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A study of Antibiotic Susceptibility Pattern of Bacteria Isolates in Blood Culture in septicemic Children in Tertiary Care Hospital

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Abstract **Original Research Article**

Introduction: Sepsis in children is a life-threatening condition triggered by an infection. Most commonly, the infection is caused by bacteria. Antibiotic susceptibility patterns of bacterial isolates in blood cultures play a crucial role in the management of septicemia in children. ***Aim of the study:*** The aim of this study was to assess the antibiotic susceptibility pattern of bacteria isolates in blood culture in septicemic children. ***Methods:*** This cross-sectional study was conducted in Department of Paediatric, Dr. Sirajul Islam Medical College, Dhaka, Bangladesh, during the period from October 2021 to February 2023. Total 849 children aged less than 18 years with septicemia were included in this study. ***Result:*** The study involved 849 participants where majority were in the age group of 5 years or younger and with a near-even gender distribution. In this study, 10.1% tested positive for bacterial growth in blood cultures, with Pseudomonas (33.7%) and Staphylococcus epidermidis (22.1%) being most prevalent. Other organisms were also detected in varying proportions. The distribution of these organisms varied according to age and sex. Antibiotic sensitivity and resistance patterns were observed. A range of antibiotics showed different effectiveness, with varying levels of sensitivity and resistance against the bacterial isolates. Notably, Pseudomonas displayed considerable sensitive to cephalosporins (24.4%) and carbapenems (11.6%). ***Conclusion:*** The current study found that pseudomonas, staphylococcus epidermidis, and staphylococcus aureus were the most prevalent. Notably, a significant percentage of these bacteria displayed varying levels of antibiotic resistance, underscoring the challenge of managing sepsis in pediatric patients. These findings highlight the need for continuous surveillance of bacterial isolates and their resistance patterns.

Keywords: Antibiotic Susceptibility Pattern, Bacteria Isolates, Blood Culture, and Septicemic Children.

I. INTRODUCTION

Globally, bacterial infections are a major source of illness and mortality, but developing countries bear the brunt of this burden. [1] the most common cause of sepsis, or systemic inflammatory reaction syndrome, is bacteremia. [2-5] Timely and effective antibiotic usage is crucial for patient survival, but the standard microbiological diagnosis of infection can take days, leading to delays in accurate antibiotic therapy. [6] This delay can result in not only poor clinical outcomes but also a rise in antibiotic resistance due to the widespread use of empirical broad-spectrum antibiotics. [6].

Fever, tachycardia, tachypnea, leucopenia/leukocytosis, or the presence of more than 10% immature neutrophils are sepsis diagnostic criteria that are less sensitive and non-specific to bacterial infection. [7]. Thus, the conclusive diagnosis on which antimicrobial therapy should be based is provided by bacterial isolation from blood samples and antibiotic sensitivity testing. [8].

Antibiotic abuse and misuse are common, with the potential of antimicrobial resistance as a result, yet these studies are often unavailable or the results are delayed, particularly in settings with limited resources. [9]. Previous studies have shown that the causative bacteria of sepsis can vary depending on the geographical location of the hospital. [10] For instance, a study conducted in Rajshahi, Bangladesh, found that E. coli was the most frequent infection, followed by Staphylococcus aureus, Candida albican, Klebsiella pneumoniae, Staphylococcus epidermidis, Salmonella spp., Streptococcus viridans, and Pseudomonas aeruginosa. [11].

Another study conducted in China found that coagulase-negative Staphylococci (CoNS) were the most common isolate, followed by Klebsiella pneumoniae and Escherichia coli. [10]. Empirical

antibiotic treatment should be unit-specific and based on the spectrum of etiological agents that are prevalent and their pattern of antibiotic sensitivity in the management of sepsis in the pediatric age group. [12,13].

