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The Association Between Adherence and Controlled Blood Glucose in Diabetic Foot Ulcer Patients

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ABSTRACT

Background: A common consequence of diabetes mellitus is diabetic foot ulcers (DFUs), which, if left untreated, can lead to amputation, extended hospital stays, and even death. Compliance in blood sugar control is one of the keys to healing diabetes wounds.

Objective: This study aims to analyze the association between medication compliance in diabetic ulcer patients and clinical outcomes.

Research methods: This study used a cross-sectional design involving diabetic ulcer patients who met the inclusion and exclusion criteria in three health services in Surabaya. Patient medication adherence data using the MMAS-8 questionnaire, while blood glucose level used for the clinical outcome data. Chi-square analysis was used to examine the association between clinical outcomes and adherence level.

Results: The number of respondents obtained was 96 DFU outpatients between July and October 2024. The majority of patients had moderate (49%), low (32%) levels of compliance and achieved clinical outcomes (66%). There is a relationship between adherence to medication use and clinical outcomes ($P<0.001$).

Conclusion: Medication adherence is associated with the controlled blood glucose of DFU patient. To achieve the optimal clinical results, patients, pharmacists, and other healthcare professionals must collaborate to increase patient compliance.

Keywords*:* Diabetes; foot; hypoglycemic; insulin; wound

INTRODUCTION

Hyperglycaemia spurred on by abnormalities in the metabolism of proteins, fats, and carbohydrates is a characteristic of diabetes. Abnormalities in insulin action, secretion, or a combination of the two are the cause of this (Holt, 2024). Every year, 19.5 million Indonesians suffer from diabetes (Indonesian Ministry of Health, 2024). Diabetic foot ulcers are the most frequent complication of uncontrolled type II diabetes mellitus. Diabetic foot ulcers is a tissue damage caused by infection, neuropathy, and ischaemia (Eckert, 2023; Edmonds, 2021; Seshadri, 2024).

DFS patients have a significantly reduced quality of life and are prone to a number of comorbidities, including peripheral artery disease (PAD), cardiovascular disease (CVD), neuropathy, retinopathy, and nephropathy. The wound healing frequently takes a long time and requires significant resources from health care systems. Re-ulcerations are common, even after wounds have healed, and they frequently result in minor or severe lower extremity amputations (Mader, 2019).

The global prevalence of diabetic ulcers is 18.84%, with more male patients than female patients. Increasing age, uncontrolled diabetes mellitus, prolonged standing and working barefoot, and slow-healing wounds are the most common factors contributing to diabetic ulcers (Adiewere, 2018; Faizah, 2024). Previous research has proven that diet and medication have an important role in managing diabetes mellitus, but compliance with both is a major challenge. Disease-specific adherence questionnaires are one of the instruments in assessing patient adherence patterns, to be able to understand the patient's perspective about medicines and diseases (Ghosh, 2017). The impact of non-adherence to treatment is poor clinical outcomes, poor quality of life and risk of complications. The patient's attitude towards compliance with treatment over a certain period of time and compliance with medical advice has a positive impact on clinical outcomes (Abdulazeez, 2014). There are numerous studies to assess the outcomes in patients with diabetic foot ulcers, however there is a shortage of information regarding medication adherence in these patients. Hence, purpose of the study was to analyze the association between medication compliance and clinical outcomes in Diabetic Foot Ulcer (DFU) patients.

RESEARCH METHODS

This research was observational with a cross sectional design conducted in 3 health services in the city of Surabaya, Indonesia in August-October 2024. Sampling was carried out using a convenience sampling technique. The inclusion criteria were patients diagnosed with type 2 DM with leg wounds, aged ≥ 18 years, receiving antidiabetic medication and willing to take part in the study by filling out informed consent, while the exclusion criteria were patients who were uncooperative, pregnant and breastfeeding patients. This research has obtained permission from the ethics commission with No. 69/EC/KEP/2024.

Tools and materials

Medication adherence data was obtained from interviews using the MMAS-8 questionnaire. MMAS-8 is a questionnaire developed by Dr. Donald E. Morisky. An Indonesian version has been validated with a Cronbach Alpha value of 0.806 (Riastienanda, 2017). The MMAS-8 consists of 8 question items that assess non-adherence behavior (Morisky, 2008). The respondent's level of compliance is assessed from the accumulated score for each question answer (answer Yes=0; No=1). Adherence categories are classified into 3, including low (0-5), medium (6-7) and high (8) (Berlowitz, 2017; Bress, 2017).

Clinical outcome is a description of the patient's clinical response regarding the effectiveness of antidiabetic therapy which can be in the form of instant blood glucose levels or fasting blood glucose levels. Blood glucose data is taken when the patient is examined at the clinic. Blood glucose is said to be achieved if the patient's blood glucose level ranges between 100-199 mg/dl. Meanwhile, fasting blood glucose level was achieved if blood glucose levels range between 100-125 mg/dl.

Research procedure

Diabetic ulcer patients who met the inclusion criteria filled out informed consent as proof of consent. Next, patients answered the Morisky Medication Adherence Scale (MMAS-8) questionnaire. Other relevant data such as patient characteristics and blood glucose were obtained from the patient's medical records.

Data analysis

The obtained data were statistically analyzed using the chi-square test. The variable which met the value of $p<0.05$ was considered significantly correlated to medication adherence.

