Objectives

Identify appropriate versus inappropriate uses of NPWT.
Discuss options available for wound fillers and contact layers used with Negative Pressure devices.
When was NPWT first used?

Many people think that negative pressure wound therapy (NPWT) was first used in the late 20th century. In fact, NPWT was first used over 2000 years ago:

- Assyria and Babylon (600BC)
- Hippocrates (400BC)
- Celsus (1st century AD)
- Galen (2nd century AD)
- August Bier (early 1900s)

Many clinicians have used NPWT since then.
NPWT in the 20th century

Many clinicians used NPWT in the 20th century

• Dr E. Klapp first used a suction pump around 1907
• Russian doctors (Soviet Union - Miller) first used a canister with NPWT in the 1980s and described gauze based dressings
• Chariker & Jeter first used a wound bed contact layer in 1989 with gauze based dressing
• Kremlinin papers – collection of Russian Studies published collectively 1994
• Morykwas & Argenta used a open-pore polyurathane foam contact layer in 1997
The Evolution of NPWT

14th century
The practice of cupping using glass bowls, which were heated to create negative pressure

1952
Dr. Raffl first uses NPWT

1962
Russian clinicians begin their epic research on NPWT

1985-1991
Notable NPWT research published in the “Kremlin Papers”

1989
Chariker-Jeter technique developed and proven effective in fistulae

1995
NPWT becomes commercially available

1989-1991
Notable NPWT research published in the “Kremlin Papers”

2001
CMS approves reimbursement

2003-2007
Other devices became commercially available

2003-present
Flexible choices of pumps to deliver NPWT and choices of interfaces (fillers and contact layers)

2010-2012
Introduction single patient use disposable devices
Negative pressure wound therapy

Topical therapy that provides controlled sub-atmospheric pressure in a sealed system on the surface of a wound.
tNPWT
Innovative….Portable NPWT devices
Management of the wound is not just about NPWT nor is it about a unique product.

........Appropriate utilization of a combination of Advanced Wound Care Dressings and NPWT.
Used for clinical treatment of many wound types

- Orthopaedic trauma (Ballero et al. 2007)
- Soft tissue trauma (Stannard et al. 2006)
- Skin grafts (Sherer et al. 2002)
- Pressure ulcers (Joseph et al. 2000)
- Venous leg ulcers (Vuerstaeck et al. 2006)
- Diabetic foot ulcers (Armstrong, Lavery 2005)
- Burns (Kamoltz et al. 2004)
- Surgical infections (Ozturk et al. 2009)
- Management of other major surgical wounds (Wild et al. 2006)
- Closed Incisions (Stannard 2011)
Foam

- Promotion of a closed **moist environment**. (Morykwas et al., 1997)
- Reduction of **tissue edema**. (Kamolz et al., 2004)
- **Contraction** of the wound edges. (Malmsjö et al., 2009)
- **Mechanical stimulation** of the wound bed. (Saxena et al., 2004)
- **Alteration of blood flow** at the wound edges. (Wackenfors et al., 2004)
- **Stimulation of angiogenesis**. (Greene et al., 2006)
- Formation of **granulation tissue**. (Armstrong and Lavery 2005)
- Physical **splinting** of grafts. (Llanos et al., 2006) and incisional wounds (Gomoll et al., 2006)
A series of basic animal studies using a new hemostatic/polyurethane foam technique (The V.A.C.) has indicated wound healing may be promoted. The technique involves placing an open-cell foam into the wound, covering the site with an adherent dressing, and applying subatmospheric pressure (-125 mm Hg) below ambient. The technique operates in a controlled environment, which is monitored by computer, and, thus, offers an opportunity for more controlled wound healing. The technique has the potential of wound infection and thus decreasing healing potential. It is still a wound in which the edges can be opposed must lead by secondary intention, and require deposition of new connective tissue and neovascularization to form granulation tissue, followed by migration of keratinocytes across the defect, a much longer process than by primary interpolation.

