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ORIGINAL ARTICLE

Bacterial Spectrum and Associated Sociodemographic Factors in Pediatric Blood Stream Infections at Tertiary Care Hospital

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ABSTRACT

Aim: To determine the bacterial spectrum and the frequency of sepsis in infants and children presenting to a tertiary care hospital, as well as its association with sociodemographic factors.
Methods: This retrospective cross-sectional research was performed at the Department of Pediatrics, Ziauddin University Hospital Karachi. A total of 199 children records in the age group from 29 days to 12 years of age with a report of positive blood culture were included in the study. Non-probability consecutive sampling technique was used. Records were reviewed retrospectively and demographic data collected such as gender, age, diagnosis, type of admission (medical or surgical), length of stay in the hospital, and primary diagnosis with associated co-morbidities. SPSS was used for statistical analysis. The findings of quantitative variables were reported in terms of mean and standard deviation and qualitative variables in terms of frequency and percentages. Inferential statistics were analyzed by using Chi-square for comparing positivity of culture with baseline characteristics and a p-value of ≤0.05 was considered significant.
Results: The mean age of the study population and the mean duration of hospital stay were 45.95±37.15 months and 7.61±3.61 days respectively. Out of a total of 199 cases with positive blood culture findings for bacterial isolates, coagulase negative staphylococci were found in 95(47.7%), Staphylococci Aureus in 57(28.6%), Streptococci species in 54(27.1%), E. Coli in 24(12.1%), Pseudomonas Aeruginosa in 14(7%), Klebsiella Pneumonia in 13(6.5%), Enterococcus species in 11(5.5%).
Practical implication: Sepsis in the pediatric age group is associated with a high mortality and increased length of hospital stay. Early diagnosis and prompt treatment is the key to improve outcome of sepsis.
Conclusion: There is a high prevalence of sepsis in children less than 48 months of age, more commonly in children with incomplete vaccination, female gender, decreased maternal educational level and a lower socioeconomic status especially in blood culture positive cases with unusual organisms such as Pseudomonas, Acinetobacter and gram-negative bacilli
Keywords: Sepsis, Tertiary care, Pediatric intensive care, gram positive organism

INTRODUCTION

Sepsis is a serious condition that rapidly becomes life-threatening due to the spread of microorganisms and their toxins in the blood.[1] In the pediatric age group blood stream infections are very common and considered to be a major cause of morbidity and mortality in infants and children[2]. Due to a weak immune barrier, infants and children are the most susceptible population group to contract illnesses[3]. Sepsis in children is an emergency and any delay in treatment may cause death. Sepsis is a common cause of mortality and morbidity in infants and children throughout the world. Community acquired pneumonia in children commonly causes sepsis and has an approximate incidence of 0.29 episodes per child-year in developing and 0.05 episodes per child-year in developed countries[4].

Early signs of sepsis are insignificant and not specific. Hence, in patients in whom sepsis is suspected, empirical antibiotic therapy should start immediately without any delay for the blood culture and sensitivity reports[5]. Sepsis is a serious global health issue especially in developing countries, resulting in significant health burdens on the already limited resources and productivity as well as negative effects on health and quality of life[6].

Appropriate selection and early treatment with antibiotics minimize the threat of severe morbidity and mortality in sepsis. The rational use of antibiotics reduces the development of multi-drug resistant organisms in intensive care units[7]. Some pathogens causing sepsis are associated with poor prognosis, particularly fungi, and infections with antibiotic-resistant bacteria, including methicillin resistant staphylococcus aureus (MRSA), gram-negative bacilli, and hospital-acquired pathogens such as Pseudomonas aeruginosa. Although a number of risk factors have been identified septic shock[8].

