Antibiotics Susceptibility Pattern in Diabetic Ulcer Patients

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ABSTRACT

Diabetic ulcers are a chronic complication of diabetes mellitus and have a high risk of infection. Severe ulcer infections are a significant cause of lower-extremity amputations in addition to trauma. Therefore, therapy for diabetic ulcer infections must be performed immediately. This study aimed to determine the bacterial susceptibility pattern to the antibiotic in diabetic ulcer patients. This study was retrospective observational descriptive by taking the results of swab culture and antibiotic susceptibility patterns data in diabetic ulcer patients at Ulin General Hospital, Banjarmasin, in 2016-2018. The results showed 41 (62.1%) monomicrobial infections and 25 (37.9%) polymicrobial infections. The number of Gram-negative bacilli (57.4%) was higher than Gram-positive cocci (42.6%). The most common bacterial isolates on pus culture were *Staphylococcus aureus* (26.6%), *Klebsiella pneumonia* (19.1%), and *Escherichia coli* (12.8%). Antibiotic susceptibility test results showed that Gram-positive bacteria were sensitive to Tigecycline (100%), Nitrofurantoin (96.9%), and Linezolid (96.8%). Gram-negative bacteria were susceptible to Ertapenem (92.7%), Meropenem, and Amikacin (90.6%). *S.aureus* isolates were sensitive 100% to Meropenem and Tigecycline. *K.peneumoniae* and *E.coli* isolates were susceptible 100% to Meropenem and Amikacin. It was concluded in this study that the prevalence of Gram-negative bacteria in diabetic ulcer infection was higher than Gram-positive bacteria. The most common isolated Gram-negative bacteria were *K.pneumoniae* and *E.coli*, while the most common Gram-positive bacteria were *S.aureus.* The most sensitive antibiotics for *K.pneumoniae* and *E.coli* were Meropenem and Amikacin, while the most sensitive antibiotics for S.aureus were Linezolid and Tigecycline.

Keywords: Diabetic ulcer, bacterial pattern, antibiotic susceptibility

INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disease characterized by an increase in blood sugar levels.[1] According to the World Health Organization (WHO), it was estimated that there were 422 million people with DM in 2014 worldwide.[2] According to the International Diabetic Federation (IDF), in 2017, the number of DM patients in Indonesia were 10.3 million people, making Indonesia the 6th country with the highest diabetes patients.[1] RISKESDAS in 2018 showed the number of DM patients increased from 6.9% in 2013 to 8.5% in 2018.[3] It is estimated that 4% of the population or 38.113 people in South Kalimantan were diagnosed with diabetes.[4]

Diabetes mellitus can lead to many complications in the body, and one of them is a diabetic ulcer.[2] Diabetic ulcer is a chronic complication of DM due to macrovascular complications causing vascular insufficiency and neuropathy.[5] The global prevalence of diabetic ulcers is 6.3%.[6] Diabetic ulcers in Indonesia is around 15%. Medical record data at Ulin General Hospital, Banjarmasin, showed an increase in the number of diabetic ulcer patient visits from 2,194 in 2012 to 2,893 in 2013.[7]

About a quarter of people with DM will suffer from diabetic ulcers, and half of them will get an infection.[8] The presence of an ulcer becomes a gap in the entry of bacteria and causes infection.[9] High blood glucose is a media for bacterial growth.[5] According to the American Diabetes Association (ADA), most infections in diabetic ulcers are polymicrobial. The most common cause is Gram-positive aerobes cocci, especially *Staphylococcus aureus*.[10] However, some studies have shown that infections are often caused by Gram-negative bacterias, such as *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli*, and *Proteus spp*.[11-13]

Diabetic ulcer infections are usually treated by administering antibiotics.[10] Empirical antibiotic therapy is selected based on the patient's clinical condition, Gram staining results, and the pattern of bacteria often isolated and sensitive to antibiotics.[8] Several studies have shown that Gram-positive bacterias are most sensitive to Imipenem and Linezolid.[8,12,13] Also, the most effective antibiotics for

Gram-negative isolates are Amikacin, Imipenem, and Meropenem.[13,14] Various studies have reported the high prevalence of Multidrug-Resistant Organisms (MDROs) in diabetic ulcer infections. Therefore, guidelines are needed for empirical antibiotic therapy for the sake of effective treatment to reduce resistance patterns, risk of complications, and health care costs.[11,12]

There are no empirical antibiotic therapy guidelines for diabetic ulcer patients in Ulin General Hospital, Banjarmasin. Therefore, this study aimed to determine the antibiotic's bacterial susceptibility pattern in diabetic ulcer patients at Ulin General Hospital. It was expected that this study's results could be helpful as a guide for the selection of appropriate empirical antibiotics.

