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Effectiveness of polyhexamethylene biguanide (PHMB) against odor in diabetic foot ulcer

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Abstract

Background: Diabetic foot ulcer are open wounds on the surface of the skin due to complications of macroangiopathy which causes vascular insufficiency and neuropathy. Odor found in diabetic foot ulcer or wound exudate can indicate the growth of microorganisms in the wound. Efforts that can be made to reduce infections that cause odor in wounds are by carrying out wound care starting at the initial stage of washing the wound. Wound washing using polyhexamethyl biguanide can reduce the odor of diabetic foot ulcer.

Purpose: To determine the effectiveness of polyhexamethylene biguanide against odor in diabetic foot ulcer at Wocare Center Bogor.

Method: This research was a quasi-experiment using a pre-test and post-test one-group design approach with a sample size of 20 people. Data was collected using the Odor assessment scoring tools. With data analysis using paired sample t-test.

Results: Based on the average value before being given PHMB, it was 1.725 and the odor level in diabetic foot ulcers after being given PHMB decreased to 1.200. So after being given PHMB it has been proven to reduce the odor of diabetic foot ulcers. The results of the paired sample t-test showed that the p-value was 0.000, this value was smaller than 0.05.

Conclusion: There was a significant difference in the level of an odor of diabetic foot ulcer between before and after being given PHMB as a fluid for washing the ulcer. polyhexamethylene biguanide is effective as a fluid for washing diabetic foot ulcers at the Wocare Center Bogor Clinic.

Keywords: Diabetic Foot Ulcer; Odor; Polyhexamethylene Biguanide.

INTRODUCTION

The number of people suffering from Diabetes Mellitus continues to increase, with 537 million people suffering from diabetes mellitus it is also stated that there are 3 out of 4 adults with diabetes mellitus in low and middle income countries and the death rate for diabetes mellitus sufferers is 6.7 million people in 2021 and will continue to increase and predicted in 2030, namely 642 million people (International Diabetes Federation, 2021).

As the number of Diabetes Mellitus sufferers increases, this causes an increase in the incidence of diabetes complications, namely Ulcers on the feet

of diabetics, which is one of the complications of diabetes mellitus. There are three factors that support the occurrence of diabetic foot ulcers, namely disturbances in nerves (neuropathy), infection, and blood circulation disorders. Disruption of the nervous system can cause numbness of the skin, as a result of which sufferers cannot feel pain and are not aware of friction or impact on the feet which can cause injuries (Purnomo, 2014). Of all amputation cases in diabetes patients, 85% are preceded by diabetic foot ulcers which then develop into gangrene or severe infection.

The global prevalence of diabetic wounds in the world is 6.3%, where the highest prevalence is in North America, 13%, and the lowest prevalence of diabetic wounds is in Oceania, 3% (Zhang, 2017). In America, the incidence of amputations is increasing, more than 154,000 amputations related to diabetes have occurred in the United States, a very significant increase of 75% in just one decade. Diabetes is the single biggest factor in the incidence of amputation, that is, more than 60% of non-traumatic lower extremity amputations occur in the diabetic population. Every 3 minutes 30 seconds in the United States a limb amputation occurs due to diabetes mellitus (American Diabetes Association, 2023).

Meanwhile, in Asia, it is 5.5% which is higher than in Europe, namely 5.1% (Zhang, 2017). In 2009 MedMarket Diligence, a wound association in America, conducted research on the incidence of wounds in the world, where there were 200,000 cases of amputation per year in the world (Primadina, 2019). The number of Diabetic Wound Sufferers in Indonesia is around 15% with an amputation rate of 30% and a mortality rate of 32% diabetic wounds are the largest cause of hospital care, around 80% for patients with Diabetes Mellitus and it is known that diabetic wound sufferers in Indonesia require quite a lot of money. high of 1.4 million to 1.6 million per month. Every year more than 1 million people lose their legs due to complications from Diabetes Mellitus in the world (Oktorina, 2019). In West Java, the number of diabetes mellitus sufferers was 1,078,875 people with diabetes mellitus in 2020 with the highest incidence rate being in the Bekasi district, namely 242,169 people, while in Bogor City there were 19,694 people with diabetes mellitus (West Java Provincial Health Office, 2023).