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Blood cultures have a high positive predictive value as the blood is normally sterile and are therefore, indispensable in the diagnosis of blood stream infections and their results guide the appropriate choice of antibiotics in the management of sepsis. The distribution of bacterial pathogens producing sepsis in a specific hospital setup is usually considered as a prime factor for selecting empiric therapy. Several other factors should also be considered including the gender, age, antibiotic susceptibility pattern and the pathogen type that is most possibly involved in that particular setup. The culture results and clinical improvement will then guide de-escalation and length of treatment. In order for the efficient diagnosis of pediatric sepsis, there is a need to understand the diagnosis, underlying risk factors, bacteriological profile and antimicrobial susceptibility pattern at all levels of the health system[9]. The response to antimicrobial drugs may vary considerably over the passage of time and across different regions, undermining the efficacy of empirical therapy. The availability of bacteriological spectrum in the local context enables physicians to initiate antimicrobial stewardship in hospitals which would help in improving the effective use of antibiotics in children. This is because antibiogram would provide doctors with a rational guideline when prescribing empirical antibiotics to treat bacterial infections, particularly life-threating infections such as sepsis locally and internationally[10].

Review of literature reveals considerable gaps in knowledge regarding the causative organisms of pediatric sepsis in different age groups especially in resource limited settings and the risk factors in the local context which if addressed could lead to a considerable decrease in the number of cases with sepsis[11]. In Pakistan as well as in other developing countries, limited research data is available on sepsis in children as only few research studies have been performed to identify common bacterial pathogens associated with neonatal and pediatric sepsis in private tertiary

care hospital settings. Furthermore, there are gaps in literature pertaining to the sociodemographic factors related to sepsis in children and the causative organisms responsible in the local context as these can help in providing recent surveillance data of these infections. The bacterial spectrum in pediatric sepsis varies in the context of variables like demographic, cultural, socioeconomic and co-morbid conditions[12]. There is a dearth of national-level data on pediatric sepsis outcomes from developing countries. Moreover, the pattern of microbiology varies from one hospital to another with variable susceptibility to antibiotics. Since this research was performed at a tertiary care hospital, the results help in depicting a realistic picture of the bacterial spectra largely responsible for pediatric sepsis in the local settings. Prevention of sepsis includes vaccination and prevention of healthcare-associated infections. More research and education for awareness of sepsis is needed to improve care[13]. This study provides research data that would help in the development of effective antimicrobial guidelines and protocols to manage sepsis in a better manner, thereby improving the local health care standards as the rationale of sepsis management protocol must be decided on appropriate and sufficient knowledge of the causative organism in the related area.

The objective of the current research was to determine the bacterial spectrum and the frequency of sepsis in infants and children presenting to a tertiary care hospital, as well as its outcome and association with sociodemographic factors. This study will thus, be helpful in reducing severe morbidity and mortality from pediatric sepsis through development of local, evidence based clinical guidelines.

METHODOLOGY

This retrospective cross-sectional research was performed at the Department of Pediatrics, Ziauddin University Hospital Karachi from December 2020 to December 2021. Approval was taken from Ethical Review Committee Ziauddin University Reference Code 5900922HMPED. All information was kept confidential and was used only for research purpose. Sample size was calculated using the WHO sample size calculator by using following parameters the prevalence of 4.9% at 3% margin of error and 95% confidence level. The required sample size came out to be 199 patients. Non-probability consecutive sampling technique was used.

A total of 199 children record in the age group from 29 days to 12 years with a report of positive blood culture were involved in the study. Children with a record of febrile seizure, urinary tract infection, malaria, dengue fever, typhoid fever, pneumonia, meningitis or encephalitis and congenital heart disease were excluded from the study.

The researchers reviewed the medical records retrospectively of all children aged 29 days to 12-years admitted to the pediatric wards or pediatric intensive care unit (PICU) either from the emergency department or the out-patient clinics with the diagnosis of sepsis. For every patient, demographic data like gender, age, diagnosis, type of admission (medical or surgical) ,length of stay in hospital, primary diagnosis with associated co-morbidities was extracted. Regarding laboratory reports, the blood sample processing for culture and identification of isolates was done by same standard method in the hospital laboratory.

