Use of Silver Dressing on Diabetic Ulcers During Infection: Case Report

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Abstract

Aims: This study aimed to describe the results of applying silver dressing on diabetic ulcers during infection in patients with infected wounds on digiti one pedis dextra.

Methods: This research uses a descriptive design, namely a case study with a nursing approach consisting of assessment, analysis of problem formulation, formulation of nursing diagnosis, intervention, implementation, evaluation, and nursing documentation. The subject of this case study is Mrs. A with diabetic ulcers on Digi 1 pedis extra with infection. Case management was carried out for three days on April 17-19, 2024. Data was collected through anamnesis, wound assessment, supporting examination, and literature study. Wound assessment was performed using the Meggitt-Wagner instrument for assessing wound severity and the SINBAD (Site, Ischemia, Neuropathy, Bacterial infection, Area ulcer, and Depth) system for improving foot ulcer management according to their severity and predicting major adverse foot events.

Results: After three days of treatment using silver dressing, the wound condition shows that the infection has been resolved, and the wound has improved significantly from a grade 2 diabetic ulcer with abscess using the Meggitt-Wagner instrument and a SINBAD score of 3 (less severe ulcer) to a grade 2 diabetic ulcer without abscess and a SINBAD score of 2 (less severe ulcer).

Conclusion: Wound care using silver dressing significantly accelerates the resolution of infections and supports the overall healing process.

Keywords: infection, wound care, diabetic ulcer, silver dressing

Introduction

Diabetes remains a significant health problem worldwide, including in Indonesia, with the number of cases continuing to increase (Nuraisyah, 2018). The number of people with diabetes worldwide reaches 537 million (20-79 years) (International Diabetes Federation, 2021). Indonesia is the fifth country with the highest number of people with diabetes, which is 19.5 million people (20-79 years) in 2021 and is predicted to reach 28.6 million people in 2045 (International Diabetes Federation, 2021). Diabetes mellitus (DM) is a metabolic disease characterized by chronic hyperglycemia because the body cannot produce a certain amount of the hormone insulin or use the insulin produced effectively (Lede et al., 2018). A person can be said to have DM if they have a blood sugar level at or above 200 mg/dl and a fasting blood sugar level above or equal to 126 mg/dl (WHO, 2019).

A frequent complication in patients with DM is diabetic ulcers, which are tissue deformities either partially (Partial Thickness) or wholly (Full Thickness). The deformities include skin extending to the tendon, muscle, bone, or joint tissue and are caused by high blood sugar levels (Hutagalung et al., 2019). The causes of diabetic foot ulcers are multifactorial, including peripheral sensory neuropathy, trauma, deformity, ischemia, callus formation, infection, and edema (Bachri Y. et al., 2022). Intrinsic factors include metabolic genetics, diabetic vasculopathy, and diabetic neuropathy, while extrinsic factors include trauma, infection, and drug therapy (Pourkazemi et al., 2020). If not treated properly, infection can occur in the ulcer (Jiang et al., 2015).

Patients with type 2 DM have a high risk of 20% for developing diabetic foot ulcers (Efendi et al., 2020). According to the International Diabetes Federation (IDF) report, the prevalence of diabetic foot ulcers with cases of 9.1 million to 26.1 million patients each year (International Diabetes Federation, 2021). The prevalence of diabetic foot ulcers worldwide is 6.3% (Zhang et al., 2017). The prevalence of diabetic foot ulcers in Indonesia is recorded at 15%, with an amputation rate of 30% and a mortality rate of 32%. In Indonesia, diabetic foot ulcers account for 80% of hospitalizations (Oktorina et al., 2019). The annual incidence of diabetic foot ulcers is 2% among all DM patients and 5-7.5% among DM patients with peripheral neuropathy (Sari et al., 2018). The prevalence of diabetic foot wound infection was 52.8%, and patients with diabetic ulcers who experience infection have a 154.5 times risk of amputation (Zhang et al., 2021). The International Diabetes Federation estimates that at least one limb is lost to a diabetic foot ulcer somewhere in the world every 30 seconds (International Diabetes Federation, 2019).

