Original Article

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Bacteriological Profile and Antibiotic Sensitivity Pattern of Blood Culture Isolates in Pediatric Intensive Care Unit (PICU) of Chittagong Medical College Hospital

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Abstract

Background: The antimicrobial sensitivity pattern of organisms is changing rapidly over a short period which is varying from country to country, one place to another, and from one institute to another. Therefore, periodic evaluation of sensitivity patterns is essential for the rational and appropriate use of antibiotics in Pediatric Intensive Care Unit (PICU) settings. This study aimed to see the bacteriological profile and antibiotic sensitivity among the patients with positive blood culture admitted to the PICU of Chittagong Medical College Hospital (CMCH).

Materials and methods: All blood culture samples sent from patients hospitalized in the PICU of CMCH between October 2021 and March 2022, were evaluated retrospectively. Information collected includes the demographic data, Primary diagnosis, causative agent and sensitivity pattern of the isolated organisms.

Results: Out of 214 blood culture samples growth was found in 29 (13.6%) samples, female (58.6%) higher than male in distribution gender, with median age of 9 months and primary diseases distribution was dominated with pneumonia (65.5%). The most common Gram-Positive Bacteria (GPB) was Coagulase-Negative Staphylococcus (CoNS) (27.9%), followed by Staphylococcus aureus (10.3%). The most common Gram-Negative Bacteria (GNB) was Klebsiella pneumoniae (13.8%), followed by Burkholderiacepacia (10.3%), Escherichia coli (6.9%), Pseudomonas aeruginosa (6.9%) and Acinetobacter baumannii (6.9%). The resistance rates of Coagulase-negative staphylococcus and S. aureus against Ampicillin were 62.5% and 66.7% respectively. The resistance rates of these two organisms to Gentamycin were 50% and 66.7% respectively. Identified GNB were also highly resistant to third generation cephalosporins with a cumulative resistance rate against Ceftriaxone and Cefixime being 50% for each and showed better susceptibility patterns for colistin and levofloxacin. Klebsiella species and E. coli showed better sensitivity to Imipenem and Ciprofloxacin. Klebsiella species were also highly sensitive andBurkholderiacepacia were highly resistant against Gentamycin..

Conclusion: The present study contributes information on the prevalence and antibiotic sensitivity of microorganisms in blood culture and use appropriate antibiotic considering the blood culture and sensitivity pattern.

Key words: Antibiotic sensitivity; Blood culture; PICU.

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Introduction

PICU is predominantly concerned with the management of children with acutely life-threatening conditions in a specialized unit and caring for such critically ill children remains one of the most demanding and challenging aspects of the field of Pediatrics. Infections remain one of the major problems in PICU and are the leading cause not only of admission, but also mortality in developing countries.[1,2] In South America, a 2021 study showed a high prevalence of sepsis and sepsis-related mortality in a sample of children admitted to PICU, with a quarter of deaths occurring within the first 24 hours of PICU admission.[3]

Timely and adequate diagnosis and treatment of infections with appropriate antibiotics are essential to reduce global childhood mortality. Diagnosis of pediatric sepsis is challenging in low-resource settings where little or no capacity for etiological diagnosis or laboratory testing exists, and providers must often rely on clinical symptoms and algorithms alone.[4] To reduce childhood mortality caused by infections, strong surveillance activities on diagnosis, aetiology and optimal management must be made at all levels of the health system. The uncertainty surrounding the

clinical approach to the treatment of pediatric sepsis can be minimized by the periodic epidemiological survey of etiological agents and their antibiotic sensitivity pattern leading to the recognition of the most frequently encountered pathogens in a particularly intensive care setting.[5]
The gold standard for the diagnosis of sepsis is the isolation of microorganism by blood culture. However, blood culture can be negative in up to 38% of infants with meningitis.[6] The result of routine blood culture and antibiotic susceptibility tests take about a week thereby needful to initiate empirical treatment of suspected cases with broad-spectrum antibiotics. Knowledge of the pattern of common pathogens is therefore useful for guiding the initial treatment of patients.[7] Hence, we aimed to determine the pattern of microorganism isolated from a blood culture from the admitted patients in the PICU of CMCH and to identify the susceptibility pattern of isolated bacteria. This hospital provides tertiary health care as a referral hospital from primary health care or secondary health care in southeastern Bangladesh. The study results would help us for rational and appropriate use of antibiotics and will cut down the treatment cost, lessen the adverse effects due to drugs, decrease the duration of hospital stay, prevent the emergence of antibiotics resistance, and will decrease the overall neonatal morbidity and mortality.

