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Background

Wound care is particularly challenging in the face of demographic shift towards ageing population and the rising trend of obesity as well as non-communicable diseases, such as diabetes mellitus, hypertension and chronic kidney disease. In Malaysia, the management of chronic wound such as diabetic foot ulcer bring about a total cost per patient per annum of MYR 5,981 in public and MYR 8,581 in private setting, with more than 260,000 people with diabetes estimated to have foot ulcers at any given time. The surgical site infections represent significant burden in the management of surgical wounds. They are associated with prolonged hospitalisation, time spent in an intensive care unit (ICU), readmission to hospital, long-term disability, the spread of antibiotic resistance, substantial financial burden and high costs for patients and families. There is a wide range of treatment modalities used for acute and chronic wounds. With the advancement in the therapeutic and clinical management for wound healing and tissue regeneration, an instrumental-based therapy called negative pressure wound therapy (NPWT) is slowly gaining popularity as adjunct wound treatment to facilitate fast healing of acute and chronic wounds.

Objective

The objective of this systematic review and economic evaluation was to assess the effectiveness, safety and cost-effectiveness of NPWT as a treatment modality for acute and chronic wounds.

Methods

Part A: Systematic review

A comprehensive search was conducted on the following databases without any restriction on publication language and publication status. The Ovid interface: Ovid MEDLINE(R) ALL <1946 to May 22, 2023>; EBM Reviews - Cochrane Database of Systematic Reviews <2005 to May 16, 2023>; EBM Reviews - NHS Economic Evaluation Database <1st Quarter 2016>. Searches were also run in PubMed. Google was used to search for additional web-based materials and information. Additional articles were identified from reviewing the references of retrieved articles. Last search was conducted on 22 May 2023.

Part B: Economic evaluation

A decision tree was developed in Microsoft Excel to estimate the expected costs and health outcomes associated with the use of NPWT and standard of care in reducing surgical site infection. The base case analysis provides the expected cost and outcome when the intervention was given to adult patients who undergone surgeries. The analysis was conducted using the healthcare provider perspective and considers a short-term time horizon on the basis that surgical complications may occur relatively soon after surgery.

Results and Conclusions

Part A: Systematic review

A total of 9,059 titles was identified through the Ovid interface and PubMed. After removing the duplicates, appraising and applying the inclusion and exclusion criteria, only 27 full text articles were eligible to be included for qualitative synthesis. The selected full text articles comprised of 11 systematic reviews and meta-analyses, and 16 economic evaluation studies.

Effectiveness

Ten systematic reviews and meta-analyses reported on the effectiveness of NPWT as treatment modality for acute and chronic wounds.

Five studies reported on the outcome of surgical site infection for closed surgical wounds. The findings showed that across a range of surgical

indications, NPWT following surgery resulted in a lower risk of surgical site infection and wound dehiscence compared with standard dressings. (**Table 1**)

Another six included studies reported on the outcome of the effect of NPWT on wound healing. The NPWT had better effect on wound healing compared to standard care across various type of acute and chronic wounds heal by secondary intention except for lower limb open fracture wounds. There was uncertainty of evidence on the benefit of NPWT on open abdominal wound in view of heterogenous pooling results. (**Table 2**)

Table 1: Comparison of NPWT with standard wound dressings for outcome of surgical site infection and wound dehiscence in closed surgical incisions

STUDY	Surgical Site Infection	Wound dehiscence
Overall Population		
Cochrane review (2022) (62 RCTS)	**Pooled RR** 0.73, 95%CI 0.63 to 0.85	**Pooled RR** 0.97, 95%CI 0.82 to 1.16
Subpopulation: Caesarean section in women with obesity		
Angarita AM et al (2021) SR & Meta-analysis (11 RCTs)	**Pooled RR** 0.79, 95%CI 0.65 to 0.96	**Pooled RR** 0.99, 95%CI 0.79 to 1.24
Subpopulation: Closed incisions in breast surgery		
Song J et al. (2023) SR & Meta-analysis (12 RCTs)	**Pooled OR** 0.59, 95%CI 0.36 to 0.96	**Pooled OR** 0.54, 95%CI 0.39 to 0.75
Subpopulation: Sternal wound post cardiac surgery		
Biancari F et al. (2022) SR & Meta-analysis (2 RCTS and 8 cohort studies)	**Pooled RR** 0.54, 95%CI 0.34 to 0.84	-
Subpopulation: Closed surgical wound after orthopaedics trauma surgery		
Xie W et al. (2021) SR & Meta-analysis (4 RCTs and 8 cohort studies)	Superficial SSI: **Pooled OR** 0.23, 95%CI 0.11 to 0.49 Deep SSI: **Pooled OR** 0.65, 95%CI 0.48 to 0.88	**Pooled OR** 0.41, 95%CI 0.21 to 0.80