METHODS

This study used a retrospective descriptive observational method using secondary data of swab culture results and antibiotic susceptibility patterns data in diabetic ulcer patients in the Clinical Pathology Laboratory of Ulin General Hospital in the period of 2016-2018. The results of bacterial antibiotics susceptibility were identified automatically using the VITEK® 2 Compact instrument. The results obtained have been validated, interpreted, and categorized as susceptible, intermediate, and resistant according to the Clinical Laboratory Standard Institute (CLSI) criteria.

RESULTS AND DISCUSSION

In this study, 66 out of 70 cultures (94.3%) showed positive and 4 (5.7%) showed negative results. Throughout 2016-2018, the results of positive culture were more dominant than negative culture. Similar results were obtained from research by Yi *et al.* at three district hospitals, Malaysia, and Saraswathy *et al.* at a tertiary care hospital, India showed that positive results were more dominant in the culture, with percentages of 67.6% and 77%.[13,15] Positive culture results might be influenced by inappropriate use of antibiotics in the initial treatment. According to IDSA, empirical antibiotics given in mild and moderate infections is a narrow-spectrum antibiotic, because it is commonly caused by is *Staphylococcus aureus*. Patients with symptoms of severe/chronic infection are given broad-spectrum antibiotics.[10] In the pre-analytical stage, the specimen collection technique also affects the culture results. Swabs are collected from the wound area after cleaning with sterile gauze and

saline solution 0.9% and then debrided (removal of necrotic tissue and foreign bodies). Specimens are collected from the wound bed and placed in a sterile transport container to be sent to the microbiology laboratory and processed.[16]

This study showed a higher number of monomicrobial infections (62.1%) than polymicrobial infection (37.9%). Similar results were obtained from research by Patil *et al.* and Jain *et al.* throughout the period of 2015-2016 in India, with the percentage of monomicrobial and polymicrobial infection was 65.3% and 64%, respectively.[11,12] In general, the nature of the infection in diabetic ulcers can be influenced by its severity. Monomicrobial isolates are more common in mild infections and had lower levels of bacterial virulence, whereas polymicrobial isolates are more common in severe/chronic infections.[13,16]

There were 94 bacterial isolates from 66 positive culture specimens consisting of 40 (42.6%) Gram-positive isolates and 54 (57.4%) Gram-negative isolates. This study's results were similar to studies by Jain *et al.* at a tertiary care center in North-East India, which showed that Gram-negative bacteria were more commonly isolated.[12] The distribution of bacteria is shown in Table 1.

In this study, the most frequently isolated bacteria were *S.aureus* (26.60%), followed by *K. pneumoniae* (19.1%) and *E.coli* (12.8%). These results were consistent with previous studies by Perim *et al.* at Geral de Palmas Hospital, Brazil, which showed that *S.aureus* was the primary pathogen in diabetic ulcer infection.[8] *S.aureus* is a normal flora of the skin and mucosa, and infection can occur due to direct contamination of the wound. *S.aureus* has a number of surface proteins as the virulence factor that mediates the attachment of bacteria to host cells. Microbial surface components recognizing adhesive matrix molecules also have an important role in producing bacterial aggregation, forming colonization, and invasion of *S.aureus*.[17] In this study, there were five species of negative coagulase *Staphylococcus* consisting of *Kocuria kristinae* (7.4%), *S.Haemolyticus* (2.1%), *S.Sciuri* (2.1%), *S.epidermidis* (1.1%), and *S.galinarum* (1.1%). Cases of diabetic ulcer infection by *K.kristinae* are rare; however, it has been mentioned in previous studies by Noor *et al.* throughout 2013-2015 at Sardjito General Hospital that *K.kritinae* is a pathogen in diabetic ulcers.[18]

In this study, the most frequently isolated Gram-negative bacteria were *Klebsiella pneumoniae* (19.1%) and *Escherichia coli* (12.8%). Similar results were obtained from research by Patil *et al.* in India.[11] *P.aeruginosa* isolates were found in small amounts

(5.3%). A similar result was obtained in study by Perim *et al.* at Geral de Palmas Hospital, Brazil, which showed that *P.aeruginosa* isolates were merely 4.5%.[8] *P.aeruginosa* produces extracellular enzymes such as elastase, protease, and two types of hemolysin as part of bacterial virulence factors and produces exotoxin A, which can cause tissue necrosis.[17] Several antibiotics are the treatment of choice for diabetic ulcers, and each bacterium shows a different sensitivity.[7] The susceptibility of antibiotics to Gram-positive bacteria is shown in Table 2.