Diabetic ulcer infection, if not treated seriously, will spread rapidly and enter deeper tissues (P. Zhang et al., 2017). In addition, it can cause problems of impaired skin integrity, ineffective peripheral perfusion, and the risk of infection (Hutagalung et al., 2019). So that proper diabetic wound care is needed. The goals of diabetes mellitus wound care are to improve quality of life, control infection, maintain health status, minimize the cost of treatment and care, and prevent amputation (Jiang et al., 2015). Diabetic ulcer care includes three components: debridement, off-loading, and infection control (Smeltzer, 2014). Wound control is an effort to prevent the spread of infection from becoming more widespread, removing infectious and necrotic tissue regularly; infection control in clients with diabetic ulcers is relatively difficult to overcome because there is damage to the blood vessels to the wound site and is affected by hyperglycemia

and ischemia due to peripheral arterial insufficiency spreading oxygenated blood flow, this situation will hinder the healing process in the wound (Efendi et al., 2020). If this situation is not treated immediately, the client is at risk of ischemic infection, and amputation becomes a choice and increases healing time and treatment costs (Mardiyono, 2019).

Wound care techniques are factors that influence wound healing. Various wound care techniques are often discussed, including wound dressing (Pourkazemi et al., 2020). The main principle in wound care is controlling infection because infection inhibits wound healing (Hutagalung et al., 2019). Along with the times, the types of wound dressings have been updated, and modern dressings can accelerate wound healing (Wahyuni, 2017). Some modern dressings contain antimicrobials that can inhibit the growth of gram-positive and gram-negative bacteria (Indrayati et al., 2018). Modern dressings are considered effective and efficient in the client's wound-healing process in terms of cost, time, and infection prevention (Meilin et al., 2019).

One of the modern dressings that contain antimicrobials is silver dressing. Silver ion dressing is an effective antimicrobial that maintains an optimal moist environment for wound healing and an outer layer of silver-coated polyethylene mesh that prevents wound contamination and exhibits a bactericidal effect (Munteanu et al., 2016). The silver dressing is effective against Staphylococcus Aureus and Pseudomonas spp, as well as other bacteria, fungi, and viruses (Bishop, 2018). Silver dressing can kill bacterial colonies and maintain moisture in the wound, accelerating the re-epithelialization process by 40% compared to using antibiotics (Armi, 2021). The purpose of treatment with silver dressing is to reduce the biological burden of the wound, treat local infections, and prevent systemic spread so that it can indirectly accelerate wound healing (Suhas & Manvi, 2018). There was a significant difference between the use of hydrophobic (Cutimed Sorbact®) and silver (Acticoat™) dressings on diabetic ulcer healing (Indrayati et al., 2018). Silver (Acticoat™) responds better, as evidenced by the high healing rate, and the time required for healing is faster than expected (Huang et al., 2021). Silver dressings enhance diabetic foot ulcer healing rate, shorten the time to complete healing, shorten the in-hospital duration, and improve infection resolution rate while having no significant effect on the reduction of ulcer area (Luo et al., 2022).

Therefore, it is essential to provide wound care using silver dressing on diabetic ulcers with infection to cure the disease, ultimately accelerating the healing of diabetic ulcers. The purpose of this case study is to describe the results of case management with the application of silver dressing on diabetic ulcers during the infection period in patients with infected wounds on digiti one pedis dextra.

Methods

This research method uses a descriptive design: a case study with a nursing care approach consisting of assessment, problem formulation analysis, nursing diagnosis formulation, intervention, implementation, evaluation, and nursing documentation (Mustafa et al., 2020). The research was conducted at the Bandung area diabetic wound care hospital. The subject of this case study was Mrs. A, who had a diabetic ulcer on digiti one pedis dextra with infection. Case management was carried out for three days, on April 17-19, 2024, to ensure optimal wound healing and closely monitor any changes in the ulcer's condition. Previously, the client was asked to fill out a consent sheet as informed consent. Data was collected through anamnesis, wound assessment using

Meggitt-Wagner instrument and SINBAD, supporting examination, and literature study. Wound assessment was performed using the Meggitt-Wagner instrument for assessing wound severity and the SINBAD (Site, Ischemia, Neuropathy, Bacterial infection, Area ulcer, and Depth) system for improving foot ulcer management according to their severity and predicting major adverse foot events (The International Working Group on the Diabetic Foot, 2023). Wound care interventions were carried out using occlusive dressing and a single silver dressing. The intervention was carried out for three days for one hour at each meeting.