A series of animal experiments are presented that form the foundation for this new hemostatic/polyurethane foam technique for treating wounds: vacuum-assisted closure. This vacuum-assisted wound closure device and methodology (The V.A.C.) is a method to achieve hemostasis and provide a safe, open-cell foam dressing to help prevent dressing-related complications. The vacuum-assisted wound closure technique involves the creation of an intimate contact between the foam and the host tissues, allowing for rapid healing of the wound. The technique is effective in a wide range of surgical and traumatic wounds, and has been shown to improve healing and reduce complications. The technique has been successfully used in a variety of clinical settings, including burn injuries, surgical wounds, and chronic wounds. The V.A.C. system is a closed-system, non-pneumatic wound therapy device that uses a vacuum-assisted system to promote healing of chronic wounds. The system consists of an open-cell foam dressing, an airtight chamber, and a vacuum pump. The foam dressing is placed on the wound and sealed in the chamber, allowing for controlled subatmospheric pressure to be applied to the wound. This pressure helps to create a seal between the foam and the wound edges, allowing for faster healing and reduced complications. The V.A.C. system has been shown to be effective in a wide range of wound types, including chronic wounds, pressure ulcers, and diabetic foot ulcers. It is also effective in accelerating the healing of acute wounds, such as surgical wounds, and has been shown to reduce healing time and improve healing outcomes. The V.A.C. system is a versatile device that can be used in a variety of clinical settings, and has been shown to be effective in promoting healing and reducing complications in a wide range of wound types.
Morykwas and Argenta 1997: the experimental data

1. Stimulation of blood flow in peri-wound tissue surrounding FT wounds in pigs: best response at -125 mm Hg (minutes)

2. Stimulation of granulation tissue formation at -125 mm Hg in FT wound in pigs (days) vs. no pressure controls.

3. Reduction in bacterial burden in FT wounds in pigs purposely infected with bacteria from over $10^5$ CFU to $10^3$ CFU per g tissue (days) -125 mmHg vs. no pressure control

4. Rescue of skin flaps which were constructed so that they suffer necrosis from one end (days). -125 mm Hg vs. no pressure control.

Important paper that has made a great contribution to patient care
Patterns of hypo-perfusion and hyper-perfusion

Malmsjö et al. University of Lund, Sweden,

Foam and gauze: microvascular blood flow

Measure blood flow in wounds using 0.5 mm laser Doppler filaments

<table>
<thead>
<tr>
<th>Side of the wound</th>
<th>Side of the wound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcutaneous</td>
<td>Subcutaneous</td>
</tr>
<tr>
<td>Muscle</td>
<td>Muscle</td>
</tr>
<tr>
<td>Muscle, bottom of the wound</td>
<td></td>
</tr>
</tbody>
</table>
Microvascular response

Custom Built suction pump

laser Doppler filament probe positions

Wound

interface media
*(gauze or foam)*

2.5cm

1cm

0.5cm
Patterns of hyper-perfusion and hypo-perfusion in NPWT

Additional understanding of NPWT mode of action

Similar patterns exist for both foam and gauze based NPWT


This pattern of blood flow may contribute to angiogenesis.
Understanding the MOA of NPWT

- Most clinicians would agree that there are multiple mechanisms of actions associated with the clinical benefits of NPWT.

- Rather than searching for one “correct” MOA it is important to appreciate that evidence is being accumulated on a number of effects which in many cases occur simultaneously during NPWT.

- It is not yet clear how each of the mechanisms of action combine to give the overall clinical effect, but this is an active area of investigation in many laboratories around the world.
Wound Interfaces

Wound filler material

Foam/Gauze – function to deliver negative pressure to the wound bed. Important to place the wound filler in direct contact with all areas of the tissue where NPWT is desired.

Wound contact layer

A non-adherent wound contact layer is place underneath the wound filler when the clinician anticipates complications and/or placed over vulnerable structures, as well as to protect from ingrowth of granulation tissue into the wound filler.

NPWT settings and dressing choices made easy
Contact material effect on MOA

Different materials are used to transmit negative pressure evenly across the wound bed.

Researchers and clinicians have questioned if the contact material is relevant to MOA.

Neither Chariker & Jeter nor Morykwas & Argenta suggest that the contact material is directly relevant to MOA.

In the past there is little research available to assist with a conclusion – this is now increasing in the literature.

