORC/C/silver-ORC dressings were placed over the right thigh STSG donor site to provide a barrier from external contaminants, manage exudate, and help promote a moist wound environment and wound healing.

![Figure 8](image1.png)

**Figure 8.** Negative pressure wound therapy with instillation and dwell time (NPWTi-d) and reticulated open-cell foam dressing with through holes (ROCF-CC) use in a large abdominal wound. (A) Wound at presentation; (B) wound after 4 days of NPWTi-d with ROCF-CC dressing; (C) wound after 11 days of NPWTi-d with ROCF-CC dressing; (D) wound after 28 days of NPWTi-d with ROCF-CC; and (E) wound following surgical debridement after 33 days of treatment. Photos courtesy of Mary Anne Obst.

![Figure 9](image2.png)

**Figure 9.** Oxidized regenerated cellulose (ORC)/collagen (C)/silver-ORC dressing use over a skin graft donor site. (A) Donor site on day of split-thickness skin graft harvest; (B) application of ORC/C/silver-ORC dressing; (C) wound immediately after application of ORC/C/silver-ORC dressing; and (D) donor site 6 months post graft harvest. Photos courtesy of Dr. Saeed A. Chowdhry.
reepithelialization (Figure 9A-9C). The ORC/C/silver-ORC dressings were covered with a secondary film dressing (3M TEGADERM Film Dressing; 3M, St Paul, MN).

The patient was discharged home 1 week after closure. The donor site fully epithelialized 12 days post graft harvest without complications. At the 6-week postoperative visit, the donor site remained fully epithelialized without any complications (Figure 9D).

**Limitations**

Limitations for this work include the lack of evidence and the open consensus formation of the meeting. Treatment recommendations and practice tips and pearls were based on the experiences of the panel members and supported by literature when possible. The open consensus format could be biased by in-person social interactions that could sway panel members to vote with the group rather than independently.

**Conclusions**

A literature search and panel meeting were conducted on the use of NPWT, NPWTi-d, or ORC/C/silver-ORC dressing use in wound care. Inpatient and outpatient treatment guidelines were developed that recommended using multiple wound care modalities to promote wound closure or wound healing. Panel members discussed tips and technical pearls based on their own experiences and supported with published literature when possible. These included using NPWTi-d with ROCF-CC in wounds with thick exudate such as fibrinous material and slough to help delineate nonviable tissue for removal with sharp debride ment. Placing ORC/C/silver-ORC dressings into explored areas of undermining in deep wounds to help promote the development of granulation tissue also was recommended. In addition, practice challenges including patient adherence, interrupted care during transition between care settings, and difficulties troubleshooting after hours and weekend device alarms were discussed.

**References**


17. Fernandez L, Ellman C, Jackson P. 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. *J Trauma Treatment.* 2017;6(5):1–5.


Assessing NPWT Systems or ORC/Collagen/Silver-ORC Dressings