Results

Assessment

On April 17, 2024, the assessment results were obtained by a client named Mrs. A, aged 56 years, a Muslim housewife from Bandung with a high school education. At the time of assessment, the client complained of swelling and pain in digiti one pedis dextra; the pain was felt persistent and increased when the client moved, or there was pressure on the lower extremity area. The pain was localized to digiti one pedis dextra with a pain scale of 4 (0-10).

The client said his current complaint started when he was punctured by a thumbtack while lifting the clothesline, but the client did not feel pain, so he just let it go until finally, the client forgot that a thumbtack had punctured him. Two weeks later, a wound and swelling appeared on digiti one pedis dextra and the client just realized that the wound was due to being punctured by tacks. The client had the wound checked twice at the clinic; the client was given wound washing, dressing changes, and oral antibiotics. One month later, the wound had not improved, and the client was referred to a diabetic wound specialist for specialized care. The client has had diabetes mellitus since five years ago. The client said that he regularly controls once a month and periodically takes glimepiride.

At the time of assessment, the client was compos mentis (E4V5M6) and appeared anxious about her condition. Blood pressure: 130/80 mmHg, pulse frequency 87x/min, respiratory frequency 19x/min, temperature: 36.7◦C, oxygen saturation: 99%, GDS: 253 mg/dL. The client weighs 50 kg and height is 155 cm. The physical examination focused on the wound area, which was on digiti one pedis dextra with wound characteristics: necrotic 50%, granulation 20%, slough 30%, purulent & sanguineous exudate in high amount, swelling (+), odor (+), CRT < 2 seconds, decreased sensation (+) by monofilament test, palpable warmth (+), purplish red in color, appeared watery, the wound measured 1.7 cm long and 1.2 cm wide, there was tunneling 4 cm deep from clockwise 6 to clockwise 9, and the wound did not hit the bone. The wound was categorized as a grade 2 diabetic ulcer with abscess using the Meggitt-Wagner instrument and a SINBAD score of 3 (less severe ulcer). The ABPI (Ankle Brachial Pressure Index) examination of the right extremity was 1.07 (Normal).

Nursing Diagnosis

Nursing diagnoses are based on the Indonesian Nursing Diagnosis Standards (SDKI) (PPNI, 2017). Nursing diagnoses that can be established based on the results of the assessment are disorders of skin integrity associated with mechanical factors (punctured by tacks) characterized by a wound on digiti one pedis dextra with wound characteristics: necrotic 50%, granulation 20%, slough 30%, purulent & sanguineous exudate in high amount, swelling (+), odor (+), CRT < 2 seconds, decreased sensation (+)

by monofilament test, palpable warmth (+), purplish red in color, appeared watery, the wound measured 1.7 cm long and 1.2 cm wide, there was tunneling 4 cm deep from clockwise 6 to clockwise 9, and the wound did not hit the bone. The wound was categorized as a grade 2 diabetic ulcer with abscess using the Meggitt-Wagner instrument and a SINBAD score of 3 (less severe ulcer). The ABPI (Ankle Brachial Pressure Index) examination of the right extremity was 1.07 (Normal).

Intervention, Implementation, and Evaluation

The intervention objectives refer to the Indonesian Nursing Outcome Standards, and the intervention plan refers to the Indonesian Nursing Intervention Standard (PPNI, 2018). The purpose of this case intervention is that after taking nursing actions for 3 x 1 hour, skin integrity is improved with outcome criteria: decreased skin layer damage, no signs of infection, and increased peripheral perfusion. The intervention performed is wound care.

The wound care intervention begins with observing the physical condition of the dressing (dirty, wet, seepage) before opening. The dressing was then slowly opened, and the client's wound condition was observed for exudate and other signs of infection. After observation, the client's wound and foot were washed using a mixture of antiseptic and bottled drinking water in a ratio of 1:4, gently scrubbing the area around the dirty wound and swabbing the wound area using gauze and soap containing silver, then washed again and dried using sterile gauze. After washing the wound, mechanical debridement and CSWD (Conservative Sharp Wound Debridement) were performed: removing dead tissue gently, followed by compressing the wound with antiseptic liquid Chloroxylenol solution and then washing the wound with a mixture of antiseptic and bottled water.

