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# A pharmacoeconomic study: cost-utility analysis of modern wound dressings vs conventional wound dressings in patients with diabetic foot ulcer

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## Keywords

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Diabetic foot ulcer  
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## Abstract

**Introduction:** Duration of treatment and outcome of therapy of diabetic foot ulcers are some of the factors that affect the quality of life and will require higher medical costs. **Aim:** This study aimed to choose an alternative wound dressing that provides the best utility at the most cost-efficient. **Methods:** The research method used was pharmacoeconomics with a patient's perspective. **Results:** The results showed the mean cost of modern wound dressings per visit was IDR 347,131, while that of conventional wound dressings was IDR 47,140. The quality of life with modern vs conventional wound dressing was significantly different ( $p < 0.05$ ). The incremental cost utility ratio (ICUR) value was IDR 22,813 per quality of life (QoL). **Conclusions:** This study showed that modern wound dressings provide a higher quality of life at a higher cost. Indeed, it cost more than IDR 22,813 to change from conventional to modern wound dressings and increase 1 unit of quality of life, but patients obtained an additional 13.15 quality of life.

## 22 Introduction

According to the World Health Organization (WHO), diabetes mellitus (DM) combined with reduced blood flow and neuropathy (nerve damage) in the feet increases the chance of foot ulcer infections and the eventual need for limb amputation (WHO, 2020). In Indonesia, around 5.3 million people suffer from Diabetic Foot Ulcer (DFU), which is the most common cause of hospital admissions (80%) for DM (Hastuti, 2008). DFU is often overlooked, making its existing core concept imprecise; consequently, many patients develop osteomyelitis, even amputation (Misnadiarly, 2006). In 2010-2011, the incidence of amputation in Indonesia due to DFU increased sharply from 35% to 54.8% (Misnadiarly, 2006).

Diabetic ulcers are the most feared chronic complication for diabetes mellitus patients in terms of both the duration and cost of treatment. The latter

costs three folds the treatment of diabetes mellitus without ulcers (Hastuti, 2008). In Indonesia, the cost of diabetic ulcer management is high, 1.3 million to 1.6 million IDR per month and 43.5 million IDR per year per patient (Hastuti, 2008).

Patients need more wound care from the onset of the wound, with 30 days required to prevent breakdowns, infections, and amputations because immediate intervention can save both the costs and the patient's leg (McGuire, 2014). According to the WHO, cost-saving and feasible interventions in developing countries include moderate blood glucose control, blood pressure control, and foot care (WHO, 2020).

The use of modern wound dressings, foam dressings, for example, has major advantages, including the ability to retain exudates, high absorption, effectiveness for wounds with excess fluid, reducing pain, ease to remove, and protecting the peri-wound area from

additional trauma (Jones *et al.*, 2006; and Hilton *et al.*, 2004). Furthermore, conventional wound dressings (wet-dry gauze with normal saline) cannot maintain a moist environment, required to provide optimal conditions for wound healing. Gauze can interfere with wound healing because it dries out and causes tissue damage when it is removed (Jones, Grey, & Harding, 2006). Additionally, conventional treatments take longer to heal (Allenet *et al.*, 2000). Several studies found that the healing efficacy of modern wound dressings is 100%, while that of conventional wound dressings is only 50% (Nurhaida, 2017). Other results showed that modern wound dressings, such as hydrogel, are three times more effective than 0.9% NaCl and that moist wound healing dressings are more effective than NaCl 0.9% + real honey (Purnomo *et al.*, 2014; and Riani *et al.*, 2017).

Unfortunately, modern wound dressings are more expensive than conventional wound dressings. Modern wound care provides better comfort and reduces the smell of the wound, but financially, conventional wound dressings are more cost-effective because they use health insurance from the government (Minarningtyas & Tami, 2018).

Therefore, it is necessary to conduct a pharmacoeconomic and cost-utility analysis on the use of modern wound dressings compared to conventional wound dressings using the quality of life of DFU patients measured by the DQOL (Diabetic Quality of Life) questionnaire and the average total cost of each wound dressing. This study aimed to perform a cost-utility analysis between modern versus conventional wound dressings in diabetic foot ulcer patients to determine an alternative cost-effective wound dressing that would provide the best utility or quality of life for diabetic foot ulcer patients.

