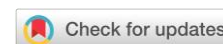


Effectiveness of Moist Wound Healing Versus Conventional Wound Care for Diabetic Ulcer Healing in Patients with Diabetes Mellitus

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ARTICLE INFO

Keywords:

Conventional,
Moist Wound Healing,
Wound Care Dressing.

ABSTRACT

Background: Diabetic ulcers are a common complication of diabetes mellitus that often occur on the legs and feet and are difficult to heal because of poor circulation and uncontrolled blood glucose, which can progress to infection and gangrene. This study aimed to compare the effectiveness of moist wound healing dressing and conventional wound care on the healing of the inflammatory phase of diabetic ulcers.

Methods: A quasi-experimental, two-group pre-test post-test design was used. Thirty patients with diabetic ulcers at Yunita Wound Care, Manado, were assigned by total sampling to an experimental group (n=15, moist wound healing dressing) and a control group (n=15, conventional wound care). Inflammatory-phase healing (redness, heat, pain, swelling, functional loss) was assessed on day 1 (pre-test) and day 3 (post-test) using a validated questionnaire and analyzed with the Wilcoxon Signed Rank Test and Independent Samples T-Test.

Results: Post-test scores were significantly lower in the experimental group than the control group for redness (1.47 vs 2.47, $p=0.001$), heat (1.33 vs 2.20, $p=0.004$), and swelling (1.47 vs 2.27, $p=0.000$). No significant between-group difference was found for pain ($p=0.158$) or functional loss ($p=0.702$).

Conclusion: Moist wound healing dressing is more effective than conventional wound care in accelerating inflammatory-phase healing of diabetic ulcers, particularly in reducing redness, heat, and swelling.

INTRODUCTION

Diabetic ulcers are a chronic wound complication of diabetes mellitus caused by neuropathy, ischemia, and infection, and most commonly affect the lower extremities. Poor peripheral circulation combined with chronic hyperglycemia impairs tissue repair and, if left untreated, can progress to gangrene and lower-limb amputation. Diabetes affects hundreds of millions of people worldwide, and its prevalence continues to rise, particularly in the Asia-Pacific region (Khan et al., 2020; Soyoye et al., 2021). Indonesia is among the countries with the highest burden of diabetic foot ulcers, and delayed recognition together with inadequate home wound care frequently allows ulcers to progress to advanced, difficult-to-heal stages.

Diabetic ulcers substantially increase morbidity, treatment cost, and psychological distress for patients, and are a leading cause of lower-limb amputation among people with diabetes (Setiawan et al., 2020). Wound care techniques have evolved considerably, ranging from conventional dressings using gauze, antiseptics, and antibiotics to modern moist wound healing approaches using alginate, foam, hydropolymer, hydrofiber, and transparent film dressings (Alfaqih et al., 2019; Mahyudin et al., 2020). Conventional dry dressings tend to adhere to the wound bed, delaying epithelialization and increasing

infection risk, whereas moist wound healing has been shown to improve epithelialization and reduce infection rates compared with dry wound care (Mahyudin et al., 2020; Santoso & Purnomo, 2017). Preliminary observation at Yunita Wound Care, Manado, found patients presenting with diabetic ulcers of varying duration, from several days to nearly three months, many of whom had received only minimal or inconsistent wound care at home before seeking treatment, consistent with reports that diabetic ulcers restrict mobility and that delayed engagement with structured wound care services can worsen outcomes (Kurdi & Priyanti, 2019; Bouillet et al., 2021). Given the clinical and economic burden of delayed ulcer healing, this study compared the effectiveness of moist wound healing dressing against conventional wound care on the inflammatory-phase healing process of diabetic ulcers.

METHODS

This study used a quasi-experimental design with a two-group pre-test and post-test approach. The population comprised all patients with diabetic foot ulcers undergoing wound care at Yunita Wound Care, Manado (N=30); total sampling was used because the population did not exceed 30. Participants were allocated by dice roll to an experimental group (n=15), receiving moist wound healing dressings (calcium alginate, foam, hydropolymer, and iodine-based antimicrobial dressings), or a control group (n=15), receiving conventional wound care (povidone-iodine, gauze, and adhesive dressing). Inclusion criteria were willingness to participate, age 30-59 years, and a diagnosis of diabetic ulcer; participants who withdrew or did not complete the full study protocol were excluded. The study was conducted at Yunita Wound Care, Manado, from January to March 2025.