SPSS version 20 was used for statistical analysis. The findings of quantitative variables (age and duration of symptoms of sepsis) were reported in terms of mean and standard deviation and qualitative variables (gender, place of residence, family monthly income, educational status of mother and bacterial spectrum)were expressed in terms of frequency and percentages. Inferential statistics were analyzed by using chi-square test for comparison of blood culture positivity with baseline characteristics. A p value of ≤0.05 was considered as significant.

RESULTS

Out of a total of 1245 patients admitted during the study period, 199 children had a positive blood culture. The prevalence of culture positive sepsis was 15.98%. The mean age of the study population was 45.95 ± 37.15 months. Gender distribution revealed 127(63.8%) females and 72(36.20%) males. There were 138(69.30%) children ≤48 months of age and 61 (30.70%) were >48 months old. The mean length of hospital stay of the study population was 7.61±3.61 days. There were 139 (69.8%) children with ≤8 days of duration of hospital stay whereas 60 (30.2%) with >8 days length of hospital admission. With regards to the socioeconomic status, 113 (56.8%) children with sepsis were from low, 60(30.2%) middle, and 26(13%) high income families. Majority of the children i.e. 128, were urban residents. Maternal education status revealed that 108 mothers (54.3%) had no formal education, 76(38.2%) had attained primary education and 15(8%) had an educational status of secondary or more. With regards to the vaccination status of the study population, in the majority i.e. 104 children, vaccination was incomplete, 32 were unvaccinated and 63 were completely vaccinated.

Bacterial spectrum revealed coagulase negative staphylococci to be isolated in majority 95(47.7%) of the positive blood cultures followed by Staphylococci aureus in 57 (28.6%), Streptococci species in 54(27.1%), E. Coli in 24(12.1%), Pseudomonas aeruginosa in 14 (7.0%), Klebsiella pneumonia in 13 (6.5%), Enterococcus species in 11(5.5%), and Acinetobacter in 10(5%) children (Table I).

Comparison was done to see the effect of bacterial spectrum on the baseline characteristics. A few significant associations were observed between the bacteriological profile and baseline characteristics. In case of coagulase negative staphylococcus infection about 70% of the children had a hospital stay of less than or equal to 8 days as compared to infection with organisms like Pseudomonas aeruginosa, Klebsiella pneumoniae or Acinetobacter wherein the duration of admission was significantly longer (p-value 0.040) . With regards to gender, Streptococcus species was mostly reported in male children with a significant p - value (0.005). Detailed Results are shown in table II. All the children with blood culture positivity with Enterococcus species were less than 48 months of age and this finding was significant (p -value 0.023) as compared to infection with other species. However, most children with Acinetobacter infection were aged more than 48 months with a significant p - value (0.039). The focus of infection was respiratory in 61.5% cases, followed by abdominal in 15.5%, in 6 % neurological, 3% renal and in 14% no cause was identified. A total of 14.5% required mechanical ventilation. Most children with a positive blood culture belonged to the low socioeconomic group. However, Enterococcus species was mostly isolated in the blood cultures of children belonging to high income families with a significant p -value (0.005). Detailed Results are shown in table III. Regarding the outcome of children with a positive blood culture, majority i.e. 172 (86.4 %) were discharged, 21 (10.6%) expired and 6 (3%) left against medical advice.

Table I : Bacterial spectrum of the children with suspected sepsis (n=199)

Isolated Microorganism	**n**	**%age**
Klebsiella Pneumonia	13	6.5
Pseudomonas Aeruginosa	12	7.0
E. Coli	15	7.5
Acinetobacter	10	5.02
Staphylococci Aureus	47	23.1
Coagulase negative staphylococci	66	33.1
Streptococci spp.	25	12.2
Enterococcus	11	6.03

Table II: Comparison of Common organisms in culture with baseline characteristics

