The Wound VAC: The Hoover of healing

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Overview

- Background on wounds
- Biology of wound healing
- Deterrents and aids to wound healing
- Science behind Wound VAC
- Clinic studies supporting Wound VAC
Why are wounds relevant?

- Wounds are a significant burden
- Chronic wounds alone affect: over 5 million patients
- Cost of wound: 20 billion dollars a year
Biology of Wound Healing

Wound healing phases
- Inflammatory
- Proliferative
- Remodeling
Inflammatory Stage

- Days 0-4
- Starts with Hemostatsis
  - platelets dominate
- Then on to Inflammation
  - Leukocytes and macrophages dominate

The phases of cutaneous wound healing

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Proliferative phase

- Days 3-14
- Fibroblasts dominant cell type

The phases of cutaneous wound healing

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Maturation phase

- Days 14 onwards
- Collagen crosslinking and reorganization
- Fibroblasts differentiate into Myofibroblast
Barriers to wound healing

- Infection
  - 100,000 bacteria per gram tissue

- Excess edema or excess dryness

- Poor blood flow
  - Hypoxia due to smoking or disease
Healing optimization

- Clean and protected environment
- Perfused
  - Tissues getting cells and oxygen
- Moist environment
- Minimize exudate and edema

What can do all this??
WOUND VAC !!
The Wound VAC!!
Negative pressure wound therapy NPWT
Topical Negative Pressure TNP

How it works:

- Polyurethane Foam is placed in wound bed, sealed with occlusive dressing
- Evacuation tube embedded in foam dressing
- Applies localized negative pressure
Why it works

Primary effect
- Contraction of wound
- Stabilization of wound
- Removal of extracellular fluid

Secondary effects
- Increase in blood flow
- Increase granulation tissue
- Increase compliance due to fewer dressing changes
Basic science research

- Pig model
- On each animal
  wound treated with
  V.A.C. compared to
  Sterile Saline gauze

Basic science research

- Blood flow levels increased **fourfold** when 125 mmHg subatmospheric pressure used
- Significantly **increased** rate of granulation tissue formation occurred with NPWT
- Tissue bacterial counts significantly **decreased** after 4 days of application

Basic science research

- 32 Japanese large-ear white rabbits.
- Left ears were treated with negative pressure wound therapy.
- Right ears (control group) treated with petrolatum gauze.

Basic science research

- VAC promoted
  - capillary blood flow velocity
  - increased capillary caliber and blood volume
  - stimulated endothelial proliferation and angiogenesis

Clinical Studies

- 1997 study of 300 patients
  - 175 chronic wounds
  - 94 sub acute wounds
  - 31 acute wounds

Findings:
- 296 wounds responded to VAC treatment
- VAC removed chronic edema
- Enhanced formation of granulation tissue

Clinical studies

- Retrospective study looking at 42 patients
- Variety of wounds
  - Sternal
  - Spinal
  - Lower extremity

Results

- Sternal wounds:
  - All 12 patients with after CABG closed by 4 weeks, with average of 12 days

- Lower extremity wounds:
  - 13 patients/14 patients responded to therapy
Clinical evidence:
Decrease in wound size

<table>
<thead>
<tr>
<th>Source</th>
<th>NPWT Patients, No.</th>
<th>Mean (SD)</th>
<th>Control Patients, No.</th>
<th>Mean (SD)</th>
<th>SMD (95% CI)</th>
<th>Favors NPWT</th>
<th>Favors Control</th>
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</thead>
<tbody>
<tr>
<td>RCTs</td>
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<td>Ford et al, 2002</td>
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<td>-51.8 (38.0)</td>
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<td>-42.1 (38.0)</td>
<td>-0.25 (-0.92 to 0.42)</td>
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<td>Joseph et al, 2000</td>
<td>18</td>
<td>-78.0 (72.0)</td>
<td>18</td>
<td>-30.0 (61.0)</td>
<td>-0.70 (-1.38 to -0.03)</td>
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<td>Mouës et al, 2004</td>
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<td>-3.8 (1.9)</td>
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<td>-1.7 (2.2)</td>
<td>-1.00 (-1.79 to -0.20)</td>
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<td>Wanner et al, 2003</td>
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<td>-25.0 (26.0)</td>
<td>11</td>
<td>-14.0 (30.2)</td>
<td>-0.38 (-1.22 to 0.47)</td>
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<td><strong>Subtotal (95% CI)</strong></td>
<td>64</td>
<td><strong>-26.4 (22.9)</strong></td>
<td>57</td>
<td><strong>-14.0 (27.2)</strong></td>
<td><strong>-0.57 (-0.94 to 0.20)</strong></td>
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<td>Non-RCTs</td>
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<td>Etöz et al, 2004</td>
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<td>-9.5 (4.1)</td>
<td>-1.19 (-2.07 to -0.31)</td>
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<td>McCallon et al, 2000</td>
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<td>9.5 (16.9)</td>
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<td><strong>Subtotal (95% CI)</strong></td>
<td>17</td>
<td><strong>-20.5 (12.7)</strong></td>
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<td><strong>9.5 (16.9)</strong></td>
<td><strong>-1.30 (-2.07 to -0.54)</strong></td>
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Comparison Study
Braakenburg’s study

