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BACTERIOLOGICAL PROFILE OF WOUND INFECTION AND ANTIBIOTIC SUSCEPTIBILITY PATTERNS IN A PUBLIC HOSPITAL IN SURABAYA, INDONESIA

PROFIL BAKTERIOLOGIS INFEKSI LUKA DAN POLA KERENTANAN ANTIBIOTIK DI RUMAH SAKIT UMUM DI SURABAYA, INDONESIA

Research Report
Penelitian

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ABSTRACT

Background: *Pyogenic infections that occur can be caused by direct bacterial contamination of the wound, such as infection in a post-surgical wound or infection after trauma. Efforts to control infection can be done with the use of antibiotics.* ***Purpose:*** *To determine the profile of bacteria and antibiotic sensitivity in wound culture in hospitalized patients in Hajj General Hospital Surabaya, East Java in 2021.* ***Method:*** *This study used the Chi-square test and descriptive analysis in the form of distribution tables and percentages using secondary data based on the results of examination of pus culture at the Clinical Microbiology Laboratory in Hajj General Hospital Surabaya, East Java in 2021.* ***Result:*** *The results of research on wound culture samples showed as many as 113 patients (56.22%) with positive culture results, which were predominantly female as many as 59 patients (50.9%) and the highest age category namely at the age of 46-55 years as many as 39 patients (33.6%). Based on bacteria, the most dominant type of bacteria in the Gram-negative group was Escherichia coli ESBL with 21 isolates (26.6%), while Gram-positive bacteria, Staphylococcus aureus, was found in 16 isolates (43.3). The results of antibiotic sensitivity on Gram-negative bacteria were Piperacillin/Tazobactam and Meropenem, and on Gram-positive bacteria Vancomycin and Linezolid were obtained.* ***Conclusion:*** *E. coli and S. aureus are the most important causes of wound infections and the suppressor organisms in this study. Antibiotic susceptibility testing of all isolates showed that the antibiotics amikacin and meropenem were sensitive to Gram-negative bacteria especially ESBL-producing bacteria, and the antibiotics vancomycin and linezolid were sensitive to Gram-positive bacteria especially MRSA.*

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ABSTRAK

Latar belakang: Infeksi yang terjadi dapat disebabkan oleh kontaminasi bakteri secara langsung pada luka, seperti infeksi pada luka pasca operasi atau infeksi setelah trauma. Upaya pengendalian infeksi dapat dilakukan dengan penggunaan antibiotik. **Tujuan:** Untuk mengetahui profil bakteri dan sensitivitas antibiotik pada kultur luka pada pasien rawat inap di RSUD Haji Jawa Timur tahun 2021. **Metode:** Penelitian ini menggunakan uji *Chi-square* dan analisis deskriptif berupa tabel distribusi dan persentase dengan menggunakan data sekunder berdasarkan hasil pemeriksaan kultur pus di Laboratorium Mikrobiologi Klinik RSU Haji Surabaya Jawa Timur tahun 2021. **Hasil:** Berdasarkan hasil penelitian sampel kultur luka didapatkan data sebanyak 113 pasien (56,22%) dengan hasil kultur positif yang sebagian besar perempuan sebanyak 59 pasien (50,9%) dan kategori umur terbanyak yaitu pada usia 46-55 tahun sebanyak 39 pasien (33,6%). Berdasarkan bakteri, jenis bakteri yang paling dominan pada kelompok Gram-negatif adalah *Escherichia coli* ESBL dengan 21 isolat (26,6%). Sedangkan untuk bakteri Gram-positif, *Staphylococcus aureus* ditemukan pada 16 isolat (43,3). Hasil antibiotik *sensitive* pada bakteri Gram-negatif diperoleh amikacin dan meropenem. Pada bakteri Gram-positif diperoleh vancomycin dan linezolid. **Kesimpulan:** *E. coli* dan *S. aureus* merupakan penyebab infeksi tertinggi pada luka. Uji kepekaan antibiotik dari semua isolat menunjukkan bahwa antibiotik vankomisin dan linezolid sensitif terhadap bakteri Gram-negatif khususnya bakteri penghasil ESBL, dan antibiotik amikacin dan meropenem sensitif terhadap bakteri Gram-positif khususnya MRSA.