Data were collected using a structured questionnaire assessing five inflammatory-phase characteristics: redness (rubor), heat (calor), pain (dolor), swelling (tumor), and functional loss (functio laesa), each scored 1-3 (total range 5-15). The instrument was tested for validity and reliability among 16 respondents at a separate clinic, yielding a Cronbach's alpha of 0.923, indicating good reliability. Wound assessments were performed on day 1 (pre-test, before treatment) and day 3 (post-test, after treatment) for each group. Data were analyzed using SPSS. The Shapiro-Wilk test indicated a non-normal distribution ($p < 0.05$); therefore, the Wilcoxon Signed Rank Test was used to compare pre- and post-test scores within each group, and the Independent Samples T-Test was used to compare post-test scores between the experimental and control groups, at a 95% confidence level ($\alpha = 0.05$). This study observed the ethical principles of informed consent, confidentiality, and anonymity; all participants signed informed consent forms prior to enrollment.

RESULTS

This study was conducted at Yunita Wound Care, Kelurahan Ternate Baru, Manado, over approximately one month, and involved 30 respondents who met the inclusion criteria. Table 1 presents the demographic characteristics of respondents. The largest age group in both the experimental (46.7%) and control (53.3%) groups was 50-59 years. Most experimental-group participants were female (66.7%), while most control-group participants were male (60.0%). Across the total sample, insulin was the predominant treatment (93.3%), and most participants (56.7%) had lived with diabetes mellitus for more than five years.

Table 1. Characteristics of Respondents

Variable	Experimental n(%)	Control n(%)
Age 30-39 years	2 (13.3)	1 (6.7)
Age 40-49 years	6 (40.0)	6 (40.0)
Age 50-59 years	7 (46.7)	8 (53.3)
Sex: Male	5 (33.3)	9 (60.0)
Sex: Female	10 (66.7)	6 (40.0)
Medication: Oral hypoglycemic agent*	2 (6.7)	
Medication: Insulin*	28 (93.3)	
DM duration < 5 years*	13 (43.3)	
DM duration $\geq$ 5 years*	17 (56.7)	

*Medication and DM-duration figures are reported for the total sample (N=30), not split by group.

Table 2 presents the mean inflammatory-phase scores before (day 1) and after (day 3) wound care treatment. In the experimental group, the Wilcoxon Signed Rank Test showed significant reductions from pre- to post-test for redness ($p=0.017$), heat ($p=0.038$), pain ($p=0.029$), and swelling ($p=0.046$), although functional loss did not change significantly ($p=0.458$). In the control group, none of the five characteristics changed significantly between pre- and post-test (all $p>0.05$).

Table 2. Inflammatory-Phase Scores Before and After Wound Care Treatment

Characteristic	Group	Pre-test M(SD)	Post-test M(SD)	Within- group p	Between- group p (post-test)
Redness (Rubor)	Experimental	2.27 (0.80)	1.27 (0.59)	0.017	0.001
Redness (Rubor)	Control	2.47 (0.74)	2.73 (0.46)	0.102	
Heat (Calor)	Experimental	2.13 (0.74)	1.33 (0.72)	0.038	0.004
Heat (Calor)	Control	2.47 (0.64)	2.20 (0.78)	0.194	
Pain (Dolor)	Experimental	2.44 (0.74)	1.53 (0.83)	0.029	0.158
Pain (Dolor)	Control	2.20 (0.86)	1.80 (0.86)	0.098	
Swelling (Tumor)	Experimental	1.93 (0.59)	1.40 (0.63)	0.046	0.000
Swelling (Tumor)	Control	2.33 (0.72)	1.93 (0.59)	0.083	
Functional loss	Experimental	2.60 (0.74)	2.73 (0.46)	0.458	0.702
Functional loss	Control	2.87 (0.35)	2.80 (0.41)	0.564	

Independent Samples T-Test comparison of post-test scores between groups showed that the experimental group had significantly lower scores than the control group for redness (1.47 vs 2.47, $p=0.001$), heat (1.33 vs 2.20, $p=0.004$), and swelling (1.47 vs 2.27, $p=0.000$). No significant between-group difference was found for pain ($p=0.158$) or functional loss ($p=0.702$).