From one location to another, septicemia's early warning signs and symptoms might differ. [14]. For the purpose of early detection and identification of blood stream pathogens, it is crucial to conduct studies to confirm pediatric sepsis. Blood is often sterile, therefore blood cultures are essential for making an accurate diagnosis of blood stream infections and choosing the right medications for the following therapy of septic neonates and children. Blood cultures also have a high positive predictive value. [15].

Numerous aspects should be taken into account when choosing an empiric medication, including the kind of pathogen that is most likely to be the source of the illness based on age, gender, risk factors, and antibiotic susceptibility patterns. Antibiotic resistance is a growing concern. A study in Pakistan found that all isolates were 100% resistant to amoxicillin-clavulanic acid. [16].

This resistance to antibiotics poses a significant challenge to the treatment of septicemia in children, emphasizing the need for continuous surveillance of antibiotic susceptibility to ensure efficient therapeutic outcomes. [10] The current study was conducted to assess the antibiotic susceptibility pattern of bacteria isolates in blood culture in septicemic children.

II. OBJECTIVES

To assess the antibiotic susceptibility pattern of bacteria isolates in blood culture in septicemic children.

III. METHODOLOGY & MATERIALS

This cross-sectional study was conducted in Department of Paediatric, Dr. Sirajul Islam Medical College, Dhaka, Bangladesh, during the period from October 2021 to February 2023. Total 849 children aged less than 18 years with septicemia were included in this study. Blood culture test was done for every children. Positive bacterial cultures were seen in 86 (10.1%) individuals. Antibiotic sensitivity and resistance were also assessed. Consent of the patient's guardians were taken before collecting data. After collection of data, all data were checked and cleaned. After cleaning, the data were entered into computer and statistical analysis of the results being obtained by using windows-based computer software devised with Statistical Packages for Social Sciences version 22.

IV. RESULT

Table-I, figure 1, 2 & 3 provides the demography of the study population, consisting of a total of 849 participants. Regarding age distribution, the study participants were divided into two groups: those aged 5 years or younger and those older than 5 years. Among the participants, 56.2% belonged to the ≤5 years age group, while 43.8% were older than 5 years. In terms of gender, the study population was almost evenly distributed, with 51.1% identified as male and 48.9% as female. Out of the total participants, 10.1% tested positive for bacterial growth in their blood culture, indicating septicemia, while the majority, 89.9%, tested negative.

The most commonly identified organism was Pseudomonas, accounting for 33.7% of the isolates. Staphylococcus epidermidis was the second most prevalent organism, constituting 22.1% of the isolates. Other identified organisms included Candida (9.3%), Klebsiella, Acinetobacter (7.0%), Enterobacter (5.8%), Salmonella typhi (3.5%), and Staphylococcus aureus (12.8%).

Table-II provides information on the pattern of organisms isolated from blood cultures in septicemic children, categorized by age groups. Among the 86 organisms found, Pseudomonas was the most prevalent, accounting for 22.1% of the isolates in the ≤5 years age group and 11.6% in the 5-18 years age group. Staphylococcus epidermidis was the second most commonly found organism, constituting 14.0% of the isolates in the ≤5 years age group and 8.1% in the 5-18 years age group. Table-III presents the distribution of different organisms isolated from blood cultures in septicemic children, categorized by sex. Pseudomonas was the most commonly found organism, accounting for 14.0% of the isolates in males and 19.8% in females. Staphylococcus epidermidis was the second most prevalent organism, constituting 12.8% of the isolates in males and 9.3% in females. Candida was found in 7.0% of the isolates in males and in 2.3% in females.

Similarly, Klebsiella accounted for 2.3% of the isolates in males and 3.5 in females. Acinetobacter and Enterobacter were both identified in a similar proportion among male and female children, with Acinetobacter accounting for 2.3% in males and 4.7% in females, and Enterobacter accounting for 3.5% in males and 2.3% in females. Salmonella typhi was found in 1.2% of the isolates in males and 2.3% in females. Staphylococcus aureus was identified in 7.0% of the isolates in males and 5.8% in females.