Kata kunci:
Antibiotik, Bakteri, Infeksi piogenik, Pus

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INTRODUCTION

Wound infection causes pus to appear as a response to inflammation. Pus formation indicates the presence of bacteria growing in the injured area (Nurmala *et a*l., 2015). Purulent infections can destroy neutrophils through leukocidin release and abscess formation. Infectious diseases caused by pathogens such as viruses, bacteria, parasites, and fungi remain prevalent in developing countries. One type of infection is a pyogenic infection, which is characterized by severe local inflammation and pus formation. Pyogenic infections occur due to the invasion and multiplication of pathogenic microorganisms in tissues and cause wounds (Apriani and Fathir, 2021).

In 2012, operations in Indonesia reached 1.2 million with a wound prevalence of approximately 2.3% to 18.3%. Another risk that can lead to wound infections is caesarean section, which may increase the incidence of surgical site infection (ILO) as well as post-operative indications by 10% (Atira *et al*., 2021; Nuriana *et al*., 2022). Bacteria commonly found in pus cultures are *Staphylococcus aureus*, *Klebsiella*, *Pseudomonas*, *Escherichia coli*, and *Streptococcus*. Attempts to control infections can be overcome by treatment with appropriate antibiotics so as not to induce antibiotic resistance (Ekawati *et al*., 2018; Utami, 2011).

Wound infections can be caused by one pathogen, known to be a single organism or multiple pathogens, known to be polymicrobial. Currently, wound infections are becoming increasingly difficult to control due to the proliferation of antibiotic-resistant bacteria. Hospital trauma is a major cause of hospital morbidity and increases treatment costs (Bhalchandra *et al*., 2018). Infections caused by *methicillin-resistant Staphylococcus aureus* (MRSA) and producers of extended-spectrum β-lactamases (ESBLs) pose significant challenges to the treatment of wound infections (Pant *et al*., 2018). This study aimed to identify the etiology of various wound infections as well as the susceptibility to antibiotics, especially MRSA and ESBL-producing bacteria involved in wound infections.

MATERIAL AND METHOD

Before commencing the study, the research protocol was approved by Hajj General Hospital Surabaya. This study was conducted according to the hospital's ethical guidelines. This is a retrospective *cross-sectional* study of 113 hospitalized patients with positive pus culture examination in 2021 at the Hajj General Hospital Surabaya. The patient population in this study was represented by hospitalized patients with positive results of bacterial infection based on the pus culture performed. The patient history used included age, gender, duration, and comorbidities. Data were collected from medical records provided by the hospital.

Laboratory identification

Blood agar plates and MacConkey agar (MERCK, Germany) were inoculated simultaneously with each pus sample and incubated aerobically for 24 hours at 37°C. The bacterial isolates were identified using standard microbiological methods including colony morphology, Gram stain reaction, and biochemical assays. Biochemical tests were performed on pure colonies from cultures for definitive identification of isolates. Colonies grown on agar were used for direct identification and susceptibility testing using the VITEK 2 system. The turbidity of the bacterial suspension was adjusted to McFarland standard 0.5 with 0.45% sodium chloride using VITEK Densichek (BioMe'rieux, USA). The VITEK 2 ID-GNB card, VITEK 2 ID-GPB card, AST-NO09 card and bacterial suspension were then manually inserted into the VITEK 2 system. The VITEK 2 system reports results automatically with software version 2.01 (Pincus, n.d.; Ling *et al*., 2001). The antimicrobial susceptibility test of isolates was performed in Mueller–Hinton agar by Modified Kirby Bauer disc diffusion method using the standard guidelines of CLSI (2011). Antimicrobial discs (Oxoid, Ltd, UK) used in this study are benzylpenicillin (10 µg), ampicillin (10 µg), oxacillin (1 µg), gentamicin (10 µg), ciprofloxacin (5 µg), levofloxacin (5 µg), moxifloxacin (5 µg), erythromycin (15 µg), clindamycin (2 µg), quinupristine (15 µg), tigecyclin (15 µg), nitrofurantoin (300 µg), rifamphicin (5 µg), trimethoprim-sulfamethoxazole (1.25 µg), Linezolid (30 µg), vancomycin (30 µg), and tetracycline (30 µg).