Baseline characteristics	Total n=199	Coagulase Negative Staphylococcus	p-value	Staphylococcus aureus	p-value	Streptococcus spp.	p-value	E. Coli	p-value
Age (Month)									
≤48	138(69.3)	66(69.5)	0.970	35 (61.4)	0.124	35(64.8)	0.397	20 (83.3)	0.113
>48	61 (30.7)	29(30.5)		22 (38.6)		19(35.2)		4 (16.7)	
Gender									
Female	72 (36.2)	40(42.1)	0.096	20 (35.1)	0.839	11(20.4)	**0.005**	6 (25.0)	0.224
Male	127(63.8)	55(57.9)		37 (64.9)		43(79.6)		18 (75.0)	
Duration of Sepsis (days)									
≤8	139(69.8)	73(76.8)	**0.040**	36 (63.2)	0.193	34(63.0)	0.196	18 (75.0)	0.558
>8	60 (30.2)	22(23.2)		21 (36.8)		20(37.0)		6 (25.0)	
Residence									
Rural	48 (24.1)	24(25.3)	0.719	12 (21.1)	0.522	14(25.9)	0.716	4 (16.7)	0.363
Urban	151(75.9)	71(74.7)		45 (78.9)		40(74.1)		20 (83.3)	
Family Income									
Low	113(56.8)	59(62.1)	0.140	27 (47.4)	0.066	30(53.7)	0.785	13 (54.2)	0.465
Middle	60 (30.2)	28(29.5)		24 (42.1)		18(35.2)		6 (25.0)	
High	26 (13.1)	8(8.4)		6 (10.5)		6(11.1)		5 (20.8)	
Education Status Of Mother									
Illiterate	108(54.3)	52(54.7)	0.553	30 (52.6)	0.920	108 (54.3)	0.488	14 (58.3)	0.328
Primary or less	76(38.2)	34(35.8)		23 (40.4)		76 (38.2)		10 (41.7)	
Secondary or more	15(7.5)	9(9.5)		4 (7.0)		15 (7.5)		0 (0)	

Table III: Comparison of less common organisms in culture with baseline characteristics

Baseline characteristics	Total n=199	Pseudomonas aeruginosa	p-value	Klebsiella pneumoniae	p-value	Enterococcus spp	p-value	Acinetobacter	p-value
Age (Month)									
≤48	138(69.3)	11 (78.6)	0.437	10 (76.9)	0.540	11 (100)	0.023	4 (40.0)	0.039
>48	61 (30.7)	3 (21.4)		3 (23.1)		0 (0)		6 (60.0)	
Gender									
Female	72 (36.2)	6 (42.9)	0.590	3 (23.1)	0.309	4 (36.4)	0.990	4 (40.0)	0.796
Male	127(63.8)	8 (57.1)		10 (76.9)		7 (63.6)		6 (60.0)	
Duration of Sepsis (days)									
≤8	(69.8)	4 (28.6)	<0.001	2 (15.4)	<0.001	9 (81.8)	0.373	3 (30.0)	0.005
>8	60 (30.2)	10 (71.4)		11 (84.6)		2 (18.2)		7 (70.0)	
Residence									
Rural	48 (24.1)	2 (14.3)	0.372	4 (30.8)	0.562	5 (45.5)	0.089	6 (60.0)	0.007
Urban	151(75.9)	12 (85.7)		9 (69.2)		6 (54.5)		4 (40.0)	
Family Income									
Low	113(56.8)	9 (64.3)	0.331	7 (53.8)	0.113	4 (36.4)	0.005	7 (70.0)	0.684
Middle	60 (30.2)	2 (14.3)		2 (15.4)		2 (18.2)		2 (20.0)	
High	26 (13.1)	3 (21.4)		4 (30.8)		5 (45.5)		1 (10.0)	
Education Status of Mother									
Illiterate	108 (54.3)	8 (57.1)	0.537	7 (53.8)	0.527	3 (27.3)	0.048	8 (80.0)	0.024
Primary or less	76 (38.2)	6 (42.9)		6 (46.2)		8 (72.7)		0 (0)	
Secondary or more	15 (7.5)	0 (0)		0 (0)		0 (0)		2 (20)	

DISCUSSION

Over the past few decades, the mortality rate associated with sepsis in the pediatric age group has reduced significantly[14,15]. The main reasons were the implementation of standard guidelines and protocols, improved clinical practice parameters, educational programs for parents and advanced goal directed therapies, throughout the world to reduce mortality associated with sepsis. Regardless of all the advancement in already developed countries, sepsis is still considered a major health issue with high morbidity and mortality in developing countries[16].