Different wound contact materials are used with different NPWT systems.
Choosing a NPWT Wound Filler

**Wound Size/Contour**

Small to moderate size wounds with shallow to deep depth
  - Both foam and gauze may be used with similar ease of application

Moderate to large surface area wounds with shallow depth
  - Gauze is generally considered easier to apply

Moderate to large surface area wounds with deep depth
  - Foam may be considered easier to use

**Wound Exudate**

  - The choice of wound filler will be influenced by the amount and consistency of wound exudate
Choosing a NPWT Wound Filler

Patient Comfort

• The choice of wound filler will be influenced by the amount of pain the patient experiences during NPWT and with dressing changes.

• Pain is a very subjective experience and will varying with each patient. Research has validated that patients report less pain with gauze*
Wound Filler: Gauze

5 days of NPWT
Wound Filler: Foam
Hypothesis: use of the interface for clinical goals

• The nature of the interface can influence the nature of the new tissue that fills the wound

• Understanding the mechanisms teaches us how to enhance or suppress the granulation response

• “Gauze” where there is good control of bacteria and debridement and a need for robust tissue without scar or contraction

• “Foam” where there is poor debridement, less control of bacteria and where scar and contraction may be desirable
Examining the clinical evidence more closely..............
Clinical Decisions - References


Birke-Sorensen et al (2011) JPRAS 64: S1-S16

Vig et al (2011) J Tissue Viability 20: suppl 1 S1-S18

Trauma & Plastics

Treatment variables

Chronic wounds
Evidence-based recommendations for the use of Negative Pressure Wound Therapy in traumatic wounds and reconstructive surgery: Steps towards an international consensus


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ABSTRACT

Negative pressure wound therapy (NPWT) has become widely adopted over the last 15 years and over 1000 peer reviewed publications are available describing its use. Despite this, there remain uncertainties regarding several aspects of use. In order to respond to this gap, an international panel was convened to develop evidence-based recommendations describing the use of NPWT. In this paper the results of the study of evidence in traumatic wounds (including soft tissue defects, open fractures and burns) and reconstructive procedures (including flaps and grafts) are reported. Evidence-based recommendations were obtained by a systematic review of the literature, grading of evidence, drafting of the recommendations by a global expert panel, followed by a formal consensus using an evidence-based methodology (consensus development conference (CDC) Conference). The CDC includes independent healthcare professionals who were able to agree or disagree with the recommendations. The criteria for agreement were set a priori and recommendations that were agreed upon were graded according to the AHCPR (Agency for Health Care Policy and Research) classification system. The development of evidence-based recommendations for NPWT with direct validation from a large group of practicing clinicians offers a valuable basis for consensus that must be work in an expert panel alike.

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### Translation of Evidence levels to graded Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A: Must</td>
<td>At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; or A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results</td>
</tr>
<tr>
<td>Grade B: Should</td>
<td>A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 1++ or 1+</td>
</tr>
<tr>
<td>Grade C: May</td>
<td>A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 2++</td>
</tr>
<tr>
<td>Grade D: Possible</td>
<td>Evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+</td>
</tr>
</tbody>
</table>

*a* Adapted from the SIGN method of classification. Modification was made by using specific terminology to clarify the strength of each evidence-based recommendation (‘Must’ for grade A, ‘Should’ for grade B, ‘May’ for Grade C).

### Evidence levels

<table>
<thead>
<tr>
<th>Evidence level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1++</td>
<td>High-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias</td>
</tr>
<tr>
<td>1+</td>
<td>Well-conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias</td>
</tr>
<tr>
<td>1−</td>
<td>Meta-analyses, systematic reviews, or RCTs with a high risk of bias</td>
</tr>
<tr>
<td>2++</td>
<td>High-quality systematic reviews of case-control or cohort studies. High-quality case-control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal</td>
</tr>
<tr>
<td>2+</td>
<td>Well-conducted case-control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal</td>
</tr>
<tr>
<td>2−</td>
<td>Case-control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal</td>
</tr>
<tr>
<td>3</td>
<td>Non-analytic studies, e.g. case reports, case series, <em>in vivo</em> or <em>in vitro</em> studies</td>
</tr>
<tr>
<td>4</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>

*a* Adapted from the SIGN method of classification.
Krug et al. (2011)