Table 1. Distribution of bacterial isolates

Gram-Positive Bacteria	2016	2017	2018	Frequency	%
Staphylococcus aureus	9	8	8	25	26.6
Kocuria kristinae	2	1	4	7	7.4
Staphylococcus pseudintermedius	1	0	1	2	2.1
Staphylococcus sciuri	2	0	0	2	2.1
Staphylococcus haemolyticus	1	0	1	2	2.1
Staphylococcus epidermidis	1	0	0	1	1.1
Staphylococcus galinarum	0	0	1	1	1.1
Gram-Negative Bacteria	**2016**	**2017**	**2018**	**Frequency**	**%**
Klebsiella pneumoniae	9	3	6	18	19.1
Escherichia coli	5	3	4	12	12.8
Pseudomonas aeruginosa	1	2	2	5	5.3
Proteus mirabilis	2	0	3	5	5.3
Acinetobacter baumannnii complex	1	0	2	3	3.2
Achromobacter xylosoxidans	3	0	0	3	3.2
Citrobacter freundii	1	1	0	2	2.1
Enterobacter cloacae	0	1	1	2	2.1
Pseudomonas fluorescens	0	0	1	1	1.1
Serratia marcescens	0	1	0	1	1.1
Raoultella ornithinolytica	0	1	0	1	1.1
Pantoea spp.	1	0	0	1	1.1
Total	39	21	34	94	100

Table 2. Antibiotics susceptibility pattern of Gram-positive bacteria

Antibiotic	Antibiotics Susceptibility of Gram-Positive Bacteria (n=32)			
	Total	Sensitive n (%)	Intermediate n (%)	Resistant n (%)
Benzylpenicillin	32	0 (0)	0 (0)	32 (100)
Amoxicillin/Clavulanic acid	27	8 (29.6)	0 (0)	19 (70.4)
Dicloxacillin	27	9 (33.3)	0 (0)	18 (66.7)
Oxacillin	32	9 (28.1)	0 (0)	23 (71.9)
Ertapenem	27	9 (33.3)	0 (0)	18 (66.7)
Imipenem	27	9 (33.3)	0 (0)	18 (66.7)
Gentamicin	32	23 (71.9)	1 (3.1)	8 (25)
Ciprofloxacin	32	16 (50)	2 (6.3)	14 (43.7)
Levofloxacin	32	17 (53.1)	2 (6.3)	13 (40.6)
Moxifloxacin	31	21 (67.7)	3 (9.7)	7 (22.6)
Erythromycin	32	17 (53.1)	0 (0)	15 (46.9)
Clindamycin	32	17 (53.1)	0 (0)	15 (46.9)
Linezolid	31	30 (96.8)	0 (0)	1 (3.2)
Vancomycin	32	24 (75)	0 (0)	8 (25)
Tetracycline	32	8 (25)	0 (0)	24 (75)
Tigecycline	29	29 (100)	0 (0)	0 (0)
Nitrofurantoin	32	31 (96.9)	0 (0)	1 (3.1)
Rifampicin	32	28 (87.5)	0 (0)	4 (12.5)
Trimethoprim/Sulfamethoxazole	32	25 (78.1)	0 (0)	7 (21.9)

This study indicated that the most sensitive antibiotic for Gram-positive bacteria was Tigecycline (100%). Tigecycline is a member of glycylcyclines derivatives of minocycline, which works by inhibiting bacterial cell protein synthesis. Tigecycline inhibits Gram-positive and Gram-negative and anaerobic bacteria. In this study, Gram-positive was sensitive to nitrofurantoin (96.9%). Nitrofurantoin is a bactericidal agent for many Gram-positive and negative bacteria (except *P.aeruginosa*). The results of this study indicated that linezolid was sensitive (96.8%) to Gram-positive bacteria. Linezolid is an oxazolidinone antibiotic that has a unique mechanism by inhibiting bacterial cell protein synthesis stages, especially in Gram-positive. The compounds in this drug interfere with the translation process by inhibiting N-formyl methionyl-tRNA formation, the initiation complex in the 23S ribosome.[17] Previous studies by Patil *et al.* and Jain *et al.* in India also showed linezolid as the most effective antibiotic for Gram-positive infections.[11,12]