## Methods

This pharmacoeconomic research is analytical and observational and uses a cross-sectional approach. It has been reviewed and approved by the Health Research Ethics Commission University of Mataram No.:109/UN18.F7/ETIK/2020. This study compared the utility and cost of two treatments for diabetic foot ulcers, i.e. modern wound dressings and conventional wound dressings. The mean utility data were collected using the DQOL questionnaire, while the cost data were obtained from the average total cost from the patient's perspective. The cost components calculated consisted of direct medical and non-medical costs and indirect costs. Then, a cost-utility analysis was performed by calculating the value of the incremental cost-utility ratio (ICUR). The validity of the DQOL questionnaire had

been tested with a validity value of  $r = 0.428-0.851$  and Cronbach alpha 0.963 (Yusra, 2011). DQOL consists of 30 questions covering satisfaction, the impact of illness, concerns about physical function in addition to psychological and social problems. All answers are rated on a Likert scale, with DQOL scores categorized into low (less than 60), moderate (60-90), and high (more than 90) quality of life (Yusra, 2011).

The study population consisted of diabetic foot ulcer patients who needed wound dressings recruited from the AWCC Lombok wound care clinic and several public health centres (*Puskesmas*) in West Lombok Regency and Mataram City. The total sampling technique was used because the number of diabetic foot ulcer patients who needed wound dressings was small. The final sample included 16 patients; 11 used modern wound dressings, and 5 used conventional wound dressings. The patients' quality of life was monitored from their first visit to the clinic or public health centre until they recovered or no longer needed wound dressing. Hence, the mean utility and costs were calculated based on the total number of visits, i.e. 75 visits distributed as follows: 55 visits by patients with modern wound dressings and 20 visits by patients with conventional wound dressings. Informed consent was obtained from all the patients. The utility and cost comparisons were performed statistically using SPSS version 20 software.

## Results

### Overview of the utility of diabetic foot ulcer patients

In this study, demographic data collected were based on factors that affect the quality of life of diabetes mellitus patients, namely gender, age, education level, ethnicity, and marital status (Rubin, & Peyrot, 1999) in addition to the grade of diabetic foot ulcers and smoking status.

Diabetic foot ulcer patients who used modern wound dressings had various wound grades, ranging from 4, 3, 2, and 1, while those who used conventional wound dressings had grades 3 and 1.

Patients with modern wound dressings were only found at the AWCC Lombok wound care clinic, while patients with conventional wound dressings were only found at public health centres in West Lombok Regency and Mataram City. In other words, there were two different research locations. Currently, more patients prefer wound care clinics than public health centres, where they will receive a modern wound dressing even though they have to spend more money. Those who choose public health centres get a conventional wound dressing for free.

Table I shows that almost all patients with diabetic foot ulcers who used modern wound dressings had a high quality of life, except for those who were unmarried (they had a moderate QOL). Patients using conventional wound

dressing who had a high quality of life consisted of those who had a high school education level or above and those who were employed.

**Table I: Overview of the utility of diabetic foot ulcer patients**

| Demography of patients | Modern Wound Dressing |            |                     | Conventional Wound Dressing |            |                     |
|------------------------|-----------------------|------------|---------------------|-----------------------------|------------|---------------------|
|                        | Total (n=11)          | Percentage | Mean utility (n=55) | Total (n=5)                 | Percentage | Mean utility (n=20) |
| <b>Gender</b>          |                       |            |                     |                             |            |                     |
| Male                   | 5                     | 45.45%     | 104.38±9.49         | 3                           | 60%        | 89.25±6.94          |
| Female                 | 6                     | 54.55%     | 97.32±15.01         | 2                           | 40%        | 84.25±7.59          |
| <b>Age</b>             |                       |            |                     |                             |            |                     |
| < 46 years old         | 2                     | 18.18%     | 106.00±5.46         | 2                           | 40%        | 85.63±6.44          |
| ≥ 46 years old         | 9                     | 81.82%     | 99.16±14.19         | 3                           | 60%        | 88.33±8.14          |
| <b>Education</b>       |                       |            |                     |                             |            |                     |
| <Senior High School    | 5                     | 45.45%     | 94.42±14.67         | 3                           | 60%        | 84.00±6.15          |
| ≥ Senior High School   | 6                     | 54.55%     | 105.76±9.19         | 2                           | 40%        | 92.13±6.77          |
| <b>Occupation</b>      |                       |            |                     |                             |            |                     |
| Employed               | 10                    | 90.91%     | 99.24±13.33         | 3                           | 60%        | 90.00±7.81          |
| Not Employed           | 1                     | 9.09%      | 112.00±4.00         | 2                           | 40%        | 83.75±5.60          |
| <b>Marital Status</b>  |                       |            |                     |                             |            |                     |
| Married                | 10                    | 90.91%     | 103.94±9.97         | 4                           | 80%        | 87.38±7.21          |
| Unmarried              | 1                     | 9.09%      | 79.63±11.29         | 1                           | 20%        | 86.75±4.57          |
| <b>Smoking Status</b>  |                       |            |                     |                             |            |                     |
| Smoking                | 3                     | 27.27%     | 102.33±9.96         | 2                           | 40%        | 85.13±4.09          |
| Not Smoking            | 8                     | 72.73%     | 99.68±14.36         | 3                           | 60%        | 88.67±8.93          |