- Global expert panel of 422 independent healthcare professionals was convened to develop evidence-based recommendations describing the use of NPWT.
- The evidence in traumatic wounds (including soft tissue defects, open fractures and burns) and reconstructive procedures (including flaps and grafts) was studied.
- Evidence-based recommendations were obtained by a systematic review of the literature, grading of evidence, drafting of the recommendations by a global expert panel, followed by a formal consultative consensus development program.
- Evidence and recommendations were graded according to the SIGN (Scottish Intercollegiate Guidelines Network) classification system.
- Twelve recommendations were developed in total; 4 for soft tissue trauma and open fracture injuries, 1 for burn injuries, 3 for flaps and 4 for skin grafts.
- The present evidence base is strongest for the use of NPWT on skin grafts and weakest as a primary treatment for burns.
- In the consultative process 11/12 of the proposed recommendations reached the 80% agreement threshold.
Krug et al. (2011) **Soft tissue trauma recommendations:**

1. NPWT may be used when primary closure is not possible after or in between debridements as a bridge to definitive closure (Grade C)

2. NPWT may be used as a method to downscale the complexity of reconstruction (descend the reconstructive ladder) (Grade C)

3. NPWT may be stopped when delayed surgical closure is possible (Grade C)

4. NPWT may be used to improve the healing of fasciotomy incisions (Grade C)

5. NPWT should be considered when primary closure is not possible after or in between debridements as a bridge to definitive closure (Grade B)

6. NPWT may be used to downscale the complexity of closure procedures (Grade C)

7. NPWT should be stopped when delayed surgical closure is possible (Grade B)
Krug et al. (2011) Burns recommendations:

8. NPWT may be beneficial at preventing burn wound progression (Grade C) – 66% rejected
9. It is possible to use NPWT as a treatment for flaps, which have suffered partial necrosis after debridement of necrotic tissue (Grade D)

10. Expert opinion recommends significant caution in applying NPWT to newly planted or compromised flaps (Grade D)

11. It is possible in flap surgery to use NPWT to manage secondary (donor site) defects which cannot be closed primarily (Grade D)

12. NPWT must be considered to improve the rate of graft success (Grade A)

13. NPWT should be considered in wounds/patients with high risk of graft loss (Grade B)

14. As an initial bolster NPWT should be left undisturbed for 3-7 days post grafting STSG (Grade B)

15. When NPWT is used as bolster, continuous pressure level should be used (Grade B)
Evidence-based recommendations for negative pressure wound therapy: Treatment variables (pressure levels, wound filler and contact layer) — Steps towards an international consensus∗

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∗The Information contained within this article was presented in part in an invited Smith & Nephew sponsored symposium at Hamburg in February 2006.
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Method

➢ This study consisted of a formal evidence-based medicine activity (i.e. a full systematic review of the literature) along with consensus development among a panel of NPWT experts

➢ 1064 records were examined (Oct 1996 – Aug 2010) to identify all of the aforementioned variables. After examination and – a total of 208 articles met the inclusion and exclusion criteria for review.

➢ Recommendations were developed according to a modification of the Scottish Intercollegiate Guidelines Network (SIGN) classification system

Presented in this article is the assessment of the evidence relating to different NPWT treatment variables: different wound fillers (primarily foam and gauze), when to use a contact layer, different pressure settings, and the impact of NPWT on bioburden
Table 2  Treatment goals achievable with NPWT.

<table>
<thead>
<tr>
<th>Treatment goals</th>
<th>Related aspect of MoA</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. To Manage and Protect the Wound</td>
<td>• improved fluid management</td>
</tr>
<tr>
<td></td>
<td>• prevention of wound dessication</td>
</tr>
<tr>
<td></td>
<td>• prevention of environmental insult</td>
</tr>
<tr>
<td>ii. To Prepare the Wound for Surgical Closure</td>
<td>• improved quality of the wound bed</td>
</tr>
<tr>
<td>To Progress the Wound by Secondary intention</td>
<td>(granulation tissue formation)</td>
</tr>
<tr>
<td></td>
<td>• contribution to infection management</td>
</tr>
<tr>
<td></td>
<td>• reduction of size and complexity of wound</td>
</tr>
<tr>
<td>iii. To improve outcome after STSG</td>
<td>• splint the wound</td>
</tr>
<tr>
<td></td>
<td>• prevention of post-operative complications (such as graft failure)</td>
</tr>
<tr>
<td>iv. To improve patient comfort</td>
<td>• reduction of wound pain</td>
</tr>
<tr>
<td></td>
<td>• reduced frequency of dressing changes</td>
</tr>
<tr>
<td></td>
<td>• improved patient mobility</td>
</tr>
<tr>
<td></td>
<td>• management of wound exudate and odour</td>
</tr>
<tr>
<td>v. To reduce costs</td>
<td>• faster progression to additional surgery/hospital discharge</td>
</tr>
<tr>
<td></td>
<td>• shorter time to closure</td>
</tr>
<tr>
<td></td>
<td>• reduced nursing time</td>
</tr>
<tr>
<td></td>
<td>• prevention of wound complications</td>
</tr>
</tbody>
</table>

