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The Description of Microbial Pattern and Antibiotic Sensitivity Among Pediatric Patients at RSUP M Djamil Padang

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ABSTRACT

Background Infection alludes to the invasion and multiplication of either microorganisms or parasites inside bodily tissues. The management of such infections is closely interrelated to the use of antibiotics. Ineffective use of antibiotics is contributed to the antibiotic resistance. Severe disease complications and lengthy hospital stays are among essential reasons why physicians may prescribe myriad types of antibiotics for longer durations. In effort to diminish resistance, the selection of antibiotics ought to be based on information about the bacterial spectrum causing the infection and the patterns of sensitivity to antibiotics. Annual reporting of microbial patterns and sensitivity testing is essential, particularly for pediatric ward patients, as it provides a guide for administering relevant antibiotics and preventing further spread of infections.
Objectives This study evaluated microbial patterns, sensitivity test results, and antibiotic resistance among patients in the pediatric ward of RSUP M Djamil Padang from January-December 2020, with a total of 138 samples.
Results The proportion of gram-negative and gram-positive bacteria are 83.3% and 16.7%, respectively. The most prevalent gram-negative bacteria are Klebsiella pneumoniae (28.9%), Escherichia coli (26.1%). Pseudomonas aeruginosa (7.9%), Staphylococcus epidermidis (7.2%) and Acinetobacter baumannii (3.7%) also present. These bacteria are predominantly found in samples of feces, urine, and blood. Gram-positive bacteria show notable resistance to the antibiotics such as erythromycin (22.2%), trimethoprim-sulfamethoxazole (19%), and ciprofloxacin (15.8%), while being sensitive to chloramphenicol (17.4%), vancomycin (15.1%), and tetracycline (12%). In contrast, gram-negative bacteria exhibit resistance to ampicillin (16.5%), ceftriaxone (12.1%), and ceftazidime (11.3%), but are sensitive to amikacin (19.8%), meropenem (19.4%), and gentamicin (10.9%).

Keywords: microbial patterns, antibiotic sensitivity, pediatric ward

INTRODUCTION

Infection refers to the invasion and amplification of microorganisms or parasites within bodily tissues. The treatment of infection is parallel to the use of antibiotics. Ineffective use of antibiotics can lead to antibiotic resistance. The use of multiple types of antibiotics over a lengthy period of time is often employed to address severe infection complications in hospitals, which contributes to bacterial resistance. In order to assuage resistance, the selection of antibiotics has to be based on information about the bacterial spectrum causing the infection and the antibiotic susceptibility patterns.[1]

A study conducted in Iran in 2018 found that 55.4% of bacteria were gram-negative, with Pseudomonas spp. comprising 26.8%, Klebsiella spp. 8.8%, and Acinetobacter spp. 7.9%. Gram-positive bacteria included CONS at 25.8%, Staphylococcus aureus at 8.8%, and Enterococcus spp. at 7.4%.[2] A study in the pediatric ward of RSUD Dr. Soetomo Surabaya in 2015 spotted Escherichia coli, Burkholderia cepacia, and Klebsiella oxytoca and CONS, Staphylococcus aureus, and Staphylococcus saprophyticus in blood cultures. Staphylococcus aureus and E. coli, Klebsiella pneumoniae, and Burkholderia cepacia were identified in urine cultures. E. coli was the only one found in rectal swab cultures. Gram-positive cocci (CONS) were predominantly found in blood cultures. E. coli, a Gram-negative rod, was the most prevailing found bacterium. Gram-positive cocci showed an immense amount of resistance to penicillin and cotrimoxazole. E. coli, mostly identified in rectal swabs and urine, exhibited high sensitivity to amikacin and meropenem yet was soaringly resistant to ampicillin and ampicillin/sulbactam.[3]

Bacterial patterns and sensitivity testing reports are necessary and should be conducted annually, particularly for patients in the pediatric ward, as a guide for appropriate antibiotic administration to prevent further infection spread. RSUP Dr. M. Djamil Padang the referral of national health centre should maintain an updated data on bacterial patterns and antibiotic sensitivity testing on an annual basis. The use of broad-spectrum antibiotics and the prolonged duration of patient treatment in the pediatric ward at RSUP Dr. M. Djamil Padang underpin the researcher's interest in investigating bacterial patterns and the results of antibiotic sensitivity testing for bacteria in the pediatric ward at RSUP Dr. M. Djamil Padang from January to December 2020.