Table-IV presents the antibiotic sensitivity and resistance pattern of the bacterial isolates obtained from blood cultures in septicemic children. Novobiocin had 14.0% sensitivity with no resistance observed. Cefoxitin showed 19.8% sensitivity and 11.6% resistance. Ceftazidime exhibited 22.1% sensitivity and 17.4% resistance. Gentamycin displayed 37.2% sensitivity and

23.3% resistance. Ciprofloxacin had 46.5% sensitivity and 34.9% resistance. Tetracycline showed 24.4% sensitivity with no resistance. Colistin exhibited 26.7% sensitivity and 15.1% resistance. Cefepime had 19.8% sensitivity and 11.6% resistance. Meropenem showed 24.4% sensitivity and 27.9% resistance. Vancomycin had 30.2% sensitivity with no resistance.

Co-Trimoxazole showed equal rates of sensitivity and resistance, both at 38.4%. Linezolid displayed 29.1% sensitivity with no resistance. Penicillin G had 9.3% sensitivity and 14.0% resistance. Amoxicillin showed 10.5% sensitivity and 37.2% resistance. Erythromycin exhibited 7.0% sensitivity and 24.4% resistance. Amikacin had 32.6% sensitivity and 12.8% resistance. Piperacillin showed 14.0% sensitivity and 9.3% resistance. Netilmicin exhibited 25.6% sensitivity and 14.0% resistance.

Tigacycline had 8.1% sensitivity and 2.3% resistance. Chloramphenicol showed 5.8% sensitivity with no resistance. Cefixime displayed 4.7% sensitivity and 4.7% resistance. Ceftriaxone had 10.5% sensitivity and 12.8% resistance. Table-V displays the antibiotic sensitivity of different organisms isolated from blood cultures in septicemic children. Among Pseudomonas isolates, cephalosporin exhibited the highest sensitivity, with 33.7% of Pseudomonas isolates being susceptible to this antibiotic.

Carbapenem displayed a sensitivity of 16.3% against Pseudomonas, while aminoglycoside showed sensitivity in 27.9% of the Pseudomonas isolates. For Staphylococcus epidermidis, cephalosporin exhibited a sensitivity of 24.4%, and tetracycline showed the highest sensitivity of 15.1%. Novobiocin, ciprofloxacin, colistin, vancomycin, co-trimoxazole, linezolid, penicillin G, amoxicillin, piperacillin, chloramphenicol, erythromycin, and netilmicin displayed varying degrees of sensitivity against Staphylococcus epidermidis.

Klebsiella showed sensitivity to cephalosporin in 2.3% of cases, while aminoglycoside displayed no observed sensitivity. Acinetobacter showed varying degrees of sensitivity to carbapenem, aminoglycoside, tetracycline, and ciprofloxacin. Enterobacter displayed sensitivity to cephalosporin, aminoglycoside, and colistin. Salmonella typhi showed sensitivity to cephalosporin, aminoglycoside, and colistin, while Staphylococcus aureus exhibited sensitivity to cephalosporin, aminoglycoside, tetracycline, ciprofloxacin, vancomycin, co-trimoxazole, linezolid, penicillin G, amoxicillin, and netilmicin.

Table-VI provides information on antibiotic resistance in different organisms isolated from blood cultures in septicemic children. In terms of cephalosporin resistance, Pseudomonas exhibited the highest percentage with 24.4%, followed by Staphylococcus epidermidis at 17.4%. Other organisms displayed lower resistance rates. For carbapenems, Pseudomonas exhibited 11.6% resistance, while other organisms showed either lower resistance or no resistance. Aminoglycosides demonstrated varying resistance rates across different organisms, with Pseudomonas displaying 14% resistance.Other organisms exhibited resistance to a lesser extent.