MoA = Mode of Action.
<table>
<thead>
<tr>
<th>Treatment goal or variable</th>
<th>Recommendation and Grade (A–D)</th>
<th>Reference (Evidence Level, 1–4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapeutic Range</td>
<td>It is recommended that NPWT is used within a therapeutic range of −50 mmHg to −150 mmHg.</td>
<td>D L3 - 18, 19, 21, 22, 39, 40, 62, 63, 68, 69, 70, 71, 85.</td>
</tr>
<tr>
<td>To reduce pain</td>
<td>To reduce pain lower negative pressures may be considered.</td>
<td>C L1 - 20&lt;sup&gt;a&lt;/sup&gt; L3: 71, 73–75.</td>
</tr>
<tr>
<td>Caution in ischaemic wounds</td>
<td>Avoidance of higher levels of negative pressure is recommended in wounds with compromised vascularity or otherwise at risk of ischaemia.</td>
<td>D L3 : 21, 22, 75, 84</td>
</tr>
<tr>
<td>Fluid management</td>
<td>To manage high levels of wound exudate or wound fluid, higher levels of negative pressure is recommended.</td>
<td>D L3: 85</td>
</tr>
</tbody>
</table>

<sup>a</sup> = extrapolated data.
Which Wound Filler Material?

Recommendations

- Gauze “should” be considered (Grade B) and PVA foam “possibly” considered (Grade D) to reduce pain on dressing removal.

- Use of PU-foam wound filler is recommended where a rapid surface granulation response is desired (Grade D)

- It is possible to use foam for deep uniform contractible wounds and gauze for shallow non-contracting wounds or complex deep cavities (Grade D)
When to use a WCL?

Recommendations

- Use of a non-adherent WCL is recommended when using PU-foam-based NPWT to bolster a skin graft (Grade D)
What level of negative pressure?

The most common pressure level used (-125mmHg) documented in the literature is based on a limited study on pigs carried out in 1997.

**Preclinical studies on maximum biologic effects can be achieved at (-80 mmHG):**

- Wound contraction (Borqguist et al 2010)
- Regional blood flow (Borqguist et al 2010)
- Formation of granulation tissue (Borqguist et al -in press/(Borqguist et al 2009)

**Clinical studies have shown that negative pressures below (-125mmHG) have resulted in excellent wound healing (Neasce 2009)**

**Series of clinical cases found that wound healing was similar when using -125mmHG and -75mmHG. Pediatric Cases (McCord et al 2007)**

High levels of negative pressure can cause pain and may sometimes need to be reduced.
Choice of Pressure Level

Recommendations

- It is recommended that NPWT be used within a therapeutic range of -40 mmHg to -150 mmHg (Grade D)
- To reduce pain. Lower negative pressures “may” be considered (Grade C)
- Avoidance of higher levels of negative pressure is recommended in wounds with compromised/reduced vascularity or otherwise at risk ischemia (Grade D)
- To manage high levels of wound exudate or wound fluid, higher levels of negative pressure are recommended (Grade D)
Role of NPWT as an adjunct to infection management

- NPWT “should” be used only as an adjunctive therapy to combat wound infection (Grade B)
- Antimicrobial gauze “may” contribute towards infection control (Grade C)
- It is “possible” that silver foam may contribute to infection control (Grade D)
- When applied underneath the NPWT wound filler, it is possible that anti-microbial WCL “may” contribute towards infection control (Grade D)
- It is possible” that fluid instillation may contribute to infection control (Grade D)
Surgical site complications

