The Relationship between Germ Patterns and Severity of Diabetic Ulcers Based on Wagner's Score at Dr. M. Djamil General Hospital Padang

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A B S T R A C T

Background: Diabetes Mellitus (DM) is a condition of increasing blood sugar levels which increases the risk of macrovascular and microvascular damage, thereby reducing the quality of life of the sufferer. One of the common complications in people with diabetes mellitus is diabetic ulcers. The classification system commonly used to determine the degree of diabetic ulcers is Wagner's criteria, which consists of 5 degrees of severity. Diabetic wounds become a place for bacterial growth and the production of exudate, which results in a longer healing process and causes tissue damage. **Methods:** This study is a cross-sectional analytic observational study in diabetic ulcer patients treated at Dr. M. Djamil General Hospital Padang. The sampling technique in this study was consecutive sampling. The subjects of this study amounted to 36 people, with the majority aged >50 years and the female sex being found more than the male. Data analysis was performed using SPSS version 25 through univariate and bivariate analysis. **Results:** The grades of diabetic ulcers in the treated patients ranged from mild to severe. All subjects in this study had monomicrobial results. Gram-negative bacteria were the most commonly found, namely, 77.8%. In this study, there was no significant relationship between bacterial patterns and the severity of diabetic ulcers based on Wagner in patients treated at Dr. M Djamil General Hospital Padang (p-value > 0.05). **Conclusion:** *Klebsiella sp is* the most common type of bacteria that causes diabetic ulcers. No polymicrobial bacteria were found in this study. No correlation was found between the pattern of germs and the severity of diabetic ulcers in patients treated at Dr. M Djamil General Hospital, Padang.

1. Introduction

Diabetes Mellitus (DM) is a condition of increased blood sugar levels that can increase the risk of macrovascular and microvascular damage, thereby reducing the quality of life of the sufferer. Diabetes Mellitus (DM) is a disease that has a high prevalence rate. Globally, there are 451 million DM sufferers aged 18-99 years, and it is estimated that this will increase to 693 million by 2045.[1] Indonesia is ranked the 9th highest in the world with 10.3 million people with diabetes. According to Riskesdas data (Basic Health Research), the prevalence of diabetes mellitus based on blood sugar examinations in 2013 reached 6.9% and increased to 10.9% in 2018.[1,2]

Diabetic ulcers are one of the common complications that occur in patients with diabetes mellitus. Limited mobility and slow wound healing lead to increased susceptibility to infection. Diabetic wounds become a place for bacterial growth and the production of exudate, which results in a longer healing process and causes tissue damage. Classification of diabetic ulcers is needed to determine the type of lesion being treated, determine the appropriate treatment strategy, and provide an understanding of diabetic ulcers. Until now, the classification system commonly used to determine the degree of diabetic ulcers is the Wagner criteria, which

consists of 5 degrees of severity.[3,4,5]

Infection is the main reason for DM patients with ulcer/gangrene complications to undergo treatment and treatment in the hospital. Infection occurs due to open sores on the feet that allow bacteria to enter and grow and spread. Several studies have been conducted on the causative bacteria in diabetic ulcers. The results of research by Akhi *et al.* in 2015 stated that infections in diabetic ulcer patients were mostly caused by poly microbial consisting of aerobic bacteria such as *Staphylococcus aureus* (28%), *Enterobacteriaceae* (24%), *Escherichiacoli* (15%), *Citrobacter* spp. (4%), *Enterobacter* spp. (4%), and *Staphylococcus* spp. coagulase-negative (17%), *Enterococcus* spp. (15%), *Pseudomonas aeruginosa* (7%) and *Acinetobacter* spp. (4%). While the anaerobic bacteria obtained *Bacteroides fragilis* (4%).[4,6]

A study showed that diabetic ulcers were mostly caused by polymicrobial (72%) compared to monomicrobial (28%). However, another study showed different results. From 62 cases of diabetic ulcer infection, it was found that the infection was mostly caused by monomicrobial (63.82%) during polymicrobial (26.9%), and the acquisition of Gram-negative bacteria as much as 66.3% and Gram-negative bacteria. Positive 33.7%. The bacteria that are often isolated from gangrene or wounds of DM patients are gram-positive *cocci* and gram-negative bacteria *Enterobacteriaceae.* The results of another study stated that *S. aureus* was the dominant bacterium in 43.2% of 100 diabetic ulcer patients and the rest consisted of several gram-negative bacteria. Bacterial isolation is carried out to separate the culture or mixture of bacteria using culture media so that pure cultures are obtained.[5,6,7]