Tetracycline resistance was observed solely in Staphylococcus epidermidis (1.2%) and Staphylococcus aureus (1.2%). Pseudomonas showed resistance to ciprofloxacin at a rate of 9.3%, and Staphylococcus epidermidis exhibited resistance at a rate of 11.6%. Other organisms displayed lower resistance rates. Colistin showed resistance solely in Pseudomonas at a rate of 14%, while the other organisms did not demonstrate resistance. Co-Trimoxazole exhibited resistance primarily in Staphylococcus epidermidis (12.8%) and Staphylococcus aureus (9.3%), with the remaining organisms displaying lower resistance rates. The resistance patterns for Penicillin G, Amoxicillin, Erythromycin, and Netilmicin varied across different organisms, with some showing resistance at relatively lower rates while others demonstrated no resistance.

Table I: Demographic characteristics (N=849)

Characteristics		**n**	**%**
Age (Years)	≤5	477	56.2
	5-18	372	43.8
Sex	Male	434	51.1
	Female	415	48.9
Blood culture test	Positive	86	10.1
	Negative	763	89.9
Name of organism	Pseudomonas	29	33.7
	Staphylococcus epidermidis	19	22.1
	Staphylococcus aureus	11	12.8
	Candida	8	9.3
	Acintobacter	6	7.0
	Klebsiella	5	5.8
	Enterobacter	5	5.8
	Salmonella typhi	3	3.5

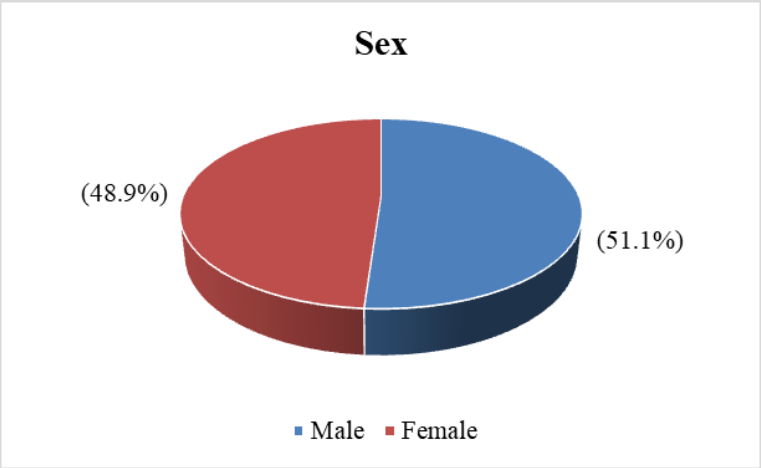

Figure 1: Sex distribution of the study subjects (N=849)

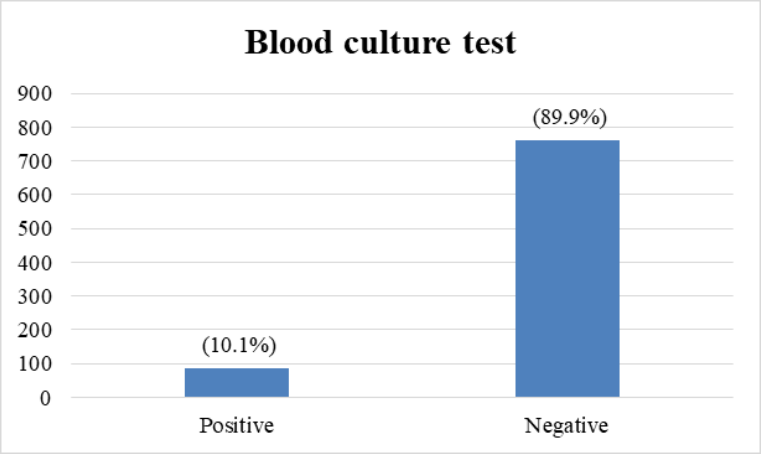

Figure 2: Blood culture test of the study subjects (N=849)