- Infection
- Seroma
- Hematoma
- Dehiscence

**High risk surgeries**
- Hip & knee arthroplasty joint replacement
- Traumatic wounds with fractures
- Amputations
- Lower extremity bypass
- Abdominal & cardiothoracic procedures
- Incisions exposed to motion and shear forces
- Closed incisions that are:
  - Edematous
  - Leaking fluid
  - Congested

Stannard (2009)
Surgical site management clinical evidence

**Stannard et al Journal Orthop Trauma 2011**
- RCT n=262 calcaneous, pilon and tibial fractures control group 121 and NPWT group 141
- Wound dehiscense control group 21 cases and NPWT group 12 (p< 0.03)
- Total wound infection control group 24 cases and NPWT group 14 (p< 0.02)

**Gomoll et al Journal of Ortho Trauma 2006**
- Case series 35 surgical orthopedic patients
- No cases of wound breakdown or infection

**Atkins et al Surgical Innovation 2009**
- Retrospective review 57 high risk sternal wound patients (Risk assessment predicted 3 infection)
- No wound infection in NPWT treated patients

**Reddix et al Am Journal of Ortho 2009**
- Retrospective review 19 morbidly obese patient with acetabular fractures treated with NPWT. No reported complication
Skin graft fixation

First dressing change 8 days 5 days post-op

Split thickness skin grafts (STSGs)
• Secured by sutures or staples (histoacryl glue in pediatrics)
• Immobilization is essential to allow successful revascularization
• Dressings applied to prevent shear forces and the risk of hematoma/seroma
• Splinting of involved joints
Key Messages: NPWT and Skin Grafts

• Traditional methods of skin graft fixation may be less than ideal
• NPWT may be considered as an effective method of fixation – especially in difficult anatomical areas
• NPWT may help to reduce shear forces
• NPWT may be beneficial where graft take is suspected to be sub-optimal
• NPWT may help to perfuse a wound and remove excess fluid
• NPWT may increase the potential for graft take

Compliments Dr. Ray Dunn, UMASS, Worcester, MA
Early clinical evidence: closed incision plastic surgery
Use of Negative-pressure Wound Therapy in Orthopaedic Trauma

Abstract
Negative-pressure wound therapy (NPWT) has become an important adjunct to the management of traumatic wounds and surgical incisions related to musculoskeletal trauma. On the battlefield, this adjunct therapy allows early wound management and safe aeromedical evacuation. NPWT mechanisms of action include stabilization of the wound environment, reduction of wound edema, improvement of tissue perfusion, and stimulation of cells at the wound surface. NPWT stimulates granulation tissue and angiogenesis and may improve the likelihood of primary closure and reduce the need for free tissue transfer. In addition, NPWT reduces the bacterial burden of wounds contaminated with gram-negative bacilli, however, an increased risk of colonization or gram-positive cocci (e.g., Staphylococcus aureus) exists. Although NPWT facilitates wound management, further research is required to determine conclusively whether this modality is superior to other management options. Ongoing research will continue to define the indications for and benefits of NPWT as well as establish the role of combination therapy, in which NPWT is used with instillation of antibiotic solutions, placement of antibiotic-laden cement beads, or silver-impregnated sponges.

From the Division of Orthopaedic Trauma, Vanderbilt University Medical Center, Nashville, TN (Dr. Streubel and Dr. Obremskey) and Brooke Army Medical Center, San Antonio, TX (Dr. Stinner).

Components of a NPWT System

Open-pore Sponge
Commercially available sponges are made of either polyurethane ether or polyvinyl alcohol. The open-pore structure is a key characteristic of...
Streubel et al. (2012). Use of Negative-pressure Wound Therapy in Orthopaedic Trauma. Journal of AAOS.

Mechanism of Action

Wound Contraction

Stabilization of Wound Environment

Microdeformation

Decreasing Edema & Removal of Wound Exudates

Application Technique

STSG, Closed incisions, Soft Tissue Defects, Combat related injuries

Cost

Evidence-based recommendations
NPWT Case Studies

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Appropriate utilization

Appropriate NPWT is a clinical decision based on:
• A comprehensive assessment of the patient
• Patient’s ability to achieve wound healing
• Severity of the wound
• Failure of the wound to respond to other therapies
• Therapeutic goals

The clinician can exercise full clinical judgment based on the needs of the patient, the wound and the care setting.
Benefits of NPWT

- Control of exudate
- Reduction in the number of dressing changes required
- Reduces infection risk
- Rapid wound granulation, epithelialization, and contraction
- Reduces pain at dressing changes
- Reduces wound odor
- Concurrent rehabilitation
- Treatment costs

NPWT is not a new therapy and is effective across a wide range of wounds.
What are the NPWT expected clinical outcomes?