Table 2: Comparison of NPWT with standard wound dressings for outcome of wound healing in wounds heals by secondary intention

STUDY	Outcome of wound healing
Overall Population	
Zens Y et al. (2020) SR & Meta-analysis (48 RCTs)	**Pooled OR** 1.56, 95%CI 1.15 to 2.13
Subpopulation: Open surgical abdominal wounds	
Cirocchi R et al. (2016) SR & Meta-analysis (2 RCT and 4 cohort studies)	**Fascial closure:** Pooled OR 0.74, 95%CI 0.27 to 2.06, p=0.57, I^2 83% **Postoperative enteroatmospheric fistulae rate**: Pooled OR 0.63, 95%CI 0.12 to 3.15; p = 0.57, I^2 69% **Postoperative abdominal abscess rate**: Pooled OR 0.42, 95%CI 0.13 to 1.34, p = 0.14, I^2 54% **Postoperative mortality rate**: Pooled OR 0.46 95%CI 0.23 to 0.91, p = 0.03, I^2 72%

Subpopulation: Open fracture wounds	
Cochrane review (2018) (4 RCTs)	At 6 weeks: Pooled RR 1.01, 95%CI 0.81 to 1.27
Subpopulation: Burn wounds	
Lin DZ et al. (2021) SR & Meta-analysis (6 RCTs)	**Graft take rate at the first week:** SMD 2.62, 95%CI 1.01 to 4.22, p = 0.001 **Infection rate at the first week:** Pooled OR 0.12, 95%CI 0.02 to 0.87, p = 0.04
Subpopulation: Chronic wound – Diabetic foot ulcers	
Chen L et al. (2021) SR & Meta-analysis (9 RCTs)	**Healing rate :** Pooled OR 3.6, 95%CI 2.38 to 5.45, p < 0.001 **Granulation tissue formation time:** MD (in days) -8.95, 95%CI -10.26 to -7.64, p<0.001
Subpopulation: Chronic wound - Grade III/IV pressure ulcers	
Song YP et al. (2021) SR & Meta-analysis (16 RCTs)	**Healing rate** : Pooled RR 1.32, 95%CI 1.32 to 1.70 **Wound healing time**: WMD (in days) -16.47, 95%CI -22.36 to -10.59, p< 0.001

Safety

NPWT is considered a safe treatment. Treatment related adverse events includes allergic skin reaction and skin blister, which are comparable to standard wound care. Serious adverse events like bleeding, infection, injuries and death are rare. They are mostly associated with unsafe use of NPWT.

Cost-effectiveness

Sixteen economic evaluation studies reported on the cost-effectiveness of NPWT as treatment modality for acute and chronic wounds. The included studies comprised of 12 cost-effectiveness analyses, one budget impact analysis and three cost analyses, comparing NPWT with standard care. Most studies were conducted from the perspective of healthcare provider in hospital setting. They were mostly from United Kingdom, USA and European countries.

Evidence from economic evaluation studies tend to suggest that NPWT is likely to be cost saving treatment in the management of wound, particularly in high risk patients with BMI ≥ 35 and severe systemic disease.

Part B: Economic evaluation

The use of NPWT was found to be effective with an estimated additional cost incurred compared with standard of care. In order to improve the access to this treatment in a resource limited setting, a careful selection of patient would ensure the optimal benefit of NPWT as an alternative option for wound management.