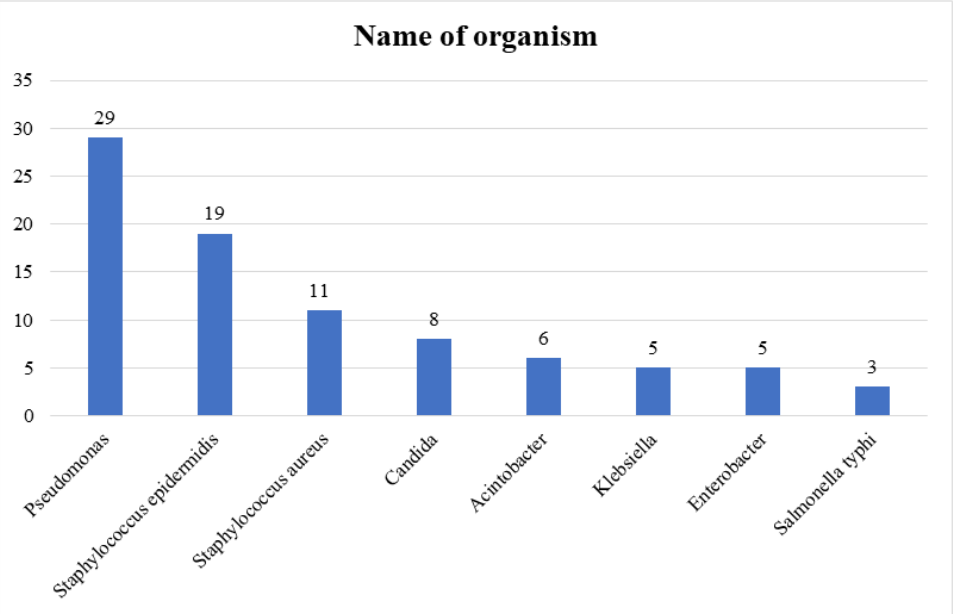

Figure 3: Name of organism (N=86)

Table II: Pattern of organisms between age groups (N=86)

Organism found	Age			
	≤5 years		5-18 years	
	n	%	n	%
Pseudomonas	19	22.1	10	11.6
Staphylococcus epidermidis	12	14.0	7	8.1
Staphylococcus aureus	8	9.3	3	3.5
Candida	7	8.1	1	1.2
Klebsiella	2	2.3	3	3.5
Acintobacter	4	4.7	2	2.3
Enterobacter	2	2.3	3	3.5
Salmonella typhi	2	2.3	1	1.2
Total	56	65.1	30	34.9

Table III: Pattern of organisms between male and female children (N=86)

Organism found	Sex			
	Male		Female	
	n	%	n	%
Pseudomonas	12	14.0	17	19.8
Staphylococcus epidermidis	11	12.8	8	9.3
Candida	6	7.0	2	2.3
Klebsiella	2	2.3	3	3.5
Acintobacter	2	2.3	4	4.7
Enterobacter	3	3.5	2	2.3
Salmonella typhi	1	1.2	2	2.3
Staphylococcus aureus	6	7.0	5	5.8
Total	43	50.0	43	50.0

Table IV: Antibiotic sensitivity and resistance pattern (N=86)

Antibiotics	Sensitivity		Resistance	
	n	%	n	%
Novobiocin	12	14.0	0	0.0
Cefoxitin	17	19.8	10	11.6
Ceftazidime	19	22.1	15	17.4
Gentamycin	32	37.2	20	23.3
Ciprofloxacin	40	46.5	30	34.9
Tetracycline	21	24.4	0	0.0
Colistin	23	26.7	13	15.1
Cefepime	17	19.8	10	11.6
Meropenem	21	24.4	24	27.9
Vancomycin	26	30.2	0	0.0
Co-Trimoxazole	33	38.4	33	38.4
Linezolid	25	29.1	0	0.0
Penicillin G	8	9.3	12	14.0
Amoxiciline	9	10.5	32	37.2
Erythromycin	6	7.0	21	24.4
Amikacin	28	32.6	11	12.8
Piperacillin	12	14.0	8	9.3
Netilmicin	22	25.6	12	14.0
Tigacycline	7	8.1	2	2.3
Chloramphenicol	5	5.8	0	0.0
Cefixime	4	4.7	4	4.7
Ceftriaxone	9	10.5	11	12.8