The suspected ESBL producing isolates were first tested with ceftriaxone (30 µg) as per the CLSI screening criteria. The isolates were suspected to be ESBL producers if zone of inhibition was ≤25 mm. The suspected ESBL producing isolates were tested for confirmation for ESBL production by ceftazidime (30 µg) and ceftazidime (30 µg) + clavulanate (10 µg). An increase in zone diameter of ≥5 mm in the presence of clavulanate from any or all of the sets was confirmed as ESBL production. The suspected MRSA isolates were tested with oxacillin (5 µg) and vancomycin (30 µg) as per the CLSI screening criteria. The isolates were suspected to be ESBL producers, if zone of inhibition was ≤10 mm and ≤15 mm. The antibiotic discs used in the study were supplied by Himedia laboratories pvt. ltd., India. As controls, *Staphylococcus aureus* ATCC 25923, *E. coli* ATCC 25922 (ESBL negative), and *Klebsiella pneumoniae* ATCC BAA-1706 (ESBL negative) were used.

Statistic analysis

Statistical analysis was performed using *Statistical Package for the Social Sciences* (SPSS) software version 21 (IBM company, Armonk, NY, USA). The frequencies and percentage selected for categorical variables and continuous variables are presented in percentage. *Chi-square* test was calculated for categorical variables to analyze significant confidence intervals (95%). A *p-value* < 0.05 was considered statistically significant.

RESULT

Of the 201 specimens collected when pus infection was suspected, 113 (56.22%) showed bacterial growth and 88 (43.78%) showed negative growth. A total of 113 specimens were collected, 58 samples from female patients and 55 samples from male patients. Most specimens were collected from the age group of 46-55 years (39 samples) and the majority were subjected to patients with a diagnosis of gangrene with 25 samples, as presented in Table 1.

Microorganisms isolated from wound specimens are shown in Table 2. Antibiotic susceptibility patterns for Gram-positive and Gram-negative bacteria are shown in Tables 3 and 4, respectively. Of the 113 samples that tested positive, Gram-positive bacteria were isolated from 35 samples and Gram-negative bacteria were isolated from 78 samples. Among Gram-positive bacteria, *Staphylococcus aureus* was the most frequently isolated bacterium in 15 samples. Similarly, the most frequently isolated bacterium among Gram-negative bacteria was *Escherichia coli* ESBL in 21 samples (Table 2).

Based on the antibiotic sensitivity test of 113 bacterial isolates, 36 of them showed resistance, with ESBL and MRSA categories. Antibiotic-resistant bacterial patterns were found in 29 samples with Gram-negative bacteria and 7 samples with Gram-positive bacteria. The highest percentage of bacteria resistant to antibiotics was shown by *Escherichia coli* (21 samples), followed by *Klebsiella pneumoniae* (8 samples), and the lowest (7 samples) by *Staphylococcus aureus* (Table 2).

The results of antibiotic sensitivity in wound specimens revealed that Gram-positive bacteria including MRSA showed sensitivity to vancomycin and linezolid antibiotics (more than 50%), and resistance to benzylpenicillin and quinupristin (less than 25%). Gram-negative bacteria including ESBL-producing *Escherichia coli* and ESBL-producing *Klebsiella pneumonia* showed the antibiotics amikacin and meropenem (more than 50%) as the most sensitive antibiotics of the bacteria found in pus culture, and were resistant to ampicillin and cefazoline (less than 50%) (Table 3 and Table 4).

Table 1. Distribution of sex, age and pus sample collection

Characteristics (n=113)		Total (%)	***p-value***
Sex (n = 113)	Male	55 (48.67 %)	0.122
	Female	58 (51.33 %)	
Age (n = 113)	0-5	3 (2.65 %)	0.510
	6-11	3 (2.65 %)	
	12-16	2 (1.77 %)	
	17-25	5 (4.42 %)	
	26-35	16 (14.16 %)	
	36-45	12 (10.62 %)	
	46-55	39 (34.51 %)	
	56-65	25 (22.12 %)	
	>65	8 (7.10 %)	
Pus sample collection (n = 113)	Gangrene	25 (22.12 %)	0.045*
	Abscess	23 (20.35 %)	
	Appendicitis	14 (12.39 %)	
	Ulcers	12 (10.62 %)	
	ILO	5 (4.42 %)	
	Cellulitis	4 (3.54 %)	
	Leukositosis	1 (0.89 %)	
	Combustion	1 (0.89 %)	
	Phlegmon	1 (0.89 %)	
	Ascites	1 (0.89 %)	
	No diagnosis	26 (23.00 %)	