Bacteria that cause diabetic ulcers are associated with the severity of ulcers. International Working Group on the Diabetic Foot (IWGFD) stated that moderate or severe diabetic ulcers tend to have gram-negative bacterial colonies compared to low grades, which are generally caused by gram-positive bacteria. This is in accordance with studies, which state that low grades (grade 1 / grade 2) are generally caused by

gram-positive and high-grade caused by gram-negative with a ratio (5:1). The number of bacterial colonies also affects the severity of diabetic ulcers. Polymicrobial causes ulcers with a heavier grade than monomicrobial.[7]. Ulcer patients' diabetic postoperative perioperative mortality rate for diabetic ulcer amputations in the UK is 10-15%. While the data at the Dr. M. Djamil Padang recorded that from 2019 to 2021, there were 175 amputations out of a total of 426 diabetic ulcer patients who were treated[3,4] This study aims to determine the relationship between germ patterns and the severity of diabetic ulcers based on Wagner's score at Dr. M. Djamil General Hospital Padang.

2. Methods

The design of this study was a cross-sectional analytic observational study on the relationship between pathogenic bacteria and Wagner's score in diabetic ulcer patients at Dr. M. Djamil General Hospital Padang. A total of 36 research subjects participated in this study, where the research subjects met the inclusion criteria, namely diabetic ulcer patients who had the first culture performed and the Wagner degree determined at M Djamil Hospital Padang recorded in the medical record. Sampling was done by consecutive sampling. This study has been approved by the Medical and Health Research Ethics Committee, Dr. M. Djamil General Hospital Padang.

The severity of diabetic ulcers was determined based on secondary data in the medical record that referred to Wagner's score. Wagner's score of grade 2 has an ulcer that extends to the tendon, bone, and capsule. Grade 3 has a deep ulcer with osteomyelitis and abscess. Grade 4 has gangrene of the fingers or forefoot, and grade 5 has gangrene of the midfoot or hindfoot. The pattern of bacteria was determined based on secondary data in the medical record, which was the result of microorganism culture from the appearance of diabetic ulcers.

Data analysis was carried out with the help of SPSS version 25 software. Univariate analysis was used to see the distribution of data for each characteristic and

displayed in the form of tables or diagrams. Bivariate analysis was performed to assess the relationship between gram-positive and gram-negative patterns with the degree of pedis Wagner's Score in patients with diabetic ulcers. Analytical test Chi-square was performed to assess the relationship between variables.

3. Results

Table 1 shows that the age of diabetic ulcer patients hospitalized at Dr. M Djamil is above 50 years of age, and the sex is mostly female. The average blood sugar level when the patients were treated was >200, namely 27 people (75%). A total of 16 patients had comorbidities. The most common type of comorbidity is CKD.

The most common types of culture found were gram-negative bacteria, with 28 samples (77.8%). There were 3 samples that did not have bacterial growth (8.3%). All samples studied consisted of monomicrobial. The highest Wagner degree was grade 2, which was found in 15 patients.

Table 1. Characteristics of research subjects

Characteristics	Frequency	%
Age		
>50 years	21	58.3
≤50 years	15	41.7
Gender		
Male	17	47.2
Female	19	52.8
Current Blood Sugar (GDS)		
>200	27	75.0
≤200	9	25.0
Comorbid		
Yes	16	44.4
None	20	55.6
Types of Comorbid		
Chronic Kidney Disease	6	37.5
Chronic Arterial Disease	2	12.5
Bronchopneumonia	1	6.25
Hypertension+ Chronic Kidney Disease	3	18.75
Chronic Arterial Disease+ Hypertension	2	12.5
Tuberculosis Pulmonary+ Chronic Kidney Disease	2	12.5
Type of Culture		
Gram-Negative	28	77.8
Gram-Positive	5	13.9
No Growth	3	8.3
Number of germs		
Polymicrobial	36	100
Monomicrobial	0	0
Wagner's Degree		
Degree 2	15	41.7
Degree 3	7	19.4
Degree 4	7	19.4
Degree 5	7	19.4

Table 2 shows that the majority of bacterial cultures of the research subjects had *Klebsiella sp*, as many as 8 people (22.2%). Followed by *Escherichia coli* in as many as 6 people (16.7%) and *Acinetobacter baumannii* in as many as 5 people (13.9%).