Table V: Antibiotic sensitivity in the organism (N=86)

Sensitivity	Pseudoms	Staph.epi.	Klebsiela	Acintobactr	Enterobactr	Salmonela typhi	Staph. aureus
Cephalosporin	29(33.7%)	21(24.4%)	2(2.3%)	3(3.5%)	4(4.7%)	10(11.6%)	15(17.4%)
Carbapenem	14(16.3%)	0	0	1(1.2%)	2(2.3%)	1(1.2%)	2(2.3%)
Aminoglycose	24(27.9%)	12(14%)	0	9(10.5%)	3(3.5%)	2(2.3%)	7(8.1%)
Tetracycline	0	13(15.1%)	3(3.5%)	3(3.5%)	0	0	8(9.3%)
Novobiocin	0	12(14%)	0	0	0	0	0
Ciprofloxacin	18(20.9%)	9(10.5%)	0	0	2(2.3%)	2(2.3%)	5(5.8%)
Colistin	12(14%)	0	4(4.7%)	3(3.5%)	3(3.5%)	1(1.2%)	0
Vancomycin	0	17(19.8%)	0	0	1(1.2%)	0	8(9.3%)
CoTrimoxaze	16(18.6%)	7(8.1%)	0	1(1.2%)	1(1.2%)	1(1.2%)	6(7%)
Linezolid	0	18(20.9%)	0	0	0	0	7(8.1%)
Penicillin G	0	6(7%)	0	0	1(1.2%)	0	1(1.2%)
Amoxiciline	1(1.2%)	4(4.7%)	0	0	1(1.2%)	1(1.2%)	2(2.3%)
Piperacillin	8(9.3%)	0	0	2(2.3%)	2(2.3%)	0	0
Chloramphenl	2(2.3%)	0	1(1.2%)	0	1(1.2%)	1(1.2%)	0
Erythromycin	0	5(5.8%)	0	0	0	0	1(1.2%)
Netilmicin	6(7%)	4(4.7%)	0	3(3.5%)	1(1.2%)	1(1.2%)	7(8.1%)

Table VI: Antibiotic resistance in the organism (N=86)

Resistance	Pseudo	Staph. epi.	Klebsiella	Acintobacter	Enterobacter	Salmonella typhi	Staph. aureus
Cephalosporin	21(24.4%)	15(17.4%)	11(12.8%)	7(8.1%)	4(4.7%)	2(2.3%)	7(8.1%)
Carbopenem	10(11.6%)	3(3.5%)	5(5.8%)	4(4.7%)	1(1.2%)	0	1(1.2%)
Amino glycoside	12(14%)	4(4.7%)	7(8.1%)	4(4.7%)	2(2.3%)	1(1.2%)	1(1.2%)
Tetracycline	0	1(1.2%)	0	0	0	0	1(1.2%)
Ciprofloxacin	8(9.3%)	10(11.6%)	3(3.5%)	2(2.3%)	3(3.5%)	1(1.2%)	3(3.5%)
Colistin	12(14%)	0	0	1(1.2%)	0	0	0
Co-Trimoxazole	8(9.3%)	11(12.8%)	3(3.5%)	5	3(3.5%)	1(1.2%)	2(2.3%)
Penicillin G	0	6(7%)	0	0	0	0	6(7%)
Amoxiciline	4(4.7%)	9(10.5%)	3(3.5%)	3(3.5%)	3(3.5%)	2(2.3%)	8(9.3%)
Piperacillin	0	0	0	0	0	0	0
Erythromycin	0	15(17.4%)	0	0	0	0	6(7%)
Netilmicin	6(7%)	0	4(4.7%)	1(1.2%)	1(1.2%)	0	0

