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Bacterial pattern and its susceptibility toward antibiotic on burn infection in Burn Unit Sanglah General Hospital

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ABSTRACT

Introduction: Infection is one of the most common complications of burns due to the invasion of microorganisms from the surrounding environment to other tissues under the skin. It is currently a big problem as a consequence of multidrug-resistant antibiotics bacteria. In order to give a proper initial empirical treatment, the pattern of bacteria and its resistance should be identified. This study aimed to identify the bacteria pattern on burn wound infections and its resistance to antibiotics in the Burn Unit of Sanglah General Hospital.

Methods: This study was a descriptive cross-sectional study. The sample of this study was data of patients' culture test from the burn unit that were recorded in the registration book of the Laboratory of Microbiology, Sanglah General Hospital from 1st January 2017 to 31st December 2017.

Result: A Total number of 194 data patients' culture test from the burn unit were found from the registration book of the Laboratory of Microbiology, Sanglah General Hospital, of which 98 of the data showed pathogenic bacterial growth and 118 bacteria were identified. It was dominated by gram-negative bacteria such as Pseudomonas aeruginosa (26.3%), Acinetobacter baumanii (26.3%), Klebsiella pneumonia ssp pneumonia (8.5%) and gram-positive bacteria such as Staphylococcus aureus (12.7%). The results of the culture test showed that these bacteria were resistant to many antibiotics.

Conclusion: Pseudomonas aeruginosa, Acinetobacter baumanii, Klebsiella pneumonia ssp pneumonia, Methicillin-resistant Staphylococcus aureus, and Methicillin-sensitive Staphylococcus aureus were the most common bacteria found in the swab culture examination of burn patients in the Burn Unit of Sanglah General Hospital.

Keywords: Antibiotics, bacteria, burn, drug resistance, wound

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INTRODUCTION

Burn wound is damage to the skin or other tissues in the body that is mainly caused by heat. Other causes of damage such as radiation, electricity, chemical and lightning strike are also classified as burn wounds. In the world, burn wound is a serious health problem; an estimated 265,000 death every year worldwide are caused by fire-related burn injuries, and this number excludes other causes of burn injuries[1,2].

One of the most common complications in burn wounds is an infection, especially nosocomial infection that occurs in hospitalized patients[1,3]. Nosocomial infection, or hospital-acquired infection, is an infection obtained after being treated for 48 hours or more in the hospital[4,5].

Burn infection is a serious problem as it has a high mortality rate. Damage to the skin leads to a decrease in the skin's protective function, and facilitates the invasion of microorganisms into deeper parts of the tissue[6,7]. This invasion could lead to bacteremia, sepsis and multiple-organ dysfunction syndrome[1,,7,8]. Burn infection occurs because of inadequate handling, contamination from the surrounding environment and bad wound closure, which lead to the colonization of microorganisms in the wound before it enters the tissues and infects the patient[9,10].

The most common pathogen to infect burn wounds is bacteria, mostly gram-positive Staphylococcus aureus, which in some cases, is a resistant bacteria called Methicillin-resistant staphylococcus aureus (MRSA), and gram-negative Pseudomonas aeruginosa and Klebsiella sp. These bacteria are frequently found in nosocomial infection and are commonly feared because they are mostly resistant to many antibiotics[8,11]. Resistant means that the bacteria can become unaffected or less affected by antimicrobial, and this situation makes the treatment ineffective and could lead to prolonged treatment, which increases treatment costs and also patient's morbidity and mortality[2].

Nowadays, the cases of resistant bacteria are

increasing, so it is essential to choose wisely the right antibiotics to treat the patient[11,12]. However, the bacterial pattern and its resistance vary in every hospital; accordingly, in order to select the right empirical antibiotics, the bacterial pattern and its resistance must be known. Knowing the bacterial pattern allows the selection of the right antibiotics so that the treatment would be effective, thereby decreasing the length of stay, hospital costs, complication risks, mortality, and morbidity[13,14]. The main objective of this study was to identify the bacterial pattern and its susceptibility towards antibiotics in the Burn Unit of Sanglah General Hospital from 1st January 2017 to 31st December 2017.