After the wound was clean, measurements and wound documentation were taken to determine the future development of the wound. Next, an antimicrobial modern dressing with silver content is given to overcome infection in the client's wound, then the wound is closed with sterile gauze, and a dressing is made according to the client's wound. The modern dressings used were Acticoat™ Flex 3. Clients are taught to avoid foods high in sugar and consume protein-rich foods. Implementation was carried out on April 17-19, 2024. On April 17, 2024, at 11.00 WIB, wound care was carried out for the first time after one month of poor care. The wound is already infected, so daily wound care is required to monitor for signs of infection and apply antimicrobial treatments.

Figure 1. Initial wound condition (April 17, 2024

Figure 2. Initial wound condition after treatment day 1 (April 17, 2024)

Evaluation of treatment day 1 **After treatment day 2**

Figure 3. Wound condition based on evaluation of treatment day one and after treatment day 2 (April 18, 2024)

Evaluation of treatment day 2 **After treatment day 3**

Figure 4. Wound condition based on evaluation of treatment day two and after treatment day 3 (April 19, 2024)

Figure 5. Wound condition based on evaluation of treatment day 3 (April 20, 2024)

Table 1. Daily evaluation of wound treatment using Acticoat™ Flex 3

Wound Assessment	Initial Condition	Evaluation of Treatment		
		1st Day	2nd Day	3rd Day
Size	1.7 cm x 1.2 cm	1.5 cm x 1.1 cm	1.5 cm x 1 cm	1.5 cm x 1 cm
Depth	2 cm	2 cm	2 cm	1.5 cm
Shape	Irregular	Still irregular but improving	More regular as healing progresses	More regular
Edge	Jagged and uneven	Less jagged	Becoming more defined and less jagged	More Defined
Tunneling	Yes, 4 cm deep from clockwise 6 to clockwise 9	Yes, 3 cm deep from clockwise 6 to clockwise 9	Yes, 1 cm deep from clockwise 6 to clockwise 9	No
Wound color	Red with extensive yellow slough	Red with reduced yellow slough	Mostly red with minimal slough	Primarily red, minimal slough
Surrounding skin condition	Erythematous with significant redness, swollen, and macerated	Erythema reduced somewhat, swollen, less macerated	Approaching normal, reduced swelling, no maceration	Near normal, no maceration
Exudate:				
Amount	High	Moderate	Mild	Mild
Type	Purulent & sanguinous	Serosanguinous	Serous	Serous
Tissue type:				
Necrotic	50%	40%	30%	20%
Granulation	20%	30%	50%	70%
Slough	30%	30%	20%	10%
Signs of Infection	Redness (+) extensive around the wound, swelling (+), heat (+), pain (+), odor (+), fever (-)	Redness (+) less extensive, swelling (+) reduced, heat (+) lessened, pain (+) reduced, odor (-), fever (-)	Redness (+) significantly reduced, swelling (+) minimal, heat (-), pain (+) less severe, odor (-), fever (-)	Redness (+) minimal, swelling (+) minimal, heat (-), pain (+) occasional discomfort, odor (-), fever (-)

Discussion

The results of the assessment showed that the client, a 56-year-old woman with a history of diabetes mellitus since 5 years ago, had a grade 2 diabetic ulcer on digiti 1 pedis dextra. So that the nursing diagnosis of impaired skin integrity was established (PPNI, 2017). The examination results showed signs of infection.

Worsening of the ulcer occurs due to decreased sensation in the client's feet, so it is late in handling. Ulcers in clients can be said to be diabetic foot ulcers because they are

caused by prolonged hyperglycemia, which causes structural changes in peripheral blood vessels (angiopathy), resulting in reduced distal blood supply, especially in the lower extremities (Bachri Y. et al., 2022). Poor maintenance of diabetic foot ulcers (DFUs) can significantly worsen the condition, leading to a range of complications, including an increased infection risk, delayed healing, and, ultimately, potential limb amputation (Yazdanpanah, 2015). Clinically, however, the infection was not limb-threatening as it appeared as a superficial ulceration without bone or joint involvement, without apparent ischemia, and the area of cellulitis was no more than 2 cm from the center of the ulcer (The International Working Group on the Diabetic Foot, 2023). The patient appeared stable and had no signs and symptoms of systemic infection.