MATERIALS & METHODS

This was a retrospective descriptive study using medical records of all pediatric ward patients and antibiotic sensitivity and resistance test data from the microbiology laboratory of RSUP Dr. M. Djamil Padang from January to December 2020. The study was conducted by collecting 138 samples. Inclusion criteria for this study were all pediatric ward patients medical records aged 0-18 years wold whose met the criteria for microbial patterns and antibiotic sensitivity and resistance testing. The exclusion criteria were medical records with defective laboratory data on pathogen types, sensitivity, and antibiotic resistance.

STATISTICAL ANALYSIS

Data analysis and processing were performed using SPSS (Statistical Package for the Social Sciences) version 21.0 for Mac.

RESULT

Table 1. Distribution of Pathogen Samples

No	Samples	N	%
1.	Blood	27	19,6
2.	Sputum	7	5,1
3.	Urine	33	23,9
4.	CSF	4	2,9
5.	Respiratory tract secretions	4	2,9
6.	Bullae fluids	1	0,7
7.	CAPD fluids	1	0,7
8.	Drain fluids	1	0,7
9.	Pleural fluids	1	0,7
10.	Nasopharynx swabs	8	5,8

11.	Pus	16	11,6
12.	Feces	35	25,4
TOTAL		138	100

In the data analysis of a total of 138 samples from patients with pathogen infections, stool samples were the most regularly tested, encompassing 35 samples (25.4%), followed by urine samples with 33 samples (23.9%), blood samples with 27 samples (19.6%), and other samples with lower percentages.

Table 2. The Frequency of Pathogens

No	Pathogens	N	%
	Gram Negatif		
1.	*Klebsiella pneumonia*	40	28,9
2.	*Escherichia coli*	36	26,1
3.	*Pseudomonas aeruginosa*	11	7,9
4.	*Enterobacter cloacae*	10	7,2
5.	*Serratia marcescens*	3	2,2
6.	*Pseudomonas fluorescens*	1	0,7
7.	*Stenotrophomonas maltophilia*	1	0,7
8.	*Acinetobacter baumannii*	5	3,7
9.	*Burkholderia cepacia*	2	1,5
10.	*Lelliotia amnigena*	1	0,7
11.	*Serratia fonticola*	1	0,7
12.	*Enterobacter aerogenes*	4	3
	Gram Positif		
13.	*Staphylococcus aureus*	3	2,2
14.	*Staphylococcus hominis*	2	1,5
15.	*Staphylococcus haemolyticus*	3	2,2
16.	*Staphylococcus epidermidis*	10	7,2
17.	*Staphylococcus gallinarum*	1	0,7
18.	*Staphylococcus warneri*	1	0,7
19.	*Staphylococcus cohnii*	1	0,7
20.	*Enterococcus faecalis*	2	1,5
	TOTAL	138	100

The most prevailing identified pathogens were gram-negative bacteria including Klebsiella pneumoniae with a total of 40 samples (28.9%), Escherichia coli with 36 samples (26.1%), and Pseudomonas aeruginosa with 11 samples (7.9%). On the other hand, amidst gram-positive bacteria, Staphylococcus epidermidis was the most frequently identified, with 10 samples (7.2%), followed by other gram-positive and gram-negative pathogens with lower percentages.

Table 3. Distribution of Antibiotic Sensitivity by Pathogen Group

Antibiotics	**Gram Positive**		**Gram Negative**	
	N	**%**	**N**	**%**
Beta Lactam				
Ampicillin	3	3,5	8	1,6
Meropenem	-	-	96	19,4
Ceftriaxone	1	1,2	28	5,7
Ceftazidime	2	2,3	46	9,3
Amoxicillin	2	2,3	2	0,4
Ampicillin Sulbactam	-	-	21	4,4
Non Beta Lactam				
Gentamicin	11	12,8	54	10,9
Amikacin	-		98	19,8