Diabetic foot ulcers are open wounds on the surface of the skin due to macroangiopathy complications resulting in vascular insufficiency and neuropathy which can develop into infections due to germs and bacteria entering the wound with high blood sugar levels becoming a strategic place for germ growth (Pouget, Dunyach-Remy, Pantel, Schuldiner, Sotto, & Lavigne, 2020). Infections that occur in the feet of diabetics tend to be difficult to treat because there is damage to the blood vessels

leading to the wound site which results in oxygen, antibiotics, food substances, and immune devices such as leukocytes and others being difficult to reach the wound site and this will, of course, hinder the wound healing process and Chronic wounds will be difficult to heal and will endanger the sufferer's life and amputation is one way out (Purnomo, 2014).

Wound infection is one of the causes of failure in wound healing (Nurlany, Damanik, & Hamka, 2021). Odor in the wound or wound exudate can indicate the growth of microorganisms in the wound (Wijaya, 2018). Bad odors are an annoying problem that produces psychological discomfort and embarrassment among patients and treating physicians and has been shown to increase levels of social isolation (Akhmetova, 2016).

Nursing intervention is the third stage of the nursing process. After finding the correct nursing diagnosis, the nurse determines and prepares the implementation of nursing interventions to be implemented when providing nursing care. All actions taken are based on the nursing process. The role of nurses is very important in caring for patients with diabetic wounds, namely providing wound care to patients who have diabetic wounds (Kamal, Munahar, Abbas, Ito, & Wahyudi, 2021). Previous wound management not yet familiar with the existence of a moist wound environment and using conventional methods which only apply normal saline or NaCl 0.9% to the wound and add povidone iodine which is then covered with dry gauze to treat the wound but the next day the gauze sticks to the wound and causes pain in the wound. patients and new tissue become damaged again, so optimal wound care methods are needed using modern dressing methods that can maintain a moist wound environment (Handayani, 2016).

Efforts that can be made to reduce infections that cause odor in wounds are by carrying out wound care starting at the initial stage of washing the wound. Wound washing is an integral part of wound management, both acute and chronic wounds. The washing fluid that should be used is not toxic to living tissue, remains effective in the presence of organic materials, can reduce the number of microorganisms, does not cause sensitive reactions, and is cost-effective. The solution that is widely used in wound care clinical practice is polyhexamethyl

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biguanide (Ruran, 2021). Polyhexamethyl biguanide is a wound care product that contains antimicrobials. PHMB contains synthetic compounds that have the same chemical elements as Anti-Microbial Peptides (AMP) in keratinocytes and neutrophils, so it is effective in healing wounds (Efendi, 2019).

The decrease in the odor of diabetic ulcers after wound treatment using Polyhexamethyl biguanide was mostly odorless, namely 7 people (58.3%) with a p value = 0.00, so there was a significant difference in the odor of diabetic foot ulcers given Polyhexamethyl biguanide (Putri, 2022).

RESEARCH METHOD

This research design is quasi-experimental using a one group pretest and posttest approach. This research design aims to provide researchers with a clear and structured path in their research. In this research, the researcher intervenes on the variables studied and Quasi-experimental research is often called interventional research. In this study, research subjects will be pretested before the intervention, and after that, they will be given a posttest to see the score results from the intervention carried out.

The sample in this study was 20 participants who had diabetic wounds and there was an odor in the diabetic wounds and were willing to be participants in this study, which was carried out at the Wocare Center Bogor Clinic located at Jl. Sholeh Iskandar No. 9 Cibadak, Tanah Sereal District, Bogor City, West Java. This study was conducted from May to August 2023.

The instrument in this study used the Odor Assessment Scoring Tool Sheet. The Odor Assessment Scoring Tool is a measuring tool sheet

that contains scores that refer to the level of odor in diabetic foot ulcers, as well as demographic data of participants. The score on the diabetic foot ulcer odor observation sheet has 4 points, namely: None: if there is no odor when next to the client with an open dressing; Low: if the odor is smelled when near the client with an open dressing; Moderate: if the odor is smelled 2-3 meters from the client with the dressing already open; High: if the odor is smelled 2-3 meters from the client with the dressing intact and not open (Wijaya, 2018).

Before intervening on the wound, the researcher will observe the diabetic wound in the patient using the Odor Assessment Scoring Tool to see if there is any odor or smell in the diabetic wound and then the researcher will document the diabetic wound suffered by the patient. After observing the patient's diabetic wound, the researcher will then intervene on the patient by washing the wound using Polyhexamethylene Biguanide as a wound washing fluid for 7 days in 2 wound treatments. Then the researcher will observe again using the Odor Assessment Scoring Tool observation sheet to see how effective the use of Polyhexamethylene Biguanide is on the odor in diabetic wounds and then the researcher will document the wound again.