In this study, Trimethoprim/Sulfamethoxazole was sensitive (78.1%) to Gram-positive bacteria. This antibiotic is a combination of sulfonamide-class antibiotics with dihydrofolate reductase inhibitors. Trimethoprim antibiotics combined with a sulfonamide can inhibit sequential stages in the formation of folate, thus enabling the synergism of both drugs' activity.[19] Gram-positive showed sensitivity to Vancomycin (75%). Vancomycin is a member of the glycopeptide group and is bactericidal for *Staphylococcus spp.* and several Gram-negative bacteria. Vancomycin act by inhibiting the early stages of the peptidoglycan synthesis process.[17] The susceptibility of antibiotics in Gram-negative bacteria is shown in Table 3.

In the present study, Gram-negative was sensitive to Ertapenem (92.7%), Meropenem, and Amikacin (90.6%). Similar results were obtained in research by Yi *et al.* in Malaysia, which showed that Gram-negative was most sensitive to Ertapenem (100%), Amikacin (100%), and Meropenem (98.9%).[13] Carbapenem has a broader spectrum of action compared to Penicillin, Cephalosporin, and a combination of β-lactam/β-lactamase inhibitors. Carbapenems have better stability to the β-lactamase enzyme compared to other β-lactam antibiotics. Therefore, Carbapenems are very active against the Gram-negative group of β-lactamase-producing enzymes.[19] In this study, the aminoglycoside Amikacin was still sensitive (90.6%) for Gram-negative isolates. Meanwhile, Gentamicin has lower sensitivity (67.9%). Aminoglycosides act by inhibiting bacterial cell protein synthesis by attaching to and inhibiting the function of the 30S subunit of ribosomes and are widely used against Gram-negative bacteria.[19] Antibiotic susceptibility to Gram-positive isolates is shown in Table 4.

S.aureus isolates were sensitive to Linezolid (100%), Tigecycline (100%), Rifampicin (96%), and Vancomycin (80%). Similar results were obtained from research by Jain *et al.*, which showed that *S.aureus* isolates were sensitive to Linezolid (100%), Vancomycin (100%), and Tigecycline (89%).[12]

Table 3. Antibiotics susceptibility pattern of Gram-negative bacteria

Antibiotic	Antibiotics Susceptibility of Gram-Negative Bacteria (N=53)			
	Total	Sensitive n (%)	Intermediate n (%)	Resistant n (%)
Ampicillin	49	4 (8.2)	0 (0)	45 (91.8)
Ampicillin/Sulbactam	50	13 (26)	6 (12)	31 (62)
Piperacillin/Tazobactam	53	42 (79.2)	5 (9.4)	6 (11.3)
Cefazolin	53	13 (24,5)	0 (0)	40 (75.5)
Ceftazidime	53	33 (62.3)	0 (0)	20 (37.7)
Ceftriaxone	49	21 (42.9)	1 (2)	27 (55.1)
Cefepime	53	32 (60.4)	4 (7.6)	17 (32)
Aztreonam	51	22 (43.1)	2 (3.9)	27 (52.9)
Ertapenem	41	38 (92.7)	1 (2.4)	2 (4.9)
Meropenem	53	48 (90.6)	1 (1.9)	4 (7.5)
Amikacin	53	48 (90.6)	0 (0)	5 (9.4)
Gentamicin	53	36 (67.9)	2 (3.8)	15 (28.3)
Ciprofloxacin	53	30 (56.6)	3 (5.7)	20 (37.7)
Tigecycline	53	31 (58.5)	10 (18.9)	12 (22.6)
Nitrofurantoin	49	20 (40.8)	9 (18.4)	20 (40.8)
Trimethoprim/Sulfamethoxazole	51	23 (45.1)	0 (0)	28 (54.9)

Coagulase-negative *Staphylococcus* were shown to be sensitive against Gentamicin, Moxifloxacin, Linezolid, Tigecycline, and Nitrofurantoin. Research by Patil *et al.* showed that linezolid was the most effective antibiotic for coagulase-negative *Staphylococcus* isolates.[11] The susceptibility of antibiotics in Gram-negative isolates is shown in Table 5.