Diabetic foot infection is defined as the invasion and multiplication of pathogenic organisms that induce an inflammatory response followed by damage to the soft tissue or distal bone of the malleolus of the diabetic foot (Hutagalung et al., 2019). Although in the client's case, there were no symptoms of systemic infection, these infections can lead to severe outcomes, including amputation and death, making prompt and effective treatment crucial (International Diabetes Federation, 2021). The proper method of wound care is by paying attention to wound hygiene, removing necrotic tissue, and choosing the type of dressing that is appropriate for the patient's wound condition

The moist wound care method can protect the wound from possible dehydration and improve wound healing (Wahyuni, 2017). A humid atmosphere can also accelerate fibrinolysis and angiogenesis, reduce the risk of infection, and form active cells and growth factors (Ko & Liao, 2023). Wound care methods with moist wound healing were chosen because they are more effective than conventional methods because they are easy to apply, can adjust to the shape of the wound, easy to remove, comfortable to wear, do not need to change dressings frequently, absorb drainage, suppress and immobilize the wound, prevent new wounds from mechanical injury, prevent infection, improve hemostasis by pressing the dressing (Rahmasari et al., 2022). This method also keeps the wound in a moist condition, thereby increasing the rate of tissue epithelialization, accelerating tissue autolysis, minimizing wound infection, and reducing pain, especially during dressing changes, so that wound healing is more effective (Angriani et al., 2019).

Modern dressings were chosen because they are non-adhesive materials that absorb small, medium, and large amounts of exudate (Jamaludin et al., 2020). Modern dressings can maintain moisture balance in the wound so that it helps reduce pain with each dressing change, helps cells to regenerate, does not damage new tissue, and allows neutrophils and macrophages to migrate better so that the wound can heal optimally (Bangu et al., 2021). Modern wound dressings are made from synthetic polymers classified as interactive, bioactive, and passive products in the form of hydrogels, hydrocolloids, alginates, films, and foams (Ko & Liao, 2023). Modern wound dressings contain antimicrobials that are effective in killing bacteria, preventing recurrent infections during the healing process, and effective in treating infected wounds to accelerate the granulation and epithelialization process (Rochmawati, 2018).

According to (Arisanty, 2014), it is necessary to use the proper antimicrobial dressing on the wound for infection control. So that the client, in this case, was given Silver dressing, which is one of the modern dressings of the type of antimicrobial dressing that binds chemically and has broad antibacterial activity against gram-positive and gram-

negative microorganisms (Huang et al., 2021). Silver ion dressing is an effective antimicrobial that maintains an optimal moist environment for wound healing and an outer layer of silver-coated polyethylene mesh that prevents wound contamination and exhibits a bactericidal effect (Munteanu et al., 2016). Silver dressing can kill bacterial colonies and maintain moisture in the wound, accelerating the re-epithelialization process by 40% compared to using antibiotics (Armi, 2021). The advantage of silver dressing on the length of the healing process of diabetic foot ulcers is the time silver requires to start working to kill bacteria, which has been proven in-vitro within 30 minutes (Indrayati et al., 2018). The release of Ag+ ions that start working within 30 minutes shows penetration into the wound, and bacteria will immediately bind to proteins on cell membrane receptors, DNA & RNA proteins so that they can kill bacteria. This speed in killing bacteria is critical because bacteria multiply rapidly (Lin et al., 2021).

Silver dressings, particularly nano-silver dressings, have emerged as a promising treatment option due to their broad-spectrum antibacterial properties and ability to promote wound healing (Suhas & Manvi, 2018). In this case, the type of silver dressing given to the client was Acticoat™ Flex 3. Acticoat™ Flex 3 is a modern antimicrobial dressing in a flexible sheet like a cloth, which contains polyester core, polyethylene mesh, and nanocrystalline silver dressing with a concentration of 70-100 ppm. The polyester core moistens the dressing, while polyethylene mesh allows the silver to penetrate the dressing (Indrayati et al., 2018). Meanwhile, nanocrystalline silver works by delivering antimicrobials (Zhang et al., 2021). The advantages of Acticoat™ Flex 3 are that it is flexible to follow the wound bed, can be used in hollow wounds, has the highest silver content in nano size, and can deliver antimicrobials in 30 minutes faster than other silver dressings (Luo et al., 2022). The application of Acticoat™ Flex 3 to the client's wound aims to kill pathogens and stop the infection first. Thus, the wound condition at the 2nd visit was found to have no pus production, although there was still exudate.