RESULTS AND DISCUSSION

This study involved 96 diabetic ulcer patients, dominated by patients aged 18-59 years (65%). The percentage of type 2 DM disease that has a duration of less than 5 years is greater (55%) compared to those with a duration of more than 5 years with a classification of 6-10 years (19%) and >10 years (26%) (Table I). The duration of the disease has a close relationship to the risk of complications such as diabetic ulcers. The duration of diabetic ulcers in most patients was >8 weeks (44%) followed by 0-4 weeks (33%) and 5-8 weeks (23%). Most of the diabetic ulcer patients in these patients had not experienced amputation (78%). The antidiabetic therapy obtained ranged from single (40%), combination insulin (34%), combination oral antidiabetic (17%) and combination insulin-oral (9%).

TABLE 1. Demographic of Diabetic Foot Ulcer Patients

Characteristics	Number of patients (n=96) (%)
Age (years)	
18-59	62 (64.58)
≥ 60	34 (35.42)
Duration of DM (years)	
0-5	53 (55.21)
6-10	18 (18.75)
>10	25 (26.04)
Duration of DFU (weeks)	
0-4	32 (33.33)
5-8	22 (22.92)
>8	42 (43.75)
Leg Amputation	
Yes	21 (21.88)
No	75 (78.12)
Medication	
Monotherapy	38 (39.58)
Combination of insulin	33 (34.38)
Combination of oral hypoglycemic agents	16 (16.67)
Combination of oral hypoglycemic agents and insulin	9 (9.37)

In table II, patients with moderate (48.9%) and low (32.2%) levels of compliance are greater than patients with high levels of compliance (18.9%) with an average MMAS-8 score of 5, 27 which can be interpreted as the patient having a low level of compliance. According to previous research regarding the description of compliance of DM patients with foot infections, the level of treatment compliance is at low (44%) and medium (42%) compliance levels (Wasnik, 2019). These results are supported by the study conducted using the MMAS-8 questionnaire in 251 subjects shows that more than 70% of them follow moderate adherence followed by 27.89% with low adherence patter (Vyas, 2015). This is different from research by Varughese et al (2023) in India, where patients with low compliance (4.67%) and patients with moderate compliance (49.2%).

TABLE 2. Association of Medication Adherence and Controlled Blood Glucose

Level of Adherence	N (%)	Controlled Blood Glucose		P Value
		Controlled	Uncontrolled	
Low	31 (32.2)	6.2	26.0	<0.001
Moderate	47 (48.9)	40.6	8.3	
High	18 (18.9)	18.9	0.0	

Patients with diabetic ulcers had the highest medication non-compliance, which is caused by not bringing medication with them when they travel (60%) according to the results. Patients quitting their medications because they feel well accounts for the second reason (42%). Ardiyani's (2015) study found that forgetfulness (38.36%) and a number of other variables, including hectic schedules, irregular control, boredom/laziness, and exhaustion, are the most common causes of prescription non-compliance among patients. According to research by Srikartika et al. (2016), patients forgetting to take their medications and paying for them late are the most frequent causes of medication non-compliance.

While worries about side effects are less common, forgetfulness and recurrent drug usage are the primary causes of non-adherence in the majority of our patients who are not at home (Srikartika, 2016; Firdiawan, 2019). In addition to workplace stress, psychosocial stress, and being away from home, non-adherence can also result from ignorance and a lack of understanding about therapy (Culig, 2011). Because patients want to recover as soon as possible, treatment expenses do not contribute to non-compliance (García-Pérez et al., 2013; Horvart, 2018; Kirkman and Rowan-Martin, 2015; Wasnik, 2019). For diabetic foot ulcers,

taking medication as prescribed is crucial because it lowers the chance of reinfection by maintaining stable blood glucose levels.

The blood glucose levels of patients who were achieved (65.7%) were higher than the clinical outcome of patients who were not achieved (34.3%). As many as 26% of patients with uncontrolled blood sugar were patients with low levels of compliance. Unreached blood glucose levels can be influenced by several factors, including non-compliance with dieting, not exercising, non-compliance with taking medication, and level of knowledge. Patient clinical outcomes are influenced by age, education, occupation, treatment patterns, duration of suffering from DM, presence of complications, BMI, comorbidities such as hypertension, non-adherence to treatment, and non-adherence to self-management such as diet, exercise, and self-monitoring of glucose (Kassahun et al., 2016; Katadi, 2019).

There is a relationship between compliance with diabetic ulcer treatment and clinical outcomes (achievement of blood glucose levels) with a P value <0.001, where patients with a high level of compliance have a higher value of achieving clinical outcomes compared to patients with a low level of compliance. Previous research shows a positive relationship between medication adherence and HbA1c as a clinical outcome (McAdam-Marx, 2014). Compliance with drug therapy is important to control blood glucose levels, diabetic ulcer patients must always be provided with optimal health services and this can be achieved through collaboration between health workers.

Non-compliance will have an impact on low quality of life, risk of complications and poor outcomes for diabetes mellitus sufferers (García-Pérez et al., 2013). In addition, poor control of glucose levels in diabetic ulcer patients can delay the process of wound healing, amputation, reamputation and infection. The aim of treating diabetic ulcer therapy is to eliminate complaints, improve and improve quality of life as well as accelerate wound healing and prevent amputation/ reamputation. The success of therapy can be seen from the control of blood glucose levels which is used as a clinical outcome in research (American Diabetes Association, 2018).

The limitation of this research is that there are other variables that need to be controlled because they can influence the results of the analysis of the relationship between treatment adherence and clinical outcomes for diabetic ulcer patients, such as knowledge, self-care and perception of disease. Apart from that, this study did not use HbA1c as a clinical outcome

parameter which better reflects a person's blood glucose control in the last three months compared to blood glucose level.

CONCLUSION

The majority of patients had moderate (49%), low (32%) levels of compliance and achieved clinical outcomes (66%). There is a relationship between adherence to medication use and clinical outcomes (P<0.001). The findings of this study can help patients and healthcare professionals emphasise treatment compliance more in order to attain positive clinical results.

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