Most of the blood culture positive samples in our study were of children belonging to urban areas and this finding has highlighted the fact that access to tertiary care health facility in rural areas is not available or limited. In the current study, the increased prevalence of sepsis in male gender is comparable to a few other previous studies[17-19]. This finding can be explained by a gender – bias and preference for male children in our society and thus their early presentation at tertiary health care facilities. More than half of the blood culture positive samples belonged to children from low socioeconomic status, that is associated with malnutrition and poor hygiene practices and these in itself are prominent risk factors for sepsis.

According to the current study findings, the bacterial spectrum revealed that coagulase negative staphylococci were the leading cause of sepsis in the study population i.e. in 47.7%, while in 28.6% of the blood cultures staphylococci aureus was isolated, streptococci viridians was isolated in 27.1%, E. Coli in 12.1%, Pseudomonas aeruginosa in 7.0%, Klebsiella pneumonia in 13(6.5%), enterococcus in 5.5% and Acinetobacter in 5%. Thus, in our study, gram positive cocci were the predominant bacterial species responsible for sepsis. These results are in agreement with a few other local researches that have reported gram positive organisms to be the main reason of pediatric sepsis in Karachi. This can be explained by a similar environment and same geographical location shared by these research studies[20,21]. In contrast to our results, however, previous studies in Pakistan and neighboring countries have reported gram negative isolates to be the main cause of pediatric sepsis[22-24].

Coagulase negative staphylococcus emerged as the most common causative organism of sepsis in our study (47.7%) as it is a normal flora of human skin ,followed by staphylococci aureus (28.6%). Carelessness and lack of awareness about patient safety protocols during medical procedures may be a reason of such a high prevalence. However, for this high incidence of coagulase negative staphylococcus bacteremia ,the possibility of blood contamination during the collection from peripheral vessel cannot be ruled out.

Available literature reveals different results from other cities of Pakistan ,outside of Karachi. Research data revealed a high incidence of Escherichia coli in Lahore [23] and Multan [11] and Enterobacter in Islamabad. [25] Among the neighboring countries, Enterobacter has been reported to be the most common cause of pediatric sepsis in Iran,[26] Pseudomonas and Klebsiella in India[14] and Bangladesh.[15] Thus, the different rate of prevalence is due to different geographical locations.

Staphylococcus aureus was isolated in 47.7% of the positive blood cultures in our study and another local study conducted in the pediatric age group, has also reported staphylococcus aureus to be present in 16.2% of the isolates.[12] However, a similar study from India [27] has observed a high prevalence of 35.7% for staphylococcus aureus in pediatric sepsis. In a study from Kabul ,[28] pseudomonas species was reported to be present in 5% of the isolates which is comparable to a prevalence rate of 7% in our study .We observed that Klebsiella , Pseudomonas and Acinetobacter were predominantly isolated from blood culture samples of children less than 48 months of age and similar findings have been reported by a study from India by Pawar et al[29]. This is explained by a lower immunity in under 4 years of age as compared to older children .In our study a low maternal educational status was observed to be the most significant factor associated with the prevalence of sepsis in children . Similar observation was made by another study from Karachi wherein maternal educational level was found to be directly linked to the development of neonatal sepsis[30].

This study has a few limitations as it is retrospective in nature and has been conducted at a single tertiary health center. Furthermore the data is from a private sector hospital which caters only to a limited portion of the population and thus, there is a selection bias so, the results may not be generalized to the entire population .

CONCLUSION

There is a high prevalence of sepsis in children less than 48 months of age, more commonly in children with incomplete vaccination, female gender, decreased maternal educational level and a lower socioeconomic status. Sepsis in the pediatric age group is associated with a high mortality and increased length of hospital stay, especially in blood culture positive cases with unusual organisms such as Pseudomonas, Acinetobacter and gram-negative bacilli e.g. Klebsiella.

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