The wound characteristics obtained at the evaluation of treatment day 3 (April 20, 2024) were necrotic 20%, granulation 70%, slough 10%, serous exudate in mild amount, swelling (-), odor (-), CRT < 2 seconds, decreased sensation (+), palpable warmth (-), surrounding skin condition near normal and no maceration, wound measuring 1.5 cm long and 1 cm wide (showing a decrease in size), tunneling (-). The wound condition shows that the infection has been resolved. The wound has improved significantly within three days of treatment, from a grade 2 diabetic ulcer with abscess using the Meggitt-Wagner instrument and a SINBAD score of 3 (less severe ulcer) to a grade 2 diabetic ulcer without abscess and a SINBAD score of 2 (less severe ulcer). During the three-day treatment, using silver dressing did not cause any side effects to the client. However, it should be noted that the silver dressing used can cause skin discoloration and may cause side effects if not used as recommended, and the client has an allergy to silver (Khansa et al., 2019). It is also important to avoid removing the dressing with a hard pull as it may damage the new tissue that has emerged due to the wound healing process (Tajdar et al., 2024).

Limitations

This study has several limitations. First, the study sample used only one respondent, so the results obtained were not varied, which could affect the generalization of conclusions. In addition, the focus of this study was only during the period of infection

in diabetic ulcers and did not follow the development of the wound until it healed. This study only discusses modern dressings and silver dressings for healing diabetic ulcer infections without examining other factors that contribute to diabetic ulcer healing. Future researchers can optimize nursing care by considering comprehensive care involving factors that can affect the length of the wound healing period in future studies. It is necessary to explain further regarding contraindications for using silver dressings.

Contribution to Global Nursing Practice

This study is relevant globally by showing the effectiveness of using modern dressings with silver dressings to accelerate the healing period of infection in diabetic ulcers. This finding can serve as a reference for intervening with patients to accelerate healing and reduce the suffering of patients with diabetic ulcers, which can be carried out worldwide.

Conclusion

Wound care using silver dressing significantly accelerates the resolution of infections and supports the overall healing process. This was shown by the prompt formation of granulation tissue and a reduction in slough and exudate. However, applying silver dressings should be part of a comprehensive treatment plan that includes rigorous infection control, regular monitoring, and patient-specific care adjustments.

Author Contribution

All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

Conflict of interest

There is no conflict of interest in this study.

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References

Angriani, S., Hariani, H., & Dwianti, U. (2019). The Effectivity of Modern Dressing Wound Care with Moist Wound Healing Method in Diabetic Ulcus at Wound Care Clinic of ETN Centre Makassar. Jurnal Media Kesehatan, 10(1), 19–24.

Arisanty, I. P. (2014). Konsep Dasar Manajemen Perawatan Luka. Penerbit Buku Kedokteran EGC.

Armi, R. D. (2021). Efektivitas Dialkycarbamoylchloride dan Silver Dressing Terhadap Penyembuhan Luka Pada Pasien Ulkus Makanan Diabetik di Puskesmas Kota Bekasi. Jurnal Ilmiah Kesehatan Medika Drg. Suherman, 55–57.

Bachri Y., Prima, R., & Putri, S. A. (2022). Faktor-Faktor Resiko Yang Berhubungan Dengan Kejadian Ulkus Kaki Diabetik Pada Pasien Diabetes Melitus Di RSUD Prof. Dr. MA. Hanafiah, SM Batusangkar Tahun 2022. Jurnal Inovasi Penelitian (JIP), 3(1), 4739–4750.

Bangu, B., Siagian, H. J., Naim, R., & Nasus, E. (2021). Modern Dressing Wound Care Mempercepat Proses Penyembuhan Ulkus Kaki pada Pasien Diabetes: A Systematic Review. Jurnal Surya Medika, 7(1), 146–155. https://doi.org/10.33084/jsm.v7i1.2650

Bishop, A. J. (2018). Using Antimicrobial Dressing to Treat Infected Wounds. The Diabetic Foot Journal, 21(3), 68–71.