*: significant *p-value* <0.05

Table 2. Distribution of bacterial isolates

Organism	No of isolates	*p-value*
Gram-positive bacteria (n = 35)		
MRSA	7 (6.19 %)	0.99
Staphylococcus aureus	15 (13.27 %)	
Coagulase negative Staphylococci (CoNS)	5 (4.42 %)	
Enterococcus spp.	4 (3.54 %)	
Streptococcus spp.	4 (3.54 %)	
Gram-negative bacteria (n = 78)		
ESBL-producing *Escherichia coli*	21 (18.59 %)	
ESBL-producing *Klebsiella pneumoniae*	8 (7.08 %)	
Escherichia coli	12 (10.63 %)	
Klebsiella pneumonia	10 (8.85 %)	
Pseudomonas spp.	7 (6.19 %)	
Proteus spp.	5 (4.42 %)	
Enterobacter spp.	3 (2.65 %)	
Citrobacter spp.	3 (2.65 %)	
Morganella morganii	2 (1.77 %)	
Providencia stuartii	2 (1.77 %)	
Serratia spp.	2 (1.77 %)	
Routella ornithinolytica	1 (0.89 %)	
Acinetobacter baumanii	1 (0.89 %)	
Shigella spp.	1 (0.89 %)	

*: significant *p-value* <0.05

DISCUSSION

Understanding microbial characteristics is an important part of efficient therapeutic strategies. Therefore, in this study, we analyzed the bacteriological profile and antibiotic susceptibility and patterns of patients with wound infections. Out of 201 samples, 113 samples (56.22%) showed bacterial growth. A similar study by Sinaga *et al.* (2021) showed the same results with a sample increase of more than 50%. The low increase in positive cases may be due to sampling from patients taking antibiotics. Pus cultures that do not undergo colony growth may be induced by antibiotics in initial treatment.

The highest infection value among tested patients (Table 1) was found in female (51.33%). The disease can affect both women and men, but severity depends on work, lifestyle, genetics, and physiological status (Setianingsih *et al.*, 2016). The immune response in the body is very important for the body to respond to foreign substances such as microorganisms and other pathogens. A similar study about wound infection conducted in Nepal showed that the number of male patients with positive results (73.56%) was higher than female patients which may be caused by more physical outdoor activities, thus increasing the risk of infection (Mahat *et al.*, 2017). The median age of hospitalized patients with pus cultures was 46-55 years (34.51%). By the age of 50, physiology generally declines as well. A change that occurs with age is the process of thymic involution and a decrease in the volume of thymic tissue. Thymus tissue is behind the sternum and above the heart, where T lymphocytes mature. T lymphocytes lose their function and ability to fight disease with age (Prahasanti, 2019).

The type of wound sampled in this study was gangrene. Severe wound infections due to diabetes and delayed treatment can lead to diabetic gangrene. Bacteria that cause diabetic gangrene infection are Gram-positive and Gram-negative (Purnomo *et al.*, 2022). High blood sugar can increase infection value and slow wound healing. Uncontrolled diabetes impairs the ability of white blood cells to destroy invading bacteria and prevent the growth of harmful bacteria that are normally present in a healthy body.

Table 3. The resistance value antibiotic of Gram-positive isolates

Class of antibiotic	*Enterococcus* spp. *(n = 5)*	*MRSA (n = 7)*	*Staphylococcus aureus (n = 16)*	*Staphylococcus* spp. *(CoNS) (n = 5)*	*Streptococcus* spp. *(n = 4)*
Penicillin					
Benzylpenicillin	100	100	100	100	50
Ampicillin	20	100	100	100	25
Oxacillin	100	57.2	25	80	75
Aminoglikosida					
Gentamicin	100	85.8	25	40	75
Quinolone					
Ciprofloxacin	100	71.5	31.3	60	75
Levofloxacin	100	71.5	25	60	0
Moxifloxacin	100	71.5	31.3	60	0
Macrolides					
Erythromycin	100	85.8	31.3	60	25
Clindamycin	100	85.8	31.3	60	25
Streptogramins					
Quinupristine	100	85.8	75	80	75
Glycylcyclines					
Tigecyclin	40	57.2	25	60	50
Nitrofuran					
Nitrofurantoin	40	57.2	31.3	60	75
Rifamphicin	100	85.8	31.3	40	100
Trimethoprim-sulfamethoxazole	100	71.5	25	60	75
Linezolid	20	42.9	31.3	40	50
Vancomycin	20	42.9	31.3	40	50
Tetracycline	80	85.8	50	80	75