In this study, the researcher used the Paired sample t-test dependent which was used to compare the results of measurements before and after the intervention was carried out on participants. This research has been declared ethically appropriate according to the seven WHO 2011 standards by the Research Ethics Committee of Pasar Rebo Regional General Hospital with the number: 3554/DL.01.

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RESEARCH RESULTS

Table 1. Characteristic of Participant (N=20)

Variables	Results
Age (n/%) (Mean±SD)(Range)(Year)	(60.8±8.170)(23-71)
19-44 Years	2/10
45-59 Years	8/40
≥ 60 Years	10/50
Gender (n/%)	
Male	7/35
Female	13/65
Diabetic Foot Ulcer Odor Before	
High	1/5
Moderate	4/20
Low	15/75
None	0/0
Diabetic Foot Ulcer Odor After	
High	0/0
Moderate	1/5
Low	12/60
None	7/35

Based on Table 1, the frequency distribution of participants based on age with a mean and standard deviation (60.8±8.170) with an age range between 23 to 71 years, the majority were female, as many as 13 (65%).

Diabetic foot wound odor before PHMB was given, it showed a high diabetic wound odor of 1 (5%), moderate 4 (20%), low 15 (75%), and no participants had no odor in diabetic wounds. While the odor of diabetic wounds after PHMB was given showed no participants had a high wound odor, moderate 1 (5%), low 12 (60%), and no odor 7 (35%).

Table 2. Diabetic Foot Ulcer Odor Level Normality Test

Variable	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistik	df	Sig.	Statistik	df	Sig
Odor Diabetic Foot Ulcer						
Before being given PHMB	0,134	20	0,200	0,924	20	0,120
After being given PHMB	0,127	20	0,200	0,922	20	0,107

Based on Table 2, the results of the Shapiro-Wilk normality test, the Odor value for Diabetic foot ulcers before being given PHMB was 0.120 > 0.05 and the Odor for diabetic foot wounds after being given PHMB was 0.107 > 0.05, which means the data is normally distributed or is parametric data. This shows that data testing can use the paired sample t test.

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Table 3. Paired Sample Statistic Test for Differences in Mean Diabetic Foot Ulcer Odor Levels (N=20)

Variable	Results	
	Mean ± SD	Std. Error Mean
Odor Diabetic Foot Ulcer		
Before being given PHMB	1.725±0.5210	0.1165
After being given PHMB	1.200±0.6366	0.1423

Table 4. Paired Sample T-Test for Differences in Diabetic Foot Ulcer Odor Levels (N=20)

Variable	Results		
	Mean ± SD	t	Std. Error Mean
Odor Diabetic Foot Ulcer Before and After being given PHMB	0.5250±0.5210	4.373	0.1165

Based on Table 3, The results of the test for the difference in the average level of Diabetic foot ulcer odor before and after the use of Polyhexamethylene Biguanide using the paired sample t-test showed that the average value before being given PHMB was 1.725 and the odor level in diabetic wounds after being given PHMB decreased to 1.200. So after being given PHMB it has been proven to reduce the odor of diabetic wounds. Furthermore based on table 4, obtained a p-value of 0.000, this value is smaller than 0.05, so it can be concluded that there is a significant difference in the level of odor of diabetic foot ulcer between before and after being given PHMB as a liquid for washing the ulcer.

DISCUSSION

Based on the results of the study, the age of participants with diabetes wounds at the Wocare Center Clinic in Bogor was mostly elderly people over 60 years, 10 participants or 50%. Gender is the second factor in the occurrence of diabetic ulcers. The results showed that most participants were female, namely 13 participants or 65%. The results of the bivariate analysis with a test of differences in the values of the diabetic wound odor observation sheet before and after being given Polyhexamethyl biguanide using the paired sample t-test obtained a p value of 0.000 ($p < 0.05$) which means that H_0 is rejected and H_a is accepted which means there is a difference in observation values before and after being given Polyhexamethyl biguanide. Based on the

average value of Pretest 1.725 and Posttest 1.200, it means that there is a decrease in the level of odor after being given Polyhexamethyl biguanide in diabetic ulcers.

