Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/burns

Extra-large negative pressure wound therapy dressings for burns – Initial experience with technique, fluid management, and outcomes

Sebastian Fischer [a,b], Jennifer Wall [c], Bohdan Pomahac [a], Robert Riviello [c], Eric G. Halvorson [a,*]

[a] Division of Plastic Surgery, Brigham and Women's Hospital, Harvard Medical School, 75 Francis St, 02115 Boston, MA, United States

[b] Department of Hand, Plastic and Reconstructive Surgery, Burn Trauma Center, BG Trauma Center Ludwigshafen, Research Group ''Trauma meets Burn'', University of Heidelberg, Ludwig-Guttmann-Strasse 13, 67071 Ludwigshafen, Germany

[c] Division of Trauma, Burns, and Surgical Critical Care, Brigham and Women's Hospital, Harvard Medical School, 75 Francis St, 02115 Boston, MA, United States

ARTICLE INFO

Article history:
Accepted 25 August 2015

Keywords:
Negative pressure wound therapy
Fluid resuscitation
Burn wound
Vacuum assisted closure device

ABSTRACT

Objective: The use of negative-pressure-wound-therapy (NPWT) is associated with improved outcomes in smaller burns. We report our experience using extra-large (XL) NPWT dressings to treat ≥15% total body surface area (TBSA) burned and describe our technique and early outcomes. We also provide NPWT exudate volume for predictive fluid resuscitation in these critically ill patients.

Methods: We retrospectively reviewed patients treated with XL-NPWT from 2012 to 2014. Following excision/grafting, graft and donor sites were sealed with a layered NPWT dressing. We documented wound size, dressing size, NPWT outputs, graft take, wound infections, and length of stay (LOS). Mean NPWT exudate volume per %TBSA per day was calculated.

Results: Twelve burn patients (mean TBSA burned 30%, range 15–60%) were treated with XL-NPWT (dressing TBSA burned and skin graft donor sites range 17–44%). Average graft take was 97%. No wound infections occurred. Two patients had burns ≥50% TBSA and their LOS was reduced compared to ABA averages. XL-NPWT outputs peaked at day 1 after grafting followed by a steady decline until dressings were removed. Average XL-NPWT dressing output during the first 5 days was 101 ± 66 mL/%BSA covered per day. 2 patients developed acute kidney injury.

Conclusion: The use of XL-NPWT to treat extensive burns is feasible with attention to application technique. NPWT dressings appear to improve graft take, and to decrease risk of infection, LOS, and pain and anxiety associated with wound care. Measured fluid losses can improve patient care in future applications of NPWT to large burn wounds.

* *Corresponding author*. Tel.: +1 617 732 6387; fax: +1 617 525 7386.
E-mail address: ehalvorson@partners.org (E.G. Halvorson).

http://dx.doi.org/10.1016/j.burns.2015.08.034
0305-4179/

1. Introduction

Negative pressure wound therapy (NPWT) has expanded our ability to treat acute and chronic wounds and belongs in the standard repertoire of every surgical department [1]. NPWT provides a sterile occlusive wound healing environment that promotes re-epithelialization [2]. Studies have shown that wound healing improves due to increased diffusion of blood and nutrients to the healing site [3,4]. For patients with large burn wounds, the inability of deep wounds to epithelialize is a significant source of infectious morbidity and mortality [5]. Dermal vessels are damaged leading to a depletion of erythrocytes and immune cells in the wound bed [6–9]. In addition, burns exceeding 15% TBSA result in the release of inflammatory mediators that provoke immunosuppression, increased vascular permeability and fluid shifts to extravascular spaces [10–12]. As a sterile occlusive dressing that promotes re-epithelialization, NPWT has the potential to reduce infectious complications and improve wound healing in burn patients. The widespread use of NPWT in burn surgery has been limited, however, likely due to challenges with dressing application in this patient population.