- Creates a moist environment
- Drains exudate
- Reduces tissue edema
- Contract the wound edges
- Mechanically stimulates the wound bed
- Alters blood flow in the wound edges
- Stimulates angiogenesis

Some MOA are interlinked. It is not yet known which MOAs are most important in terms of wound healing.

Clinical studies are still somewhat inconclusive regarding removal of bioburden.
What are the goals of treatment?

**SHORT TERM**
- Management of wound exudate
- Management of wound odor
- Reduction in pain
- Removal of sloughy tissue
- Prevention of infection

**LONG TERM**
- Reduction in wound area
- Reduction in wound exudate volume
- Production of healthy granulation tissue
- Wound closure through surgical means or secondary intention
- Restoration of physical function in the wound site
Precautions

• Weakened blood vessels
• Exposed delicate structures
• Bleeding
• Fistulae
• Patients requiring certain treatments (MRI, HBO, defibrillation)
• Patients with spinal cord injury
• Infected wounds
• Wounds with sharp edges (ie bone fragments)
• Vascular anastomoses

http://fda.gov/MedicalDevices/Safety/AlertsandNotices/PublicHealthNotifications/ucm190658.htm
Contraindications

CONTRAINDICATIONS

• Osteomyelitis
• Malignancy - Except palliative care
• Non-enteric and unexplored fistulae
• Exposed vasculature, nerves, anastomotic sites or organs
• Necrotic tissue with eschar present or thick slough in wound bed

http://fda.gov/MedicalDevices/Safety/AlertsandNotices/PublicHealthNotifications/ucm190658.htm
When should NPWT be discontinued?

- NPWT should be discontinued when the goal of treatment has been achieved
  
  • When uniform granulation tissue and little depth to the wound is present
  
  • The patient is not tolerating the NPWT, or withdraws consent to treatment
  
  • When wound volume reduction is less than 15% over a two week period (WUWHS 2008-
    http://www.woundsinternational.com/content_37.PDF
  
  • The patient complains of extreme pain
  
  • There is excessive bleeding
  
  • An alternative treatment option is more suitable
  
  • There are signs of local or spreading infection.
56 yo male with DM, PVD

- Staph abscess RLE
- s/p intra op l & D
- On antibiotics

- NPWT appropriate? Why?
- What is goal of therapy?
28 yo with undifferentiated calciprophylaxis
47 yo with necrotizing fasciitis
How would you protect this patient’s peri wound skin/ maintain a seal?
Is there such a thing as too much pressure for negative pressure???
Is it useful to help prevent ‘unravelling of the thread’?
28 yo with necrotizing fasciitis
18 yo s/p MVA; comp syndrome
54 yo female with calciphylaxis
Troubleshooting

- Adhesives
- Adhesive gel strips
- Ostomy paste
- Transparent film/drapes
- Stethoscope
- Reinforce suction drain, suction port or suction pad
- Secure cannister
- Hydrocolloids
Limitations of Therapy

- Patient compliance
- Lack of financial resources
- Rural locations
- Cost (facility, patient)
- Staff inexperience
In Summary

- Negative pressure wound therapy has the potential to benefit a large number of patients in terms of both symptom management and wound healing.
- The combination of managing exudate, reducing odor and promoting granulation tissue formation are major benefits of the therapy.
- Best results are found when used on wounds that have been debrided and where rapid granulation is sought.
- The decision to use foam and gauze interfaces should be based on the individual patient and wound assessment, and on the goals that need to be achieved, whether they be wound healing or symptom management or both.
- Clinicians, patients and carers should be fully informed about NPWT as a therapy, how the system works, what the benefits are and, most importantly, what to do when there is a problem.
Most important part of therapy??

Appropriate patient selection!!!
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NPWT options........
Positive Thinking in a Negative Pressure Environment

Thank you!