Noted: R = Resistant, S = Susceptible

Of the total 113 isolates, 78 (69.03%) samples were Gram-negative and 35 (30.97%) samples were Gram-positive. A similar study was performed by Yakha *et al.* (2014) and Acharya (2012) showed a preponderance of Gram-negative bacteria (70.6% and 59.3%, respectively). Gram-negative bacterial isolation value during this study were higher because Gram-negative bacterial growth in skin abscesses and wounds tended to be aerobic and facultatively anaerobic. Gram-negative isolates are also increasing in hospital-acquired infections (HAIs). Also, the results of a study conducted by Banjara (2002) at TUTH showed the presence of high levels of Gram-negative bacteria in HAI. Although the gastrointestinal tract is a source of Gram-negative bacteria that contaminate postoperative wounds if no precautions are taken, Gram-positive bacteria usually enter contaminated wounds through the skin surface itself (K.C. *et al.*, 2013).

The highest number of bacteria found in the samples (Table 2) were *Escherichia coli* ESBL (n = 21, 18.59%), *Staphylococcus aureus* (n = 15, 13.27%), and *Klebsiella pneumoniae* (n = 10, 8.85%). A study reported by Karkee (2008) also supports the findings of this study, with the most common bacterial isolates (46.58%) being *Staphylococcus aureus* and *Escherichia coli* (12.38%) being a common wound infection emerged as the causative agent. Similar results were reported by Maharjan and Mahawal (2020) and Moinuddin *et al.* (2016), with the most prevalent wound infection isolate being *Staphylococcus aureus* (37.12%), followed by *Klebsiella* sp. (20.45%). *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae* are prevalent pathogens in nosocomial infections and also cause postoperative wound contamination and post-traumatic infections (Amelia and Burhanuddin, 2018). In addition, increased ESBL-producing bacteria are often associated with antibiotic use in patients, and the choice of antibiotic

Table 4. The resistance value antibiotic of Gram-negative isolates

Class of antibiotic	*ESBL-producing E. coli (n=21)*	*E. coli (n=12)*	*K. pneumonia (n=10)*	*Pseudomonas spp. (n=8)*	*ESBL-producing K. pneumonia (n=8)*	*Proteus spp. (n=5)*	*Citrobacter spp. (n=3)*	*Enterobacter spp. (n=3)*	*Serratia spp. (n=2)*	*Morganella morganii (n=2)*	*Providencia stuartii (n=2)*	*Routella spp. (n=1)*	*Shigella spp. (n=1)*	*A. baumanii (n=1)*
Penicillin														
Ampicillin	71.5	75	70	100	75	60	100	100	50	50	100	100	100	100
Ampicillin/ Sulbactam	52.4	66.7	10	100	87.5	80	100	100	50	100	100	0	100	100
Piperacillin/ Tazobactam	38.1	16.7	30	50	25	40	34	34	50	50	0	0	0	0
Cephalosporins														
Cefazoline	71.5	75	80	62.5	75	90	100	100	50	50	100	100	100	100
Ceftazidime	42.9	8.4	10	50	50	0	34	34	100	0	100	0	0	0
Ceftriaxone	71.5	16.7	20	100	75	0	34	34	100	0	100	0	0	100
Cefepime	33.4	16.7	20	50	62.5	20	0	0	100	100	50	0	0	99
Monobactams														
Aztreonam	62	16.7	10	62.5	62.5	20	34	34	50	50	0	0	0	100
Carbapenem														
Ertapenem	76.2	66.7	70	100	75	80	34	34	50	50	0	0	100	100
Meropenem	28.6	8.4	20	50	25	20	0	34	50	50	0	0	0	0
Aminoglycosides														
Amikacin	28.6	8.4	30	50	25	20	0	0	50	50	0	0	0	100
Gentamicin	57.2	16.7	30	50	62.5	20	34	0	50	0	100	0	100	0
Fluoroquinolones														
Ciprofloxacin	71.5	33.4	30	50	75	20	34	34	50	0	100	0	100	100
Tetracycline														
Tigecycline	28.6	8.4	30	75	37.5	100	0	0	100	50	100	100	100	100
Nitrofurantoin	47.7	16.7	50	100	100	80	34	67	100	50	100	100	100	100
Trimethoprim-sulfamethoxazole	28.6	50	20	100	50	60	100	100	100	50	100	0	100	100

type should be based not only on the method of administration of the antibiotic, but also on the suitability of testing result susceptibility, is also unwise (Arrizqiyani and Nurlina, 2016; Nazmi *et al.*, 2017).