In this study, *Klebsiella pneumoniae* were sensitive to Amikacin (100%), Meropenem (100%), and Ertapenem (94.4%). This result was also consistent with previous research by Nur *et al.* at Zainal Abidin and Meuraxa General Hospital, Aceh, which showed that *K.pneumoniae* were sensitive to Amikacin (97.7%) and Meropenem (97.7%).[14] The results of this study indicated that *Escherichia coli* showed sensitivity (100%) against Amikacin, Ertapenem, and Meropenem. Similar results were obtained from research by Yi *et al.* in Malaysia showed that Amikacin and Carbapenem were the most sensitive antibiotics against *E.coli.*[13] *E.coli* had a 91.7% sensitivity against Piperacillin/Tazobactam, in accordance with the result of a study by Saraswathy *et al.* in India, which showed sensitivity of

Table 4. Antibiotics susceptibility pattern of Gram-positive bacterial isolates

Antibiotic	Antibiotics Susceptibility of Gram-Positive Bacterial Isolates				
	S. aureus (=25) S (%)	*S.pseudintermedius* (n=2) S (%)	*S. sciuri* (n=2) S (%)	*S.haemolyticus* (n=2) S (%)	*S. epidermidis* (n=1) S (%)
Benzylpenicillin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Amoxicillin/Clavulanic acid	8 (33.3)	-	-	0 (0)	0 (0)
Dicloxacillin	9 (37.5)	-	-	0 (0)	0 (0)
Oxacillin	9 (36)	0 (0)	0 (0)	0 (0)	0 (0)
Ertapenem	9 (37.5)	-	-	0 (0)	0 (0)
Imipenem	9 (37.5)	-	-	0 (0)	0 (0)
Gentamicin	17 (68)	1 (50)	2 (100)	2 (100)	1 (100)
Ciprofloxacin	14 (56)	0 (0)	0 (0)	1 (50)	1 (100)
Levofloxacin	14 (56)	0 (0)	2 (100)	0 (0)	1 (100)
Moxifloxacin	15 (60)	1 (100)	2 (100)	2 (100)	1 (100)
Erythromycin	15 (60)	0 (0)	0 (0)	1 (50)	1 (100)
Clindamycin	14 (56)	0 (0)	1 (50)	1 (50)	1 (100)
Linezolid	25 (100)	0 (0)	2 (100)	2 (100)	1 (100)
Vancomycin	20 (80)	0 (0)	1 (50)	2 (100)	1 (100)
Tetracycline	6 (24)	0 (0)	2 (100)	0 (0)	0 (0)
Tigecycline	25 (100)	-	2 (100)	1 (100)	1 (100)
Nitrofurantoin	24 (96)	2 (100)	2 (100)	2 (100)	1 (100)
Rifampicin	24 (96)	0 (0)	1 (50)	2 (100)	1 (100)
Trimethoprim/Sulfamethoxazole	20 (80)	1 (50)	1 (50)	2 (100)	1 (100)

Table 5. Antibiotics susceptibility pattern of Gram-negative bacterial isolates

Antibiotic	Antibiotics Susceptibility of Gram-Negative Bacterial Isolates				
	K.pneumoniae (n=18) S (%)	*E.coli* (n=12) S (%)	*P.aeruginosa* (n=5) S (%)	*P.mirabilis* (n=5) S (%)	*A.baumanni complex* (n=3) S (%)
Ampicillin	0 (0)	3 (25)	0 (0)	1 (20)	0 (0)
Ampicillin/Sulbactam	5 (27.8)	4 (33.3)	0 (0)	1 (20)	1 (33.3)
Piperacillin/Tazobactam	12 (66.7)	11 (91.7)	4 (80)	3 (60)	2 (66.7)
Cefazolin	3 (16.7)	7 (58.3)	0 (0)	2 (40)	0 (0)
Ceftazidime	6 (33.3)	9 (75)	4 (80)	3 (60)	2 (66.7)
Ceftriaxone	5 (27.8)	8 (66.7)	0 (0)	3 (60)	0 (0)
Cepefime	6 (33.3)	10 (83.3)	4 (80)	3 (60)	2 (66.7)
Aztreonam	5 (27.8)	8 (66.7)	2 (40)	2 (40)	0 (0)
Ertapenem	17 (94,4)	12 (100)	0 (0)	3 (60)	0 (0)
Meropenem	18 (100)	12 (100)	3 (60)	3 (60)	2 (66.7)
Amikacin	18 (100)	12 (100)	4 (80)	5 (100)	2 (66.7)
Gentamicin	12 (66.7)	8 (66.7)	3 (60)	4 (80)	2 (66.7)
Ciprofloxacin	9 (50)	7 (58.3)	4 (80)	3 (60)	2 (66,7)
Tigecycline	12 (66.7)	12 (100)	0 (0)	0 (0)	2 (66.7)
Nitrofurantoin	5 (27.8)	12 (100)	0 (0)	0 (0)	0 (0)
Trimethoprim/Sulfamethoxazole	7 (38.9)	5 (41.7)	0 (0)	2 (40)	2 (66.7)