V. DISCUSSION

The findings from the current study demonstrate the importance of bacteriological analysis in the management of septicemia in children, a condition that is both life-threatening and challenging to diagnose and treat. The data reflects the global issue of antibiotic resistance in bacterial infections and reiterates the significance of regular monitoring of antibiotic sensitivity patterns. [17].

In our study, a significant portion of the participants were under the age of five, which aligns with data that suggests children under five are more susceptible to bacterial infections. [18]. The presence of bacterial growth in 10.1% of the blood cultures obtained in the study provides insight into the proportion of septicemia cases attributed to bacterial infections, a finding that corroborates studies conducted in similar contexts. [19].

The distribution of bacterial species identified in our study indicates Pseudomonas and Staphylococcus epidermidis as the most common isolates. Both bacteria are commonly associated with septicemia, especially in healthcare-associated infections. [20, 21].

This finding reiterates the importance of controlling for these pathogens in pediatric healthcare settings. The patterns of antibiotic sensitivity and resistance are of utmost importance in our study. It was observed that Novobiocin, Tetracycline, Vancomycin, and Linezolid showed no resistance, which indicates their effectiveness for treating septicemia caused by the bacterial species studied. These findings parallel the results from earlier research suggesting these antibiotics are relatively potent in treating bacterial infections. [22, 23].

However, resistance was observed in a majority of antibiotics tested, a trend that aligns with

the global increase in antibiotic resistance. [24]. Ciprofloxacin, once considered potent against many bacterial infections, showed resistance in 34.9% of the isolates, a finding that mirrors worldwide patterns of increasing resistance. [25].

Likewise, the high resistance rate to Penicillin G and Amoxicillin aligns with global studies documenting widespread resistance to these antibiotics. [26]. as for organism-specific antibiotic sensitivity, it was found that cephalosporin had the highest sensitivity against Pseudomonas isolates. This is in line with earlier studies that document cephalosporin's effectiveness against this organism. [27].

The highest sensitivity of Staphylococcus epidermidis was observed towards Tetracycline, a finding that corroborates previous research. [28]. In terms of antibiotic resistance, Pseudomonas displayed the highest sensitivity to Cephalosporin, while resistance to Carbapenems and Aminoglycosides was observed to a lesser extent. These findings are consistent with previous studies that have documented increased resistance to these classes of antibiotics in Pseudomonas. [29]. Similarly, Staphylococcus epidermidis showed high resistance to Cephalosporin and Ciprofloxacin, reinforcing the emerging global pattern of multi-drug resistance in this bacterium. [20].

The findings underscore the importance of routine monitoring of antibiotic resistance to guide effective treatment strategies. The emergence of resistance in key pathogens, especially Pseudomonas and Staphylococcus epidermidis, is a concern that requires attention from healthcare providers and policy-makers alike.

Limitations of the Study

In our study, there was small sample size and absence of control for comparison. Study population was selected from one center in Dhaka city, so may not represent wider population. The study was conducted at a short period of time.

VII. CONCLUSION AND RECOMMENDATIONS

The current study found that pseudomonas, staphylococcus epidermidis, and staphylococcus aureus were the most prevalent. Notably, a significant percentage of these bacteria displayed varying levels of antibiotic resistance, underscoring the challenge of managing sepsis in pediatric patients. These findings highlight the need for continuous surveillance of bacterial isolates and their resistance patterns. Timely and accurate identification of these pathogens and their sensitivity profiles can optimize antibiotic use and improve treatment outcomes in septicemic children. Future research should explore novel strategies to overcome growing antibiotic resistance.

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