Vancomycin	13	15,1	3	0,7
Ciprofloxacin	11	12,8	53	10,7
Sulfamethoxazole + Trimethoprim	7	8,1	30	6
Cefepime	-		45	9,1
Chloramphenicol	15	17,4	4	0,8
Erythromycin	6	7	1	0,2
Tetracycline	12	14	2	0,4
Cefotaxime	2	2,3	1	0,2
Cephazolin	1	1,2	-	-
Cefoxitin	-		2	0,4
TOTAL	86	100	494	100

On the analysis of the antibiotic sensitivity distribution, among the total of 86 sensitivity results for gram-positive pathogens, the non-beta-lactam antibiotic chloramphenicol displayed the highest sensitivity, with 15 pathogens (17.4%), followed by vancomycin with 13 pathogens (15.1%) and tetracycline with 12 pathogens (14%), besides other antibiotics from both beta-lactam and non-beta-lactam categories with lower sensitivity percentages. Among the total of 494 sensitivity results for gram-negative pathogens against non-beta-lactam antibiotics, amikacin demonstrated the highest sensitivity, with 98 pathogens (19.8%), followed by meropenem, a beta-lactam antibiotic, with 96 pathogens (19.4%), and other antibiotics, both beta-lactam and non-beta-lactam, with lower pathogen percentages.

Table 4. Distribution of Antibiotic Resistance by Pathogen Group

Antibiotics	**Gram Positives**		**Gram Negatives**	
	N	**%**	**N**	**%**
Beta Lactam				
Ampicillin	7	11,1	92	16,5
Meropenem	-	-	9	1,6
Ceftriaxone	3	4,8	67	12,1
Ceftazidime	2	3,2	63	11,3
Amoxicillin	2	3,2	4	0,7
Ampicillin Sulbactam	-	-	62	11,2
Non Beta Lactam				
Gentamicin	8	12,7	53	9,5
Ciprofloxacin	10	15,8	52	9,4
Sulfamethoxazole + Trimethoprim	12	19	64	11,5
Vancomycin	-	-	2	0,4
Amikacin	-	-	5	0,9
Cefepime	-	-	50	9
Chloramphenicol	1	1,6	2	0,3
Erythromycin	14	22,2	4	0,7
Tetracycline	2	3,2	-	-
Cefotaxime	2	3,2	1	0,2
Cephazolin	-	-	25	4,5
Cefoxitin	-	-	1	0,2
TOTAL	63	100	556	100

According to the analysis of the antibiotic resistance distribution, the non-beta-lactam antibiotic showed amongst the highest resistance against gram-positive pathogens was erythromycin, with 14 pathogens (22.2%), followed by sulfamethoxazole + trimethoprim with 12 pathogens (19%) and ciprofloxacin with 10 pathogens (15.8%), as well as other antibiotics from both beta-lactam and non-beta-lactam categories with lower pathogen percentages. Among the total of 556 sensitivity results for gram-negative pathogens, the beta-lactam antibiotic Ampicillin exhibited the highest resistance, with 92 pathogens 16.5%), followed by ceftriaxone with 67 pathogens (12.1%), and sulfamethoxazole + trimethoprim from the non-beta-lactam category with 64 pathogens (11.5%), as well as other antibiotics, both beta-lactam and non-beta-lactam, with lower pathogen percentages.

DISCUSSION

The pattern of antibiotic sensitivity and resistance in gram-positive and gram-negative pathogens has remarkably changed over recent years, attributed to various internal and external factors.[4] The limited amount of obtainable antibiotic therapies for pediatric patients presents a significant challenge.[5] Thus, ongoing surveillance programs and research on pathogen prevalence, resistance patterns, and antibiotic sensitivity are indispensable.

