Negative Pressure Wound Therapy

Postgraduate Course in General Surgery
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Negative Pressure Wound Therapy (NPWT):
What is it?
- Vacuum assisted closure (VAC) first reported in 1997 (Ann Plast Surg 1997;38:563-576);
- >600 peer-reviewed publications;
- $1.2 Billion market worldwide in 2007 (KCI, Smith & Nephew);
- Multiple systems (sponge sizes, sponge types, pumps, pressures).

"Official" Indications
- acute and chronic wounds
- diabetic foot ulcers
- venous stasis ulcers
- orthopedic/hand trauma
- composite tissue flaps
- burn wounds
- split-thickness skin grafts
- open abdomens
- pressure ulcers
- sternal wound infections
- high-risk incisions
Negative Pressure Wound Therapy (NPWT): “Off-Label” Indications

- empyemas
- bronchopleural fistulas
- hidradenitis suppurativa
- transport of blast injuries
- soft tissue infections
- Fournier’s gangrene
- maxillofacial reconstructions
- acute soft tissue loss

NPWT: Proposed mechanisms of action

- wound contraction (macrodeformation)
- stabilization of wound environment

NPWT: Proposed mechanisms of action

- wound contraction (macrobeformation)
- stabilization of wound environment
- removal of extracellular fluid
- microdeformation at foam-wound interface (mechanotransduction)

Secondary effects: changes in blood flow, wound biochemistry, systemic inflammatory response and bacterial load.

Negative wound pressure penetrates < 1 mm into adjacent tissues

Figure 2. Interstitial fluid pressures with depth at −200 and 0 mmHg. T-test between values at that depth was statistically significant (p < 0.05). Values were significantly different to a depth of 0.9 mm.
Negative Pressure Wound Therapy (NPWT): Does it work?

Although a number of independent reports suggest compelling evidence, the small number of prospective, randomized studies makes it difficult for public health policymakers to assess clinical efficacy.


### Table: Health technology assessment summary

<table>
<thead>
<tr>
<th>Source</th>
<th>Conclusion</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Health Technology Advisory Committee, 2001</td>
<td>VAC therapy may be useful for healing various types of wounds but effectiveness could not be empirically quantified</td>
<td>- Small sample size and patient populations</td>
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<tr>
<td>AABB/BlueCross/BlueShield, 2004</td>
<td>Body of evidence insufficient to support conclusions about effectiveness</td>
<td>- Poor study design</td>
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<tr>
<td>Cochrane Review, UK, 2007</td>
<td>Weak evidence of effectiveness</td>
<td>- Outcome measures could not be compared</td>
</tr>
<tr>
<td>Cochrane Review, UK, 2007</td>
<td>Weak evidence of effectiveness</td>
<td>- Small number of studies</td>
</tr>
<tr>
<td>Cochrane Review, UK, 2007</td>
<td>Weak evidence that TNP is superior to granular dressings</td>
<td>- Insufficient evidence or standard treatment of wounds in Scotland</td>
</tr>
<tr>
<td>Cochrane Review, UK, 2007</td>
<td>Weak evidence of effectiveness</td>
<td>- Need for more RCTs</td>
</tr>
<tr>
<td></td>
<td>Management strategy before early v. delayed abdominal fascial closure;</td>
<td>- Methodological limitations</td>
</tr>
<tr>
<td></td>
<td>Limited published evidence in 36 reports (n=346), majority Level III evidence – only 1 RCT;</td>
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<td></td>
<td>Most reports describe trauma patients (damage control laparotomy);</td>
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<td></td>
<td>Only 74 cases reported that involve general surgery indications, including abdominal sepsis, intestinal fistulas, and compartment syndromes;</td>
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<td></td>
<td>Open abdomen associated with significant morbidity (fistulas 2-25%; intra-abdominal abscess 83%; hernias 25%) and 30% mortality rates.</td>
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**Negative Pressure Wound Therapy (NPWT):**

**Impact on Bacterial Bioburden**

- Occlusive dressings over contaminated or infected wounds are traditionally thought to be detrimental to wound healing due to promotion of bacterial growth;

- Weed et al. measured quantitative wound cultures (via swab technique) before, during and after VAC therapy in 26 wounds:

  - **Pre-VAC**
  - **Post-VAC**

- The bacterial bioburden was highest during VAC therapy and no difference between pre- and post-VAC measurements.
Negative Pressure Wound Therapy (NPWT): Intestinal Fistulas

- Fistula-vac;
- Early vs delayed management of enteroatmospheric fistulas;

### Table 1: Patients with EAFs treated with NPWT therapy

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Etiology of DLE</th>
<th>Initial classification DLE*</th>
<th>t(NPWT)*</th>
<th>Duration of surgery</th>
<th>Abdominal closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>89</td>
<td>AS</td>
<td>Grade 3A</td>
<td>41</td>
<td>Fistula extirpation</td>
<td>Primary closure</td>
</tr>
<tr>
<td>2</td>
<td>67</td>
<td>AS – peritonitis</td>
<td>Grade 4</td>
<td>63</td>
<td>Fistula extirpation</td>
<td>SIT</td>
</tr>
<tr>
<td>3</td>
<td>81</td>
<td>Bowel abscess + anastomotic leakage</td>
<td>Grade 4</td>
<td>42</td>
<td>Fistula extirpation</td>
<td>Primary closure</td>
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<tr>
<td>4</td>
<td>77</td>
<td>Bowel abscess + anastomotic leakage</td>
<td>Grade 3</td>
<td>40</td>
<td>Fistula extirpation</td>
<td>Primary closure</td>
</tr>
<tr>
<td>5</td>
<td>49</td>
<td>Peritonitis</td>
<td>Grade 4</td>
<td>61</td>
<td>Fistula extirpation</td>
<td>Bilateral closure</td>
</tr>
<tr>
<td>6</td>
<td>82</td>
<td>Peritonitis</td>
<td>Grade 6</td>
<td>56</td>
<td>Fistula extirpation</td>
<td>Skin graft</td>
</tr>
<tr>
<td>7</td>
<td>55</td>
<td>Peritonitis</td>
<td>Grade 5</td>
<td>78</td>
<td>Fistula extirpation</td>
<td>SIT</td>
</tr>
<tr>
<td>8</td>
<td>44</td>
<td>Peritonitis</td>
<td>Grade 3B</td>
<td>49</td>
<td>Fistula closure</td>
<td>Skin graft</td>
</tr>
<tr>
<td>9</td>
<td>60</td>
<td>Peritonitis</td>
<td>Grade 3</td>
<td>64</td>
<td>Fistula closure</td>
<td>Skin graft</td>
</tr>
</tbody>
</table>

*ALD = abdominal septic syndrome, SIT = separation of compartment technique, (NPWT) = duration of NPWT therapy, d = days — — spontaneous closure of fistula, no bowel resection at fistula closure.

**Classification of ALD as proposed by Rivas et al.**  
- Grade A: Abscesses without fistula.
- Grade B: Abscesses with fistula.
- Grade C: Peritonitis with fistula.
- Grade D: Peritonitis without fistula.

54 year old woman with a history of hypertension, COPD, morbid obesity and smoking, presented with a complete SBO due to an incarcerated ventral hernia.

After 3 days, she underwent an exploratory laparotomy and adhesiolysis. All of her intestines were viable. Despite passing a Baker tube through an enterotomy to decompress the intestine, small bowel edema prevented primary closure of the abdomen. A porcine biologic prosthesis was placed as an onlay.

On POD #11 she returned to the OR due to sepsis and enteric contents draining from her wound. An EAF was identified and closed primarily.

On POD #13 enteric contents were again draining from her wound. She returned to the OR where an EAF was identified, intubated with a 19Fr red Robinson catheter and a negative pressure wound therapy dressing applied to her frozen visceral block.

After 10 days of respiratory and renal failure, she was transferred to my care.

10 weeks later

Negative Pressure Wound Therapy (NPWT): Open Abdomen

Negative Pressure Wound Therapy (NPWT): Open Abdomen – Morbidity & Mortality

• Popular and versatile management strategy;
• Limited high-quality evidence in support of clinical and cost-effectiveness;
• Benefits focused on wound management – no survival benefits;
• Only 74 cases reported that involve general surgery indications, including abdominal sepsis, intestinal fistulas, and compartment syndromes;
• Impact on wound bacterial burden suggests very limited use in infected wounds;
• Requires precision and care when used to manage open abdomens ± enteroatmospheric fistulas to avoid creating fistulas.