**Cost of modern wound dressing and conventional dressing**

The cost calculation was carried out based on the patient’s perspective. The calculated cost components were direct medical costs (wound dressing costs and wound care costs), direct non-medical costs (home care costs for modern wound dressing patients and transportation costs for conventional wound dressing patients), and indirect costs (loss of productivity cost). The loss of productivity cost was calculated based on the human capital approach, i.e., the number of days lost due to illness or treatment according to daily income (Setiawan, Endarti, & Suwantika, 2017).

Table II shows that the direct medical cost of conventional wound dressings was 0 IDR since patients underwent wound care at a public health centre free of charge. The direct medical costs were borne by the Social Security Administrator for Health (BPJS Kesehatan). Patients only incurred direct non-medical costs in the form of transportation costs from home to the public health centre. Even if the care is provided free of charge, the indirect costs (loss of productivity cost) create a financial burden. Meanwhile, the direct non-medical cost of modern wound dressings was high because patients received wound care at home. The

average cost was IDR 347,131, or 7 times higher than the total cost of conventional wound dressings.

**Table II: Cost of modern wound dressing and conventional dressing per visit**

| Cost components          | Modern wound dressing (n=55)<br>Total IDR | Conventional wound dressing (n=20)<br>Total IDR | p-value |
|--------------------------|---|---|---------|
| Direct medical cost      | IDR 12,034,000                            | IDR 0   | <0.0001 |
| • Cost of wound dressing | IDR 5,094,000                             | (IDR 0)   |         |
| • Cost of wound care     | (IDR 6,940,000)                           | (IDR 0)   |         |
| Direct non-medical cost  | IDR 1,650,000                             | IDR 88,000                                      | <0.0001 |
| Indirect cost            | IDR 5,408,223                             | IDR 854,795                                     | 0.009   |
| Total cost               | IDR 19,092,223                            | IDR 942,795                                     |         |
| Mean cost                | IDR 347,131±129,309                       | IDR 47,140±39,183                               | <0.0001 |

**Discussion**

This study results show that modern wound dressings provided a high mean utility compared to conventional

wound dressings. Basic wound treatments rely heavily on antiseptics misuse and drying of the wound, resulting in lengthy, expensive, and painful care (Vuagnat & Comte, 2016). Complications experienced, such as diabetic ulcers, can result in lower quality of life in diabetes mellitus patients, where these complications can result in physical, psychological, and even social limitations (Yusra, 2011). Patients with diabetic ulcers had a low quality of life as physical health is closely related to patient feelings about the pain and anxiety experienced, dependence on medical care, energy and fatigue, mobility, sleep and rest, daily activities, and work capacity (Utami, Karim, & Agrina, 2014). The quality of life of diabetes mellitus patients was significantly influenced ( $p < 0.05$ ) by gender, age, education, disease duration, including complications in the form of diabetic ulcers (Eristina, 2017).