Conventional
- Daily dressing
- Increases in nursing interventions
- Increased discomfort for patients
- Increase length of hospital stay

VAC
- 3 times a week
- Lower nursing staff costs
- Overall, Pts more comfortable
- Decrease length of hospital stay
- Faster wound healing in patients with Diabetics and Cardiovascular disease
Sternal infections

- Retrospective analysis of sternal wound infection
- 68 cases
  - 35 patients could be allocated to the vacuum group and
  - 33 patients to the conventional group wet to dry.

NOT KCI funded
Sternal infections

End points

- Time interval from sternal infection until freedom of microbiological cultures
- In-hospital stay
- Sternal status at discharge
- Survival rates

NOT KCI funded
## Sternal infections

<table>
<thead>
<tr>
<th></th>
<th>Conventional dressings</th>
<th>VAC</th>
<th>p</th>
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<tbody>
<tr>
<td>Wound healing</td>
<td>28 days</td>
<td>21 days</td>
<td>&gt; 0.05</td>
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<tr>
<td>in-hospital stay</td>
<td>25 days</td>
<td>34 days</td>
<td>&lt; 0.01</td>
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<tr>
<td>d/c with an open sternum</td>
<td>21 out of the 33 patients</td>
<td>10 out of the 35 patients</td>
<td>&lt; 0.01</td>
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</tbody>
</table>
Sternal infections

- Survival rate
  97% vs 74%

![Graph showing survival rates](image-url)
Clinical study

Diabetes

- Randomized control study Diabetic foot amputation wound
- 24 patients assigned to NPWT or standard wound dressing
- End point was time in reaching 90% of wound granulation.

RESULTS:
- VAC 18.8 +/- 6 days versus Standard wound care 32.2 +/- 13.7
- Statistically significant difference (P=0.007).

efficacy
Contraindications to VAC

- Necrotic tissue
- Cancer in wound
- Fistulas
- Not on blood vessels
Thoughts on the Future

- Health care cost
- Use in emergencies
## Cost

Vuerstaek’s study

<table>
<thead>
<tr>
<th></th>
<th>Conventional n=30</th>
<th>VAC n=30</th>
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<tbody>
<tr>
<td>VAC cost</td>
<td>0</td>
<td>847</td>
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<tr>
<td>Bandage dressing</td>
<td>4770</td>
<td>2391</td>
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<tr>
<td>Personnel</td>
<td>508</td>
<td>583</td>
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<tr>
<td>Nurse</td>
<td>175</td>
<td>124</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>5452</strong></td>
<td><strong>3881</strong></td>
</tr>
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</table>

P = .001
Cost

- Compared VAC to wet to dry dressing.
- VAC had higher material costs.
- VAC had lower number of time-consuming dressing changes.
- VAC had shorter duration of therapy.
- Thus VAC and wet to dry therapy being equally as expensive.

Thoughts on the Future of VAC

- Health care cost
- Use in emergencies
88 high-energy soft tissue wounds identified in 77 patients in Balad Iraq

Patients treated initially with debridement and wound vac placement

Patients then underwent serial surgical debridement and wound VAC changes

The wound infection rate was 0% and the overall wound complication rate was 0%. All patients survived and were discharge with closed wounds

Leininger BE, Experience with wound VAC and DPC of contaminated soft tissue injuries in Iraq. J Trauma. 2006;61(5):1207-11
references

Go Steelers!