This is in line with research conducted at Dr. H. Abdul Moeloek Hospital, Lampung Province, where the majority of diabetic foot ulcer sufferers are elderly people aged 56-65 years as many as 55 respondents (46.2%) in and stated that people aged >60 years or more are more at risk of experiencing diabetic ulcers with diabetic wounds because at that age body function decreases due to the degenerative process and this is because in the elderly there is glucose intolerance which causes a decrease in the ability of β cells to produce insulin (Detty, Fitriyani, Prasetya, & Florentina, 2020). People with Diabetes Mellitus have a greater risk of experiencing diabetic wound complications. Gender factors can also influence the occurrence of diabetic wounds based on research by researchers showing that the majority of women are 13 participants or 65%. This is in line with previous research which stated that women are more at risk of experiencing diabetic ulcers due to decreased estrogen hormones due to menopause. The hormones estrogen and progesterone can affect cells to respond to insulin because after women experience menopause, hormonal changes trigger fluctuations in blood sugar levels. When women experience menopause, these two hormones experience a decrease in production which results in disruption of glucose metabolism

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and blood sugar control. Unlike women, men have the hormone testosterone which does not function in controlling blood sugar levels but affects the formation of bone muscle, so it can be concluded that women are more at risk of developing diabetic foot ulcers (Audrey, Wisnu, & Tahapary, 2022).

According to researchers, age has a big influence on the occurrence of diabetic wounds, where older people are more likely not to take care of their feet, this is due to a lack of knowledge and information which has an impact on participants, causing the risk of complications from chronic wounds, which often cause odor in the wounds. As you get older your ability to see will also decrease which will result in the risk of injury and perfusion disorders and the immune system will also decrease which will result in diabetic wounds which will cause odor if they experience infection due to improper handling. According to researchers, everyone certainly has a risk of developing DM. However, based on the research above, women are more at risk of developing diabetic ulcers compared to men, because women tend to have less activity and therefore burn less carbohydrates or glucose than men. Apart from that, researchers assume that women who enter menopause will experience hormonal changes, one of which is a decrease in the hormones estrogen and progesterone, which will result in a buildup of blood sugar levels.

Polyhexamethylene Biguanide also known as polyhexanide is a polymerized biguanide compound used as a broad-spectrum antiseptic, disinfectant, and preservative. Effective against various pathogens including *Escherichia coli*, *Staphylococcus Epidermis*, and even *Ancanthamoeba Castellanii* (Worsley, Vassileva, Tsui, Song, & Good, 2019).

This is in line with previous studies examining the differences in the effectiveness of polyhexamethyl biguanide and octenidine solutions to eliminate odors in diabetic ulcers, where there was a decrease in the odor of diabetic wounds after wound care using polyhexamethyl biguanide most of which became odorless as many as 7 people (58.3%) (Putri, 2022). The odor in diabetic wounds will harm the patient's quality of life where the patient will feel less confident, feel guilty and often the patient's family complains that they are very disturbed by the odor

caused by the respondent's diabetic foot ulcers which makes the patient not want to leave the room and isolate themselves. This is also in line with research on the diabetic wound care process, all respondents were treated using washing procedures, removing dead tissue, and changing dressings (Probst, Saini, & Skinner, 2019). To eliminate the odor of diabetic wounds, after the wound is washed using soap, spray Polyhexamethylene Biguanide thoroughly on the diabetic wound, then leave it for 10 minutes with a gauze compress containing Polyhexamethylene Biguanide, then perform mechanical debridement techniques to remove dead tissue, which aims to improve the granulation process in the wound healing process (Hamid & Ibrahim, 2017).

The research results show that all participants who used Polyhexamethylene Biguanide wound-washing liquid showed no side effects when using it, which means this liquid is safe for the body. Modern dressing techniques using moist techniques in wound care also need to be noted that the dressing must be changed immediately if the dressing gets wet because of large amounts of exudate, especially if the dressing oozes out of the dressing which causes the dressing to smell and look dirty.

CONCLUSION

In the paired sample t-test, the sig. (2-tailed) result was 0.000, this value is smaller than 0.05, which means that there is a significant difference in the level of odor of diabetic wounds before and after PHMB is given as a diabetic wound washing fluid. Polyhexamethylene Biguanide (PHMB) is effective as a diabetic wound washing fluid at the Wocare Center Bogor clinic.

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