MATERIALS AND METHODS

This was a descriptive cross-sectional study using secondary data. The sample in this study was data of patient's swab culture, which were collected between 1st January 2017 and 31st December 2017(one year). This research took all data available within that period (total sampling). Data on the bacterial pathogen that infected patients with burn wounds and their susceptibility were taken from the Registration Book of the Microbiology Laboratory, Sanglah General Hospital. Inclusion criteria all burn wound patients data that has been recorded in the patient registration book within the period of January 1 to December 31, 2017, exclusion criteria patient data outside the study period and/or data are available in the registration book but not complete. The bacterial data and its susceptibility on the register book based on the result of the Vitek system (Vitek analyser -bioMerieux, UK) which available in the Microbiology Laboratory. All data in this study were presented descriptively and were expressed in percentage.

Table 1. Characteristic of sample

Characteristic	Frequency	Percentage (%)
Gender		
Male	141	72.7
Female	53	27.3
Total	194	100
Bacterial growth		
Pathogenic bacterial	98	50.5
Normal regional flora	11	5.7
Sterile	62	32
Incomplete data	23	11.8
Total	194	100
Gram Distribution		
Gram-positive	25	21.2
Gram-negative	93	78.8
Total	118	100

RESULT

Between 1st January 2017 and 31st December 2017, 194 data of swab culture results were found. As seen in Table 1, 98 swab culture data showed pathogenic bacterial growth, 11 showed the growth of normal regional flora, 62 were sterile, and 23 culture data were incomplete. In 98 swab cultures showing pathogenic bacterial growth, there were cultural swabs that were overgrown by more than one bacteria. A total of 118 bacteria were found from 98 data. Bacterial distribution was dominated by gram-negative bacteria, which accounted for 78.8% of the cases, while the rest were gram-positive bacteria (21.2%).

Pseudomonas aeruginosa and Acinetobacter baumanii dominated the results of the swab cultures, both having 31 cases each. They were followed by Klebsiella pneumonia ssp pneumonia with 10 cases. These gram-negative bacteria are the top tier agents causing infection in burn wounds.

Meanwhile, only 25 gram-positive bacteria were found, which mostly consisted of Methicillin-Resistant Staphylococcus aureus (MRSA), Methicillin-Sensitive Staphylococcus aureus (MSSA) and Streptococcus pyogenes with 8, 7 and 4 cases respectively. The complete result of the total bacterial found in swab culture was presented in Table 2.

All of the *Pseudomonas aeruginosa* that were found in 31 cases were resistant to almost all the antibiotics used to test. It resisted 100% to ampicillin, ampicillin/sulbactam, cefazolin, tigecycline, nitrofurantoin, and cotrimoxazole. It also resisted to ciprofloxacin (93.5%), ceftazidime & cefepime (77.4%), gentamicin (74.2%) and meropenem (71%). *Pseudomonas aeruginosa* tends to be intermediate to aztreonam (64.5%). Amikacin had the highest effectivity against *Pseudomonas aeruginosa,* where it showed sensitivity in 38.7% cases (Table 3).

All *Acinetobacter baumanii* cases were resistant to ampicillin, cefazolin, aztreonam, and nitrofurantoin. This was followed by ceftriaxone, ceftazidime, ciprofloxacin, piperacillin/Tazobactam, cefepime, gentamicin and cotrimoxazole that have a level of resistance above than 90% of the cases. On the other side, all of the *Acinetobacter baumanii* found showed sensitivity towards tigecycline (Table 3).

We found that *Klebsiella pneumonia ssp pneumonia* was resistant to ampicillin in every case and 70% of the cases showed intermediate to

Table 2. Pattern of bacteria found on burn wound swab culture in the burn unit of Sanglah General Hospital,Denpasar Bali-Indonesia.