According to the data analysis from a total of 138 samples of patients with pathogen infections at RSUP Dr. M. Djamil Padang from January to December 2020, the most prevalent specimen locations with detected pathogens were stool (25.4%), followed by urine (23.9%), and blood (19.6%). A study conducted at RS Dr. Soetomo Surabaya, which encompassed 1,138 samples from 2011-2016, found that the most common specimen types with detected pathogens were blood (44.6%), urine (19.15%), and stool (8.96%), mainly comprising gram-negative bacteria.[6]

In this investigation gram-negative pathogens were more prevalent compared to gram-positive bacteria. The incidence of infections led by gram-negative pathogens has been increasing annually This study indicates that therapeutic options for gram-negative pathogens, particularly Klebsiella pneumoniae and Pseudomonas aeruginosa, are now very narrow, despite the fact that alternatives for other pathogens remain available.[7] Pseudomonas aeruginosa, a gram-negative bacterium, displays increasing resistance to a handful of antibiotics. gram-positive bacteria, particularly Staphylococcus species, are among the main pathogens found in bloodborne infections. Nevertheless, gram-negative bacteria are common in children, especially within the first year of life.[4] The mortality rate is higher in children with nosocomial infections and bloodstream infections acquired in healthcare facilities.[8] Considering the high mortality rates in pediatric patients, it is essential to evaluate the distribution of pathogen sensitivity and resistance to ensure relevant antibiotic treatment.[9]

This study disclosed among the five most prevalent gram-negative pathogens: Klebsiella pneumoniae (28.9%), Escherichia coli (26.1%), Pseudomonas aeruginosa (7.9%), Staphylococcus species, especially Staphylococcus epidermidis (7.2%), and Acinetobacter baumannii (3.7%). These findings are correlated with the study in Iran, which found Klebsiella pneumoniae as the most common pathogen at Children’s Medical Center Hospital, Tehran, followed by E. coli, S. marcescens, Pseudomonas aeruginosa, and Enterobacter spp. A study conducted in 2012 at RS Moewardi Yogyakarta found that gram-negative pathogens were the most common (66.04%) compared to gram-positive pathogens (33.96%).[10] However, this diverge from a study conducted in the United States, where, out of 2,423 isolated organisms, gram-positive bacteria were the most common (57%) compare to gram-negative bacteria (40.2%), with Staphylococcus aureus (26%) being the most frequent, followed by E. coli (13%), coagulase-negative staphylococci (8.3%), Enterococcus faecalis (7.1%), and Klebsiella pneumoniae (6.9%).[11] The differences in pathogen proportions is possibly attributed to population size, antibiotic regimen protocols, health awareness, and detection methods used at the respective locations.[12]

The sensitivity tests singled out three non-beta-lactam antibiotics as the most effective against gram-positive pathogens: chloramphenicol (17.4%), vancomycin (15.1%), and tetracycline (12%). This is coherent with a study where vancomycin was one of the most sensitive antibiotics, along with dalbavancin, daptomycin, linezolid, and tigecycline, showing effectiveness greater than 99.0%.[11] Chloramphenicol use is limited to short durations in multidrug-resistant (MDR) patients ascribed to its side effects, which helps in maintaining high sensitivity.[13]

As for the gram-negative pathogens, the most sensitive antibiotics were amikacin (19.8%), meropenem (19.4%), followed by gentamicin (10.9%) and ciprofloxacin (10.7%). These findings align with a study showed amikacin is 100% effectiveness against gram-negative pathogens, especially Pseudomonas aeruginosa. Antibiotic such as ceftazidime-avibactam, also showed similar effectiveness to amikacin.[11] In addition to that, amikacin demonstrated high sensitivity against E. coli from stool specimens (97.05%) and Klebsiella pneumoniae from ETT isolates (100%).[10] A study at RSUD Dr. Soetomo, Surabaya, found that E. coli, predominantly from rectal swab and urine specimens, was exceedingly sensitive to amikacin (100%) and meropenem (100%), though highly resistant to ampicillin (65%) and ampicillin-sulbactam (45%).[3] Meropenem, while still sensitive to gram-negative pathogens in the pediatric ward at RSUP Dr. M. Djamil, should be administered with caution. A systematic review from Lebanon, analyzing 192 journals from 2010-2020, found a rising prevalence of carbapenem resistance, particularly in Acinetobacter baumannii and Pseudomonas aeruginosa, in the Eastern Mediterranean region over the past decade.[14]

Excessive use of antibiotics has led to the rising of resistance levels.[15] Antibiotic resistance arise through several mechanisms, encompassing neutralizing the antibiotic, expelling it from the cell, or modifying the external structure of the bacterial cell, thereby preventing drug binding. The mechanisms of resistance are classified into two categories:

1. Intrinsic Resistance

Bacteria altering their own structure or components.