DISCUSSION

The predominance of participants aged 50-59 years in this study is consistent with the well-documented age-related decline in glucose tolerance and vascular reactivity, which increases susceptibility to diabetic ulceration in older adults (Bereda, 2022; Khan et al., 2020). The higher proportion of female participants in the experimental group may reflect hormonal changes after menopause that are associated with increased body mass index and insulin resistance, both recognized risk factors for diabetes-related complications; sex-based differences in the severity and course of diabetic foot disease have also been reported elsewhere (Zhang et al., 2021). Most participants had lived with diabetes for more than five years, in line with previous findings that a longer diabetes duration increases the risk of chronic hyperglycemia, vascular complications, and lower-limb amputation (Soyoye et al., 2021; Yunir et al., 2022). Insulin was the predominant treatment among participants, consistent with common clinical practice of intensifying glycemic control once ulceration and infection risk increase (Bereda, 2022).

The significant reduction in inflammatory-phase scores among the experimental group indicates that moist wound healing dressings, by maintaining a moist wound environment, support angiogenesis, cell proliferation, granulation, and epithelialization more effectively than conventional dry dressings (Alfaqih et al., 2020; Mahyudin et al., 2020). Conventional gauze dressings dry quickly and adhere to the wound bed, which can disrupt newly formed tissue during dressing changes, prolong the inflammatory phase, and increase the risk of infection (Dimantika et al., 2020). These findings are consistent with prior studies reporting that modern moist dressings and related advanced wound-care technologies accelerate healing and reduce infection rates compared with conventional dressings (Djavid et al., 2020; Khoirunisa et al., 2020; Subandi & Sanjaya, 2020; Colin & Listiana, 2022; Wu et al., 2023; Chand et al., 2026). Combination approaches that pair moist wound healing principles with adjunct topical agents have also shown promising results in accelerating diabetic ulcer healing in recent studies (Syara & Lubis, 2025).

The lack of significant improvement in pain and functional-loss scores in either group suggests that these dimensions may require a longer observation period or a more sensitive measurement instrument to detect change within a short three-day window. Emerging objective assessment tools, such as fluorescence imaging, have been proposed to detect subtle changes in wound status that simple ordinal scoring instruments may miss (Lindberg, 2021). Wound healing is also influenced by factors beyond

dressing type, such as nutritional status, glycemic control, and psychological stress, which were not directly controlled for in this study; anxiety and reduced quality of life are common among patients with diabetic ulcers and may in turn slow recovery (Setiawan et al., 2020; Kusnanto et al., 2021). Timely referral to specialized wound care services has also been shown to improve outcomes and may explain some of the residual variability in inflammatory recovery observed in the control group in this study (Bouillet et al., 2021).

This study has several limitations. The small sample size (n=15 per group) limited the ability to balance sex distribution between the experimental and control groups, which may have introduced confounding. Wound care was delivered predominantly through home visits across geographically dispersed households, extending daily treatment time and introducing variability in the interval between dressing changes; the research team could not monitor wound condition continuously between visits and relied on telephone contact with participants or their families, which may have introduced reporting bias. The functional-loss (functio laesa) subscale of the study instrument produced non-significant results in both groups and may require further validation and refinement. Wound area and depth were not measured directly, limiting the precision of healing assessment beyond the ordinal inflammatory-characteristic scores used. Psychological stress and comorbid conditions were not assessed at baseline, even though both may influence wound healing trajectories. Finally, the specific dressing materials used within the experimental group varied according to individual wound condition, which may have introduced additional variability in treatment effect. Future studies should consider larger, sex-balanced samples, longer observation periods, direct wound measurement, and standardized dressing protocols to address these limitations.

CONCLUSION

Moist wound healing dressing was significantly more effective than conventional wound care in reducing redness, heat, and swelling during the inflammatory phase of diabetic ulcer healing, although neither method produced a significant improvement in pain or functional loss within three days of treatment. These findings support the use of moist wound healing dressings as the preferred wound care approach for diabetic foot ulcers to accelerate early-phase healing and reduce infection risk. Further research with a longer observation period, a larger and gender-balanced sample, and additional wound measurements (e.g., wound area and depth) is recommended to confirm these findings and address the limitations of this study.

ACKNOWLEDGMENTS

The authors would like to thank the management and staff of Yunita Wound Care, Manado, and all patients who participated in this study.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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