No	Bacteria species	Frequency	Percent (%)
1	*Pseudomonas aeruginosa*	31	26.3
2	*Acinetobacter baumannii*	31	26.3
3	*Klebsiella pneumonia ssp pneumonia*	10	8.5
4	*Staphylococcus aureus (MRSA)*	8	6.8
5	*Staphylococcus aureus (MSSA)*	7	5.9
6	*Proteus mirabilis*	7	5.9
7	*Escherichia coli*	6	5
8	*Enterobacter cloacae ssp cloacae*	4	3.4
9	*Streptococcus pyogenes*	4	3.4
10	*Pseudomonas luteola*	1	0.8
11	*Streptococcus dysgalactiae ssp eqisimilis*	1	0.8
12	*Providencia stuartii*	1	0.8
13	*Streptococcus mitis/oralis*	1	0.8
14	*Streptococcus agalactiae*	1	0.8
15	*Enterococcus durans*	1	0.8
16	*Achromobacter dentrificans*	1	0.8
17	*Enterococcus faecalis*	1	0.8
18	*Staphylococcus lentus*	1	0.8
19	*Pseudomonas putida*	1	0.8
	Total	118	100

nitrofurantoin. Other antibiotics were still sensitive against *Klebsiella pneumonia ssp pneumonia*, especially meropenem and ertapenem (100%) (Table 3).

As seen in Table 4, gram-positive bacteria, *Methicillin-resistant Staphylococcus aureus* (MRSA), showed resistance toward ampicillin/sulbactam, piperacillin/tazobactam, cefazolin, ceftriaxone, cefepime, benzylpenicillin, oxacillin in every case (100%). It also showed resistance to cotrimoxazole (87.5% cases), gentamicin, ciprofloxacin, levofloxacin, and moxifloxacin (75% cases). MRSA also showed sensitivity towards tigecycline, nitrofurantoin, linezolid, vancomycin, and rimfampicin. It showed sensitivity to these antibiotics in every data cases (100%).

In contrast, all seven cases of *Methicillin-Sensitive Staphylococcus aureus* (MSSA) found were only resistant to benzylpenicillin and tetracycline, even though one case (14.3%) of MSSA was resistant to ciprofloxacin, cotrimoxazole, levofloxacin and moxifloxacin, the remaining cases (85.7%) were sensitive.

For *Streptococcus pyogenes*, tetracycline is a bad choice because the bacteria were resistant against this antibacterial in all cases. It was also intermediate against nitrofurantoin. Overall, *Streptococcus pyogenes* was still sensitive to many antibiotics, as can be seen in Table 4.

Table 3. Profile of Gram-negative bacteria susceptibility toward different antibiotic on Burn Infection in Burn Unit Sanglah General Hospital Denpasar Bali-Indonesia.

Antibiotics	Bacteria							
	PAE (n = 31)			ABA (n = 31)			KPN (n = 10)	
	R (%)	I (%)	S (%)	R (%)	I (%)	S (%)	R (%)	I (%)
Ampicillin	100	0	0	100	0	0	100	0
Ampicillin/Sulbactam	100	0	0	87.1	3.2	9.7	40	0
Piperacillin/Tazobactam	-	-	-	93.6	3.2	3.2	-	-
Cefazolin	100	0	0	100	0	0	40	0
Ceftazidime	77.4	0	22.6	96.8	0	3.2	40	0
Ceftriaxone	-	-	-	96.8	3.2	0	40	0
Cefepime	77.4	12.9	9.7	93.6	3.2	3.2	40	0
Aztreonam	32.3	64.5	3.2	100	0	0	40	0
Ertapenem	-	-	-	0	0	0	0	0
Meropenem	71	0	29	58	9.7	32.3	0	0
Amikacin	38.7	22,6	38.7	77.4	6.5	16.1	20	0
Gentamicin	74.2	16.1	9.7	90.3	0	9.7	40	0
Ciprofloxacin	93.5	0	6.5	93.5	0	6.5	10	0
Tigecycline	100	0	0	0	0	100	10	0
Nitrofurantoin	100	0	0	100	0	0	20	70
Cotrimoxazole	100	0	0	90.3	0	9.7	40	0