2. Acquired Resistance

Bacteria obtain new resistance genes and DNA from other resistant bacteria. Genetic changes in DNA alter protein production hence bacterial components and receptors can no longer be recognized by antibiotics. Altered DNA can be horizontally passed on to other bacteria by transformation, transduction, or conjugation.[16]

In 2017 the World Health Organization (WHO) published a list of pathogens resistant to certain antibiotics, categorized into three groups: critical, high, and medium (figure 1).[17]

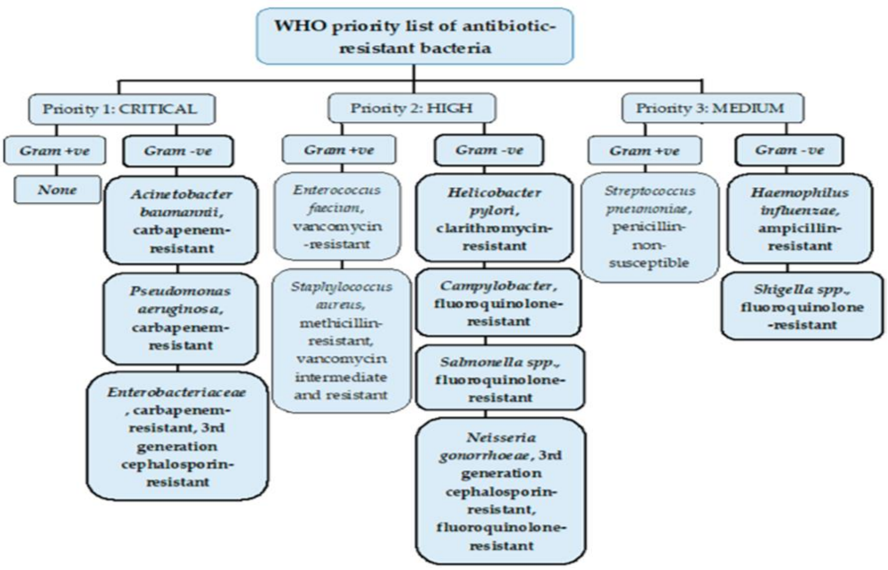

Figure 1. The WHO priority list of antibiotic resistant bacteria

The study findings specify that the antibiotics with the highest resistance levels against gram-positive pathogens were primarily non-beta-lactam antibiotics: erythromycin (22.2%), trimethoprim-sulfamethoxazole (19%), and ciprofloxacin (15.8%). These results are relevant with a study conducted in Turkey, reported the resistance levels against Gram-positive pathogens, particularly Staphylococcus aureus, including erythromycin (18%), trimethoprim-sulfamethoxazole (6%), and ciprofloxacin (21.95%).[18]

In the number of gram-negative pathogens, amongst the three antibiotics with the highest resistance levels were all beta-lactam antibiotics: ampicillin (16.5%), ceftriaxone (12.1%), and ceftazidime (11.3%). This finding coherent with the study in Iran, which indicated that E. coli strains have a high resistance rate to ampicillin (96%).[19]

Various limitations of this study should be remarked. First this study was a retrospective study not a cross-sectional study. Secondly the study could not determine the mortality rate or the effectiveness of the antibiotics administration. Third it is unclear whether the antibiotic resistance observed in the respondents originated from RSUP Dr. M. Djamil or outside. Hence, further investigation is suggested to probe the risk factors associated with antibiotic resistance at the hospital.

CONCLUSION

The five most frequently identified gram-negative pathogens were Klebsiella pneumoniae, Escherichia coli, Pseudomonas aeruginosa, Staphylococcus species, particularly Staphylococcus epidermidis, and Acinetobacter baumannii. The majority of sensitive antibiotics against gram-positive pathogens were non-beta-lactam antibiotics comprising, chloramphenicol, vancomycin, and tetracycline. Amikacin, meropenem, gentamicin, and ciprofloxacin were among the most sensitive antibiotics against gram-negative pathogens. This study needs to be continued so that antibiotic therapy can be given based on microbial pattern.

Declaration by Authors

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