A sterile wound environment, proper wound healing and adequate fluid resuscitation are mandatory for survival in critically ill burn patients. Although the latter is more crucial in the initial phase of large burns, fluid replacement regains importance after surgical debridement and autologous skin grafting due to enlargement of the affected body surface area from the donor site [13]. In current clinical practice, insensible fluid losses are estimated using body weight, heart rate, blood pressure, urine output, laboratory values, and other parameters. These attempts to estimate the patient's fluid status and volume repletion are often imprecise and can lead to pulmonary edema or renal failure with life-threatening consequences [14–17]. In order to limit the effects of dramatic shifts in wound area, a staged approach to excision and autografting is often implemented, which on the other hand has the potential to prolong hospitalization and increase the risk of wound infections and other nosocomial complications [18]. By quantifying wound exudate, NPWT has the potential to improve one of the most vexing problems in current burn care: fluid management. More informed fluid management may lead to reduced pulmonary and renal complications.

Kamolz et al. recently reported about feasibility of NPWT for large-scale burns exceeding 25% TBSA burned in 37 patients [19]. Although this excellent study clearly demonstrates beneficial effects of NPWT for severely burned patients and thus increases the demand for more evidence supporting this technique, detailed data regarding complications and fluid losses associated with NPWT were not provided.

Several studies have demonstrated that NPWT is capable of reducing infection rates and enhancing graft take after burn wound excision and autografting [1,20]. These studies, however, are limited to small burns that do not exceed an average of 10% TBSA. Based on these studies it is impossible to know if NPWT has a beneficial effect on the systemic alterations associated with larger burns. Finally, there is some data to suggest that NPWT has a beneficial effect on re-epithelialization of skin graft donor sites [21]. Nevertheless, this data is based on an animal study and case reports involving small wounds.

The aim of this study was to evaluate our outcomes using extra-large NPWT (XL-NPWT) dressings in burn patients with wounds ≥15% TBSA burned, and provide a description of technical refinements that make dressing application feasible for large burn wounds. A secondary aim was to quantify wound exudates using NPWT in an effort to predict estimated fluid losses after excision and autografting. We sought to compare these outputs to estimated insensible losses using standard calculations, and to suggest measuring NPWT exudate as a useful tool for clinicians managing burn patients.

2. Patients and methods

An IRB-approved retrospective review was performed of patients admitted to our burn center from April 2012 to April 2014. We included patients that received NPWT after burn excision and grafting with wounds ≥15% TBSA burned. Wounds were covered with xenografts or autografts using a power dermatome (0.10–0.12 inches) and 2:1 or 3:1 mesher. Patient records were reviewed to determine graft take (%), donor site healing (time to 95% re-epithelialization), ventilation days, complications, length of stay (LOS), and volume of wound exudate. Dressing size was measured manually with a conventional ruler and also calculated as a percentage of the TBSA via Lund and Browder method [22]. Estimates of insensible losses were calculated by the formula of DuBois and DuBois involving body weight and height [23]. Wound exudate was gathered daily and provided in total (grafted + -donor sites) as well as separately for graft and donor sites. Wound exudate output was calculated in mL per percentage of VAC covered body surface area per day and given in average of the first 5 days after grafting as well as for each of the first 5 days separately. NPWT dressings placed over xenografts were excluded from these calculations to simplify our analysis. Daily burn related evaporative losses (BREL) were calculated according to the following formula [24]:

$$\text{BREL} = (25 + \%\text{TBSA}) \times (\text{BSA in cm}^2) \times 24.$$

Hospital LOS was compared with average LOS provided by the American Burn Association (ABA) according to patients' age and TBSA burned.

3. Negative pressure wound therapy dressing application

NPWT dressings were applied to both burn wounds and donor sites. In the majority of cases, tangential excision and autografting was performed. Less often, fascial excision with or without grafting was performed. Xenografts were used in certain cases to test the wound bed or provide temporary biologic coverage. Graft recipient sites were covered with non-adherent fine mesh gauze (N-TERFACE, Winfield Laboratories, Richardson, Texas, USA and/or Xeroform Covidien, Mansfield, MA, USA) and donor sites with thin silver-impregnated non-adherent foam (Mepilex Ag, Mölnlycke Health Care, Gothenburg, Sweden). All surfaces were then covered with NPWT