PAE: *Pseudomonas aeruginosa*, ABA: *Acinetobacter baumanii*, KPN: *Klebsiella pneumonia spp pneumoniae*, R: Resistance, I: Intermediate, S: Sensitive

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Table 4. Profile of Gram-positive bacteria susceptibility toward different antibiotic on Burn Infection in Burn Unit Sanglah General Hospital Denpasar Bali-Indonesia

Antibiotics	Bacteria							
	MRSA (n = 8)			MSSA (n = 7)			SP (n = 4)	
	R (%)	I (%)	S (%)	R (%)	I (%)	S (%)	R (%)	I (%)
Ampicillin	-	-	-	-	-	-	0	0
Ampicillin/Sulbactam	100	0	0	0	0	100	-	-
Piperacillin/Tazobactam	100	0	0	0	0	100	-	-
Cefazolin	100	0	0	0	0	100	-	-
Ceftazidime	-	-	-	-	-	-	-	-
Ceftriaxone	100	0	0	0	0	100	0	0
Cefepime	100	0	0	0	0	100	-	-
Gentamicin	75	-	25	0	0	100	-	-
Ciprofloxacin	75	12.5	12.5	14.3	0	85.7	-	-
Tigecycline	0	0	100	0	0	100	-	-
Nitrofurantoin	0	0	100	0	0	100	-	-
Cotrimoxazole	87.5	0	12.5	14.3	0	85.7	0	0
Benzylpenicillin	100	0	0	100	0	0	0	0
Oxacillin	100	0	0	0	0	100		
Levofloxacin	75	12.5	12.5	14.3	0	85.7	0	0
Moxifloxacin	75	12.5	12.5	14.3	0	85.7	-	-
Azithromycin	25	0	75	0	0	100	-	-
Erithromycin	25	0	75	0	0	100	0	0
Clindamycin	25	0	75	0	0	100	0	0
Linezolid	0	0	100	0	0	100	0	0
Vancomycin	0	0	100	0	0	100	0	0
Tetracycline	62.5	0	37.5	100	0	0	100	0
Rifampicin	0	0	100	0	0	100	-	-

MRSA: *Methichillin Resistant Staphylococcus aureus*, MSSA: *Methichillin Sensitive Staphylococcus aureus*, SP: *Streptococcus pyogenes*, R: Resistance; I: Intermediate; S: Sensitive

DISCUSSION

In the present study three species of gram-negative bacteria and two-species of gram-positive bacteria were the most common bacterial pathogen have been isolated from burn wound in the Burn Unit of Sanglah General Hospital. However gram-positive bacteria less in number than gram-negative bacteria**.** Gram-negative bacteria *Pseudomonas aeruginosa*, *Acinetobacter baumanii* and *Klebsiella pneumonia spp pneumonia* were the top three bacteria that dominated burn wound infections. This finding is similar to the results of a previous study in the Burn Unit of Cipto Mangunkusumo Hospital, where the most common bacteria found in infected burn wounds were also *Klebsiella Pneumonia*, *Pseudomonas aeruginosa,* and *Acinetobacter baumanii*[15,16]. Similar results were also obtained in a study conducted in Singapore General Hospital (SGH), where burn wound infections were found to be dominated by *Acinetobacter baumanii*, *Enterobacter*, *Klebsiella spp.* and *Pseudomonas aerugonisa*[17].

Based on previously reported, *Pseudomonas aeruginosa* and *Acinetobacter baumanii* are indeed the most common causes of infection in burn wounds. Sepsis caused by these bacteria often results in mortality and morbidity[18,19]. The resistance of *P. aeruginosa* to antimicrobials is a serious and major problem in burn patients. The resistance of this bacterium to antibiotics makes it difficult to treat infection and related to morbidity and mortality of burn patients in the world[20].