The statistical results (Table II) showed significant differences in the direct medical costs, direct non-medical costs, indirect costs, and the average cost between modern and conventional wound dressings ( $p < 0.05$ ). A study conducted at Karanganyar General Hospital reported that complications significantly affected direct medical costs ( $p < 0.05$ ) and that the average cost of complications for diabetes ulcers was IDR 765,662.00±42,085.58 (Eristina, 2017). Another research conducted at Sanglah General Hospital Denpasar found that the average cost of modern wound dressings was IDR 335,500, not much different from the average cost of modern wound dressings in this study (IDR 347,131). Furthermore, in a study conducted in 2015 at Banyuasin Hospital, the unit cost of the service for hospitalised patients with diabetes mellitus complications was IDR 4,147,032.53. Previous research conducted between September and November 2019 concluded that the average treatment for type 2 diabetes mellitus with the complication of diabetic foot ulcers was IDR 29,139,247 (Tiara, 2012; Rahman, 2016; & Rondonuwu *et al.*, 2020). The differences in costs are influenced by the grade or severity of the wound (which requires more extensive therapy), cost of action, including accommodation costs in the hospital.

### Cost-utility analysis

Table III shows a significant difference in the mean cost and the mean utility between modern wound dressings and conventional wound dressings ( $p = 0.0001$ ). Thus, the two methods yield different quality of life results, where modern wound dressings provide a higher quality of life than conventional wound dressings.

**Table III. Cost-Utility Analysis between Modern vs Conventional Wound Dressing**

| Calculations                          | Modern wound dressing (n=55) | Conventional wound dressing (n=20) | p-value |
|---------------------------------------|------------------------------|------------------------------------|---------|
| Mean cost                             | IDR 347,131±129,309          | IDR 47,140±39,183                  | <0.0001 |
| Mean utility                          | 100.4±13.27                  | 87.25±7.45                         | <0.0001 |
| Cost utility ratio (CUR)              | IDR 3,457                    | IDR 540                            |         |
| Incremental cost utility ratio (ICUR) | IDR 22,813                   |                                    |         |

The CUR and ICUR values were calculated after obtaining the results of the utility and cost calculations. The results of the CUR (Table III) show that modern wound dressings were in quadrant 1, while conventional wound dressings were in quadrant 3, so a cost-utility analysis was carried out by calculating the ICUR value. Modern wound dressings provided a higher quality of life at a higher cost than conventional wound dressings. The results of ICUR showed that it costs more than IDR 22,813 to change from conventional to modern wound dressings and increase 1 unit of quality of life, but patients obtained an additional 13.15 quality of life. Further studies comparing the GDP per capita, or the threshold value, or the willingness to pay are necessary to determine whether the addition is commensurate or not.

A study conducted in Germany reported that patients who used the new wound dressing (foam dressing) had a reduced mean frequency of dressing change by 1.3 times per week (from 4.6 to 3.3). The cost of dressings per change increased slightly, but the average cost of dressings per week was reduced by approximately 23% (Kronert, Roth & Searle, 2016). Another study conducted at Jss hospital, India, found that topical sucralfate was more cost-effective than conventional dressings, as it required a lower number of dressings and reduced hospital stay significantly (Preethi, & Dhanasekaran, 2019). Based on research conducted in the United States of America (USA), the incremental cost-effectiveness ratio of Dermagraft(R) (human dermal replacement) equals 38,784 FF, indicating the extra investment that the decision-maker has to accept for an additional ulcer healed with Dermagraft(R) compared with conventional treatment (Allenet *et al.*, 2000). However, it is different from the results of research in the UK reporting no difference in effectiveness and quality of life of N-A (a non-adherent, knitted, viscose filament gauze), Inadine (an iodine-impregnated dressing), both traditional dressings, and Aquacel, a newer product. The only statistically significant difference found in the health economic analysis was the cost associated with the provision of

dressings (mean cost per patient: N-A 14.85 pounds, Inadine 17.48 pounds, Aquacel 43.60 pounds) (Jeffcoate *et al.*, 2009).

### Limitations of the study

The number of patients included in the evaluation was small, so the analysis in this study used the number of patients visits. Nevertheless, it would be beneficial to undertake further work in other wound care clinics and public health centres to increase confidence in the generalisability of the results.

### Conclusion

This study showed that modern wound dressings provide a higher quality of life at a higher cost. Indeed, it cost more than IDR 22,813 to change from conventional to modern wound dressings and increase 1 unit of quality of life, but patients obtained an additional 13.15 quality of life. Further studies comparing the GDP per capita, or the threshold value, or the willingness to pay are necessary to determine whether the addition is commensurate or not.

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### Conflict of Interest

The authors declare no conflict of interest.

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