Antibiotic	Antibiotics Susceptibility of Gram-Negative Bacterial Isolates					
	A.xylosoxidans (n=3) S (%)	C.freundii (n=2) S (%)	E.cloacae (n=2) S (%)	P.fluorescens (n=1) S (%)	S.marcescens (n=1) S(%)	R.ornithinolytica (n=1) S(%)
Ampicillin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ampicillin/Sulbactam	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)	1 (100)
Piperacillin/Tazobactam	3 (100)	2 (100)	2 (100)	1 (100)	1 (100)	1 (100)
Cefazolin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)
Ceftazidime	3 (100)	2 (100)	2 (100)	1 (100)	0 (0)	1 (100)
Ceftriaxone	0 (0)	2 (100)	2 (100)	0 (0)	0 (0)	1 (100)
Cepefime	0 (0)	2 (100)	2 (100)	1 (100)	1 (100)	1 (100)
Aztreonam	0 (0)	2 (100)	2 (100)	0 (0)	0 (0)	1 (100)
Ertapenem	0 (0)	2 (100)	2 (100)	0 (0)	1 (100)	1 (100)
Meropenem	3 (100)	2 (100)	2 (100)	1 (100)	1 (100)	1 (100)
Amikacin	0 (0)	2 (100)	2 (100)	1 (100)	1 (100)	1 (100)
Gentamicin	0 (0)	2 (100)	2 (100)	1 (100)	1 (100)	1 (100)
Ciprofloxacin	0 (0)	1 (50)	1 (50)	1 (100)	1 (100)	1 (100)
Tigecycline	0 (0)	1 (50)	2 (100)	0 (0)	1 (100)	1 (100)
Nitrofurantoin	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)	1 (100)
Trimethoprim/Sulfamethoxazole	3 (100)	1 (50)	1 (50)	0 (0)	1 (100)	1(100)

93.3%.[15] Effective antibiotics against *P.aeruginosa* are Amikacin, Ceftazidime, Cefepime, and Ciprofloxacin. This result was also consistent with research by Yi *et al.*, which also showed that *P.aeruginosa* was sensitive to Amikacin (100%), Ceftazidime (95%), Cefepime (95%), and Ciprofloxacin (95%).[13]

However, since this study used secondary data, other factors that might affect the antibiotics susceptibility pattern in diabetic ulcer patients at Ulin General Hospital was unable to be evaluated, such as the clinical condition of the patient, severity of the ulcer, duration of illness, as well as the history of previous antibiotic use.

CONCLUSION AND SUGGESTION

Diabetic ulcers mostly showed monomicrobial infections. Gram-negative bacteria were more commonly isolated than Gram-positive bacteria. The most common bacteria isolated were *S.aureus*, followed by *K.Pneumoniae* and *E.coli*. The most sensitive antibiotics for *S.aureus* were Linezolid, Tigecycline, Nitrofurantoin, and Rifampicin, while the most sensitive antibiotics for *K.pneumoniae* were Meropenem, Ertapenem, and Amikacin. The most sensitive antibiotics for *E.coli* were Ertapenem, Meropenem, Amikacin, Tigecycline, Nitrofurantoin, and Cepefime.

Studies regarding antibiotic susceptibility in diabetic ulcer patients must be conducted periodically to determine the trend of changes in bacterial susceptibility to antibiotics. It was expected that the data obtained in this study could be used as a guide in the selection of appropriate empirical therapy. Further research was needed to determine the pattern of antibiotic sensitivity in diabetic ulcer patients based on the severity of the ulcer according to Meggit Wagner's classification.

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