Compared to the previous study at Cipto Mangunkusumo Hospital[16], the bacterial susceptibility towards antibiotics in the current study was slightly different. *Pseudomonas aeuroginosa* found in the Burn Unit of Sanglah General Hospital was 38.7% resistant to amikacin compared to 73% in Cipto Mangunkusumo, yet both of them were equally resistant to tigecycline. In this study *Pseudomonas aeruginosa* bacteria were found to have resistance to almost all antibiotics that have been tested. As reported previously this

pathogen is one of the most difficult causative agents associated with morbidity and mortality of burn patients in the world[20].

Acinetobacter baumani were highly resistant to ceftriaxone in both Sanglah General Hospital and Cipto Mangunkusumo Hospital. In Sanglah General Hospital, ABA was sensitive to tigecycline, but this was not the case in Cipto Mangunkusumo Hospital[16]. In other country *Klebsiella sp* the second most frequent bacteria after *Pseudomonas sp*[7,10,21] whereas in the present study *Klebsiella sp* was the third most frequent pathogen after *Pseudomonas sp* and *Acinetobacter sp*, this bacteria were also resistant to ampicillin. Considering that all gram-negative bacteria species isolated from infected burn wounds, resistance to ampicillin, cefazolin, tigecycline, nitrofurantoin, and cotrimoxazole, so can be concluded that those antimicrobial should not be used in the treatment of burn infections in the Burn Unit of Sanglah General Hospital.

Staphylococcus aureus is a gram-positive bacterium that lives as commensal to the skin, mouth and upper respiratory system, making it a great opportunity to become an opportunistic and nosocomial infection[3,4,22]. In the present study, gram-positive bacteria such as *Staplylococcus sp* were found in the Burn Unit of Sanglah General Hospital. *Staphloccus aureus* along with *Pseudomonas aeruginosa*, and *Acinetobacter baumannii*, define as the most frequently occurring multiple-drug resistant organisms (MDROs) in specific burn units in several country[20,23,24] patients with infections caused by MDROs are at greater risk to develop sepsis. Previously reported that all Staphylococcus species were sensitive to vancomycin[25] whereas we found that both MRSA and MSSA species were sensitive not only to vancomycin but also to tigecycline, nitrofurantoin linezolid, and rifampicin. It can be inferred that those antimicrobial may have a good choice for treatment of burn infection due to staphylococcal in the Burn Unit of Sanglah General Hospital.

CONCLUSION

Pseudomonas aeruginosa, *Acinetobacter baumanii*, *Klebsiella pneumonia ssp pnemoniae, Methicillin-resistant Staphylococcus aureus,* and *Methicillin-sensitive Staphylococcus aureus* were the most common bacteria found in swab culture examination of burn patients in the Burn Unit of Sanglah General Hospital from 1st January 2017 to 31st December 2017. These bacteria were almost resistance toward all of the tested antibiotics. However several antibiotics were still intermediate and sensitive toward these bacteria.

CONFLICT OF INTEREST

The authors declare no conflict of interest regarding this study.

ETHICAL CLEARANCE

This study obtained ethical clearance from the Ethical Commission in Research of the Faculty of Medicine, Udayana University/Sanglah General Hospital-Denpasar, Indonesia with approval number: 496/UN14.2.2/PD/KEP/2018.

AUTHOR CONTRIBUTION

Bramardipa was involved in conceptualizing the idea, the design of the study, defining the intellectual content, literature search, clinical studies, data acquisition, data analysis, statistical analysis, manuscript preparation, and manuscript editing. Sukrama contributed to the concept, design, the definition of intellectual content, data acquisition, statistical analysis, manuscript preparation, manuscript review, and guarantor. Budayanti contributed to the concept, design, definition of intellectual content, data acquisition, statistical analysis, manuscript preparation, and manuscript review.

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