Efendi, P., Heryati, K., & Buston, E. (2020). Faktor yang Mempengaruhi Lama Penyembuhan Gangren Pasien Diabetes Mellitus di Klinik Alfacare. MNJ (Mahakam Nursing Journal), 2(7), 286. https://doi.org/10.35963/mnj.v2i7.165

Huang, C., Wang, R., & Yan, Z. (2021). Silver Dressing in the Treatment of Diabetic Foot. Medicine, 100(7), e24876. https://doi.org/10.1097/MD.0000000000024876

Hutagalung, M. B. Z., Ejatin, D. S., Awalita, S. V. P., Sianturi, G. D. A., & Santika, G. F. (2019). Diabetic Foot Infection (Infeksi Kaki Diabetik): Diagnosis dan Tatalaksana. Continuing Medical Education, 46(6), 414–418.

Indrayati, N., Koto, Y., & Mulyadi, B. (2018). Penyembuhan Ulkus Diabetik dengan Aplikasi Antimikrobial Wound Dressing Silver (ActicoatTM). Jurnal Ilmiah Ilmu Keperawatan Indonesia, 8(04), 508–515. https://doi.org/10.33221/jiiki.v8i04.174

International Diabetes Federation. (2019). IDF Diabetes Atlas-9th Edition. Http://Www.Diabetesatlas.Org/.

International Diabetes Federation. (2021). IDF Diabetes Atlas 10th Edition. Https://Diabetesatlas.Org/Idfawp/Resource Files/2021/07/IDF_Atlas_10th_Edition_2021.Pdf .

Jamaludin, T. S. S., Nurumal, M. S., Saidi, S., Che Hasan, M. K., Mohammad Said, N. F., Samsudin, N. H., & Chong, M. C. (2020). A Narrative Review on Modern Wound Dressing for Diabetes Mellitus Wound. INTERNATIONAL JOURNAL OF CARE SCHOLARS, 3(2), 50–56. https://doi.org/10.31436/ijcs.v3i2.142

Jiang, Y., Ran, X., Jia, L., Yang, C., Wang, P., Ma, J., Chen, B., Yu, Y., Feng, B., Chen, L., Yin, H., Cheng, Z., Yan, Z., Yang, Y., Liu, F., & Xu, Z. (2015). Epidemiology of Type 2 Diabetic Foot Problems and Predictive Factors for Amputation in China. The International Journal of Lower Extremity Wounds, 14(1), 19–27. https://doi.org/10.1177/1534734614564867

Khansa, I., Schoenbrunner, A. R., Kraft, C. T., & Janis, J. E. (2019). Silver in Wound Care—Friend or Foe?: A Comprehensive Review. Plastic and Reconstructive Surgery - Global Open, 7(8), e2390. https://doi.org/10.1097/GOX.0000000000002390

Ko, A., & Liao, C. (2023). Hydrogel Wound Dressings For Diabetic Foot Ulcer Treatment: Status-Quo, Challenges, and Future Perspectives. BMEMat, 1(3). https://doi.org/10.1002/bmm2.12037

Lede, M. J., Hariyanto, T., & Ardiyani, V. M. (2018). Pengaruh Kadar Gula Darah Terhadap Penyembuhan Luka Diabetes Mellitus di Puskesmas Dinoyo Malang. Nursing News: Jurnal Ilmiah Keperawatan, 3(1), 539–549.

Lin, H., BoLatai, A., & Wu, N. (2021). Application Progress of Nano Silver Dressing in the Treatment of Diabetic Foot. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 14, 4145–4154. https://doi.org/10.2147/DMSO.S330322

Luo, Y., Li, L., Zhao, P., Yang, C., & Zhang, J. (2022). Effectiveness of Silver Dressings in The Treatment of Diabetic Foot Ulcers: A Systematic Review and Meta-Analysis. Journal of Wound Care, 31(11), 979–986. https://doi.org/10.12968/jowc.2022.31.11.979

Mardiyono, M. (2019). Modern Combinations Dressing and Ozone. Bagging Treatment Reduces The Amount Of Bacteria In Grade II Diabeticum. Journal of Applied Health Management and Technology, 1(1), 28–37.

Meilin, A., Sidabutar, B., Patty, R. A., & Simanjuntak, S. (2019). Gambaran Pengetahuan Perawat Tentang Perawatan Luka Modern Dressing Di Satu Rumah Sakit Swasta Di Indonesia Barat. Jurnal Keperawatan Raflesia, 1(2), 77–86.