Bhandari *et al.* (2016) reported the *Escherichia coli* had the highest susceptibility, with 68 (49.3%) suspected to be ESBL producers. The resistant bacteria are the most important, followed by the type of antibiotic used and the study population. The emergence of MDR is clearly related to the number of antibiotics and how they are used. This study found *E. coli* to be the most prevalent ESBL-positive isolate, followed by *Klebsiella pneumoniae*. A pattern of *E. coli* as the most dominant ESBL-positive isolate was found in several other studies conducted by Poudyal (2004) and Baral *et al.* (2011), with 14 out of a total of 72 samples (19.44%) was reported to be an ESBL isolated. In addition, the current global prevalence of ESBL-producing organisms varies from <1% to 74%.

The most effective antibiotics against Gram-positive bacteria, including all of MRSA were vancomycin and linezolid with total isolate resistance being less than 50%, but benzylpenicillin and quinupristin showed resistance with total isolate resistance being more than 75%. Among Gram-negative bacteria, the sensitive antibiotics were piperacillin/tazobactam and meropenem with total isolate resistance being less than 50%, and ampicillin and cefazolin showed resistance with total isolate resistance being up to 100%. This result is consistent with the studies by Harshan and Chavan (2015) and Maharjan and Mahawal (2020). The most effective drugs against MRSA are linezolid and vancomycin with 100% sensitivity, followed by amikacin (79.3%). The results of the same study were shown by Sherchan and Gurung (2019) with an effective antibiotic for ESBL, namely imipenem (carbapenems) (93.8%) which also showed the highest sensitivity (97.14%) to meropenem (carbapenems). This small difference may be due to the geographically varying prevalence of ESBL-producing isolates. Similarly, genetic level tests, i.e. different gene sequences, are responsible for MRSA and ESBL.

Antibiotics are highly recommended because they can play an important role in limiting wound infection to a minimum if there is a possibility of the emergence of drug-resistant bacteria. If there is empirical drug therapy, speeding up the wound healing process, then using the right drug reduces the cost of treating wound infections. Vancomycin is used for nosocomial infections which can also specifically be used to treat bacteria that are resistant to betalactam antibiotics such as penicillin (benzylpenicillin, phenoxymethylpenicillin, flucloxacillin, ampicillin, amoxicillin, piperacillin, sulbenicillin, and ticarcillin), cephalosporins, and carbapenems. A study conducted by Rinawati *et al.* (2021) identified antibiotics used to treat gangrene, namely oxacillin, trimethoprim, vancomycin, and linezolid, from the results of antibiotic susceptibility testing.

Piperacillin is a broad-spectrum penicillin antibiotic that, in combination with tazobactam, protects piperacillin from hydrolysis of various β-lactams. Piperacillin/tazobactam is indicated for intra-abdominal infections, pelvic infections, skin and soft tissue infections (Nurmala *et al.*, 2015; Yunita and Sukrama, 2015). Based on the Infectious Disease Society of America (IDSA) guidelines, vancomycin or linezolid plus piperacillin/tazobactam, carbapenems or ceftriaxone, and metronidazole are empirical antibiotics for the treatment of soft tissue and skin infections (Widuri, 2022).

The main causes of antimicrobial resistance are widespread ranging from irrational use, short-term use of low doses, to factors in patients buying their own antibiotics without a doctor's prescription. The use of inpatient care in hospitals also triggers massive use of antibiotics in inpatient wards because more intensive use of antibiotics can cause patients to become very sensitive to infections and susceptible to nosocomial infections (Utami, 2011). Antibiotics are used not only for treatment, but also for controlling bacterial populations, so the dosage of antibiotics must be appropriate and penetration of the bacterial site is appropriate. Because if the right dose is given, resistance will not develop quickly and side effects can be minimized (Pratiwi, 2017).

CONCLUSION

Based on 113 samples with positive pus cultures, there were 35 samples of Gram-positive bacteria and 78 samples of Gram-negative bacteria. *Staphylococcus aureus* and *Escherichia coli* are the most important causes of wound infections and the suppressor organisms in this study. Antibiotic susceptibility test of all isolates showed that 29 samples belonged to the ESBL group and 8 samples belonged to the MRSA group. Based on these results, the treatment of infection should be treated with appropriate antibiotics. Vancomycin and linezolid are antibiotics that can be used for treatment, with the lowest resistance value (less than 50%) for Gram-positive and MRSA and meropenem is an antibiotic for Gram-negative and ESBL-producing bacteria with the lowest resistance value for isolates (less than 30%).

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