Negative Pressure Wound Therapy

Is a modified wound dressing system where a porous material is placed in the wound bed and enclosed using polyurethane films to form an airtight seal. A vacuum source is connected to the dressing via tubing creates continuous or intermittent negative pressure inside the wound (Psinos et al, 2009).

A Sealed System
- Open-pore foam (polyurethane or polyvinyl alcohol) dressing or moistened antimicrobial gauze (Chariker-Jeter® technique)
- Transparent film
- Vacuum source for negative pressure
- Connecting tubing

History of NPWT
- Used as part of the wounds treatment in the form of various drains since 1940s. (Vikatmaa et al, 2008)
- Developed as treatment technique for open wounds based on negative pressure in Germany and the US during 1990s. (Argenta et al, 1997)
- Since 1997, the first device for NPWT was cleared by Food & Drug Administration (FDA) for marketing in USA.

Indication
- Acute: limb trauma, fracture & tissue loss
- Chronic: pressure ulcer, leg ulcer, sternotomy wound
- Prepare wd bed for surgery: skin graft fixation, flap surgery
- Non-healing wound, unfit for surgery
Contraindication
- Wound with necrotic tissue
- Untreated Osteomyelitis
- Unexplored Fistula
- Malignant ulcer
- Area closed to major vessels

(Preston G, 2008) (FDA)

Mechanism of action
- Increase local blood flow
- Reduction of tissue oedema
- Decrease bacterial colonization
- Removal of chronic wound exudates
- Occlusion effect and maintain moist wound environment

Mechanical effect
- Macromechanical effects (wound contraction)
- Micromechanical effects (interaction of tissue and dressing at a microscopic level)

(Borgquist, 2010)

Increase local blood flow
- NP < 150 mmHg increase dermal blood flow 4 times (laser doppler flowmetry)
- >200mmHg decrease blood flow (collapse of vessels if critical hydrostatic pressure is exceeded)
- Avoid constricting effect over circumferential area e.g. limbs

Increase local blood flow
- Increase blood circulation leads to better
  - Exchange of gases
  - Nutritional supply
  - Removal of waste products
  - Increase body defending cells
- Tissue oxygenation is crucial to inflammatory process and angiogenesis

Reduction of tissue oedema
- Remove interstitial fluid
- Beneficial to acute trauma, crush injury, burn especially during acute phase
**Decrease bacterial colonization**

- Both experimental and clinical studies
- Significant decrease in quantitative bacterial counts after 5 days
- Superior to topically applied dressing, growth factors, enzymes

**Remove chronic wound exudates**

- Dynamic balance of healing and remodelling important in wound healing
- Proteolytic enzymes in chronic wound surface impair keratinocytes and fibroblasts
- Removal of proteolytic enzymes lead to dynamic balance favouring wound healing

**Improved granulation after negative pressure therapy**

- Less purulent sloughing
- More pinkish granulation
- Reduced exudates and collection

**Occlusion, protection and moist wound environment**

- Occlusive dressing e.g. Opsite / tagaderm to air-tight effect
- Prevention of contamination of wound by external causes
- Maintain moist wound environment
- Keep surrounding skin dry

**Application**

- Acute wounds
  - limb trauma, fracture and tissue loss, limb trauma, wound dehiscence
- Chronic wound
  - pressure ulcer, sternotomy wound, leg ulcers
- Adjuvant to surgery
  - preparation of wound bed, skin graft fixation, flap surgery
- Salvage
  - non-healing wound, unfit for surgery

**Suction devices**

- Commercially available device KCI, VISTA
- Wall suction
### Comparison

<table>
<thead>
<tr>
<th>Wall Suction</th>
<th>KCI machine</th>
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</thead>
<tbody>
<tr>
<td>Easily available</td>
<td>Need to purchase intermittent suction</td>
</tr>
<tr>
<td>Continuous suction only</td>
<td>Continuous suction or intermittent</td>
</tr>
<tr>
<td>Suction force variable</td>
<td>Calibrated controlled suction force</td>
</tr>
<tr>
<td>No alarm</td>
<td>Built in safety device and alarm</td>
</tr>
<tr>
<td>Low cost</td>
<td>Expensive</td>
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</tbody>
</table>

### Regimes of application

- **Negative pressure:**
  - 50-75 mmHg Split skin graft, leg ulcer
  - 125 mmHg All other sites

- **Cycle**
  - Continuous for 48 hrs, then intermittent wound assessment determines cycle
  - Dressing changes every 4 - 5 days daily / every 48 hrs if infected
  - No universal consensus, depends on types of wound, exudates & infection status

### Pressure Regime

- Continuous negative pressure of
  1. younger patients 50-75 mmHg
  2. Older patients 100-125 mmHg

Borgquist et al concluded that negative pressure of -80 mmHg has similar blood flow effect as -125 mmHg. It needed to decrease pressure if patient experiences pain or when treating poorly vascularizes tissue.

- Avoid constricting effect over circumferential area e.g. limbs

### Advantages

- Help decrease the number of dressing changes,
- Reduce the time between debridement and definitive closure,
- Reduce costs associated with a protracted course of hospital stay (McCallon et al 2000)

### Complications

- Abrasions to surrounding skin
- Allergy reaction to adhesive dressing
- Hemorrhage
- Overgrowth of granulation into the foam
- Late infection

### Complications

- Pain usually on initiation of suction
- Desiccation of wound if not completely sealed
- Blocked tubing / kinking
- Pressure effect of tubing to body
- Fistula formation for dehiscence abdominal wound
Serious Complications

- 6 death & 77 injuries reported over 2007-2009
- Bleeding was the most serious complication occurring in all 6 deaths and in 7 of the injuries.

(FDA, 2009)

Negative pressure dressing

- Cannot replace surgical debridement
- Nonviable necrotic tissue best removed by surgical debridement
- Once haemostasis achieved, foam can be applied and negative pressure initiated
- Difficult to maintain air-tight seal in irregular surface
- Poor ambulation of patient (not applicable for portable device)
- Alternative method for wound closure


- Compared TNP with saline gauze dressings
- Trial 1 reported a statistically significant reduction in wound volume at 6 weeks in favour of TNP
- Trial 2 (continuous suction, followed by intermittent suction after 48 hours) reported a reduction in the number of days to healing and a reduction in wound surface area at 2 weeks in favour of TNP, although no statistical analysis was reported
- CONCLUSIONS: The two small trials provide weak evidence suggesting that TNP may be superior to saline gauze dressings in healing chronic human

Evaluation on NPWT

- Financially affordable
- Patient’s acceptability & co-operation
- Cannot replace surgical debridement
- Nonviable necrotic tissue best removed
- Alternative method for wound closure
- Clinical effectiveness


- Seven trials involving 205 participants
- Compared TNP with different comparator treatments: gauze soaked in 0.9% saline or Ringer’s solution, hydrocolloid gel, plus gauze
- Data do not show TNP significantly increases the healing rate of chronic wounds compared with comparators
- CONCLUSIONS: Trials comparing TNP with alternative treatments for chronic wounds have methodological flaws and data do not demonstrate a beneficial effect of TNP on wound healing however more, better quality research is needed.

Reference

Reference