Munteanu, A., Ip, F., & Nitescu, C. (2016). A Modern Method of Treatment: The Role of Silver Dressings in Promoting Healing and Preventing Pathological Scarring in Patients with Burn Wounds Case Reports. Journal of Medicine and Life, 9(3), 306–315.

Nuraisyah, F. (2018). Faktor Risiko Diabetes Mellitus Tipe 2. Jurnal Kebidanan Dan Keperawatan Aisyiyah, 13(2), 120–127. https://doi.org/10.31101/jkk.395

Oktorina, R., Wahyuni, A., & Harahap, E. Y. (2019). Faktor-Faktor Yang Berhubungan Dengan Perilaku Pencegahan Ulkus Diabetikum Pada Penderita Diabetes Mellitus. REAL in Nursing Journal, 2(3), 108. https://doi.org/10.32883/rnj.v2i3.570

Pourkazemi, A., Ghanbari, A., Khojamli, M., Balo, H., Hemmati, H., Jafaryparvar, Z., & Motamed, B. (2020). Diabetic foot care: knowledge and practice. BMC Endocrine Disorders, 20(1), 40. https://doi.org/10.1186/s12902-020-0512-y

PPNI. (2017). Standar Diagnosis Keperawatan Indonesia: Definisi dan Indikator Diagnostik (1st ed.). DPP PPNI.

PPNI. (2018). Standar Intervensi Keperawatan Indonesia: Definisi dan Tindakan Keperawatan (1st ed.). DPP PPNI.

Rahmasari, I., Martins, F. F., Musta'an, M., & Purwaningsih, I. (2022). Modern Wound Treatment with Moist Wound Healing Effective for Healing Diabetic Ulcus. Proceedings of the International Conference on Nursing and Health Sciences, 3(1), 163–166. https://doi.org/10.37287/picnhs.v3i1.1144

Sari, Y. O., Almasdy, D., & Fatimah, A. (2018). Evaluasi Penggunaan Antibiotik Pada Pasien Ulkus Diabetikum di Instalasi Rawat Inap (IRNA) Penyakit Dalam RSUP Dr. M. Djamil Padang. Jurnal Sains Farmasi & Klinis, 5(2), 102.

Smeltzer, S. C. (2014). Keperawatan Medikal Bedah. Penerbit Buku Kedokteran EGC.

Suhas, K., & Manvi, P. M. N. (2018). Efficacy of Nano Silver Dressings Over Conventional Dressings in Chronic Wounds. International Surgery Journal, 5(12), 3995. https://doi.org/10.18203/2349-2902.isj20185033

Tajdar, Y., Singh, S., Raj, A., Raj, A., & Bhushan, V. (2024). Effect of Silver Colloid Dressing Over Conventional Dressings in Diabetic Foot Ulcer: A Prospective Study. Turkish Journal of Surgery, 40(1), 28–35. https://doi.org/10.47717/turkjsurg.2024.6168

The International Working Group on the Diabetic Foot. (2023). Guidelines on The Classification of Foot Ulcers in People with Diabetes: IWGDF 2023 update. www.iwgdfguidelines.org.

Wahyuni, L. (2017). Effect Moist Wound Healing Technique toward Diabetes Mellitus Patients with Ulkus Diabetikum in Dhoho Room RSUD Prof Dr. Soekandar Mojosari. Jurnal Keperawatan, 6(1), 63–69.

WHO. (2019). Classification of Diabetes Mellitus. World Health Organization.

Yazdanpanah, L. (2015). Literature Review on The Management of Diabetic Foot Ulcer. World Journal of Diabetes, 6(1), 37. https://doi.org/10.4239/wjd.v6.i1.37

Zhang, K., Li, Y., He, J., Xu, J., Wan, Y., Wan, S., Wang, R., & Zeng, Q. (2021). Therapeutic Effect of Epidermal Growth Factor Combined With Nano Silver Dressing on Diabetic Foot Patients. Frontiers in Pharmacology, 12. https://doi.org/10.3389/fphar.2021.627098

Zhang, P., Lu, J., Jing, Y., Tang, S., Zhu, D., & Bi, Y. (2017). Global Epidemiology of Diabetic Foot Ulceration: A Systematic Review and Meta-Analysis. Annals of Medicine, 49(2), 106–116. https://doi.org/10.1080/07853890.2016.1231932