Table 2. Types of diabetic ulcer bacteria

Type of germ	Frequency	%
Gram-negative bacteria	**28**	**77.8**
Acinetobacter baumannii	5	13.9
Citrobacter koseri	1	2.8
Escherichia coli	6	16.7
Klebsiella pneumoniae	3	8.3
Klebsiella sp	8	22.2
Proteus mirabilis	3	8.3
Pseudomonas aeruginosa	1	2.8
Yersinia enterocolitica	1	2.8
Gram-positive bacteria	**5**	**13.9**
Staphylococcus aureus	3	8.3
Staphylococcus epidermidis	2	5.6

Tables 3 and 4 show that mild-moderate diabetic ulcer patients had 17 gram-negative and 3 gram-positive cultures. Meanwhile, patients with severe grades found 11 patients with gram-negative bacteria culture results and 2 people with gram-positive bacteria culture results. Based on the results of statistical tests, there was no significant relationship between the pattern of bacteria and the severity of diabetic ulcers based on Wagner's score in patients treated at Dr. M. Djamil General Hospital Padang.

Table 3. Relationship of germ pattern with Wagner's degree

Wagner's degree	Germ pattern				*p-value*
	Gram-Negative		**Gram-Positive**		
	f	**%**	**f**	**%**	
Degree 2	13	86.7	2	13.3	
Degree 3	4	80.0	1	20.0	***0.535***
Degree 4	6	100.0	0	0.0	
Degree 5	5	71.4	2	28.6	

*p <0.05 significant

Table 4. Relationship between germ pattern and Wagner's degree by category (moderate, severe)

Wagner's Degree	Germ Pattern				*p-value*
	Gram-Negative		**Gram-Positive**		
	f	**%**	**f**	**%**	
Moderate (Grade 2-3)	17	85.0	3	15.0	***0.976***
Severe (Grade 4- 5)	11	84.6	2	15.4	

*p<0.05 significant

4. Discussion

The most common gram-negative bacteria found was *Klebsiella sp,* while the most common gram-positive bacteria was *Staphylococcus aureus.* This is in accordance with a study that reported that the most gram-positive bacteria found in diabetic ulcer patients was *Staphylococcus aureus* (32.9%). Previous studies reported that *Staphylococcus aureus* was the most common type of gram-positive bacteria found in diabetic ulcers. However, there is a difference in gram-negative, where the most commonly obtained bacterial culture is *Escherichia coli* (20%) and followed by *Klebsiella sp* (11.89%).[8,9] All subjects in this study had monomicrobial culture results, and no polymicrobial culture was found. A study found more monomicrobial than polymicrobial cultures, namely 55.6% and

44.4%, respectively. Similar results were also reported in a study that reported that monomicrobial bacteria were found to be 63.82% and polymicrobial at 26.9%. However, other studies reported different results, where polymicrobial were more abundant than monomicrobial, namely 72% and 28%, respectively. Some of the possible causes of bias in this study include inappropriate sampling techniques and locations and inappropriate cultural media used.[10-14] The most common degree of Wagner's is grade 2. This is in accordance with a study that reported that the severity of diabetic ulcers in patients was grades 1 and 2, which was 30%.[15]

Gram-negative bacteria are more dominantly found in diabetic ulcer patients in both mild and severe degrees. Of all subjects, 85% mild-moderate gram-negative bacteria and 84.6% severe gram-negative bacteria were found. Meanwhile, gram-positive bacteria were found at 15% in mild-moderate and 15.4% in severe degrees. Based on the results of statistical tests, it is known that there is no significant relationship between the pattern of germs and the severity of ulcers based on Wagner's score in diabetic ulcer patients who are treated at Dr. M. Djamil General Hospital Padang (p-value > 0.05). Another study reported the same thing, where gram-negative bacteria were more dominantly found in mild (64%) to severe (12.9%) diabetic ulcers. Compared with gram-positive bacteria, it was 36.4% in mild and 11.1% in severe. This study also showed that there was no relationship between bacterial patterns and the severity of diabetic ulcers based on Wagner's score.[16-19]

5. Conclusion

Klebsiella sp is the most common type of bacteria that causes diabetic ulcers. No polymicrobial bacteria were found in this study. There was no relationship between the pattern of germs and the severity of diabetic ulcers in patients treated at Dr. M. Djamil General Hospital Padang.

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