Materials and methods

This descriptive study was conducted in the PICU of the Department Of Pediatrics, CMCH, Chattogram, Bangladesh. Approval was obtained from the Ethical Review Committee of Chittagong Medical College (Date: 27.04.2022, number: 2016/324). Informed consent was not obtained from the patients because the study was conducted retrospectively.
All blood culture samples sent from patients in the PICU between October 2021 and March 2022, were evaluated retrospectively. Information collected includes the demographic data, Primary diagnosis, causative agent, and antibiotic sensitivity pattern.
A total of 10 beds were present in the PICU. Blood culture samples were obtained half an hour or just before initiation of antibiotic treatment and just before the next dose in patients who were receiving antibiotic treatment. Blood culture was done by BactAlert 3D automated method and VersaTREK automated blood culture system in two private laboratories (Chevron Private Limited and Epic Health Care, Chattogram).
Once data collection was completed, data were compiled and tabulated according to key variables. Non-parametric data were expressed as median values (25th percentile-75th percentile). Frequency data were expressed as percentages (%). The SPSS Statistics for Windows (Version 23.0.) statistical program was used for data processing and analysis.

Results

It was found that 214 blood culture samples were sent from the PICU during the study period. Growth was found in 29 (13.6%) blood cultures. Among the patients who were found to have growth in blood culture, 41.4% (n=12) were males and 58.6% (n=17) were females. The median age of the patients was 9 months (range1-96 months) and most of them were infants (62.1%). Most of the patients (75.9%) lived in rural areas (Table I).

Table I Demographic characteristics of the PICU patients with positive blood culture (n=29)

Variables		Frequency	Percentage (%)
Age, months	≤12 months	18	62.1
	>12 months	11	37.9
	Median (Range)	9.0 (1.0-96.0)	
Sex	Male	12	41.4
	Female	17	58.6
Residence	Urban	7	24.1
	Rural	22	75.9

*Data were expressed as frequency and percentage if not mentioned otherwise.

Primary diseases admitted to patients in PICU with culture-positive results were dominated by respiratory tract infection and followed by nervous system infection (Table II).

Table II Primary disease distribution of positive blood culture results in PICU patients (n=29)

Primary disease	Frequency	Percentage (%)
Pneumonia	19	65.5
Meningoencephalitis	3	10.3
Acute lymphoblastic leukaemia	2	6.9
Congenital heart disease	1	3.4
Acute watery diarrhoea	1	3.4
Aplastic anaemia	1	3.4
Very late-onset septicemia	1	3.4
Nephrotic syndrome	1	3.4

Among all microorganisms isolated, the most common gram-positive bacteria was coagulase-negative staphylococcus (n=8, 27.9%). This was followed by Staphylococcus aureus (n=3, 10.3%) (Table II). The most common Gram negative bacteria was Klebsiella pneumoniae (n=4, 13.8%) followed by Burkholderiacepacia (n=3, 10.3%) Escherichia coli (n=2, 6.9%) Pseudomonas aeruginosa (n=2, 6.9%) and Acinetobacter baumannii (n=2, 6.9%).

Table III Distribution of the microorganisms isolated from blood cultures (n=29)

Name of the microorganism	Frequency	Percentage (%)
Gram-positive bacteria		
Coagulase-negative staphylococcus	8	27.6
Staphylococcus aureus	3	10.3
Staphylococcus hominis	1	3.4
Gram-negative bacteria		
Klebsiella pneumoniae	4	13.8
Burkholderiacepacia	3	10.3
Escherichia coli	2	6.9
Pseudomonas aeruginosa	2	6.9
Acinetobacter baumannii	2	6.9
Elizabethkingiameningoseptica	1	3.4

The Gram positive bacteria were highly resistant to first line and second line antibiotics (Amoxicillin and Gentamycin) and third generation cephalosporins used at ICU. The resistance rates of coagulase-negative staphylococcus and S. aureus against Ampicillin were 62.5% and 66.7% respectively. Similarly, the resistance rates of these two organisms to gentamycin were 50% and 66.7% respectively. Identified gram positive bacteria were also highly resistant to third generation cephalosporins with a cumulative resistance rate against ceftriaxone and cefixime being 50% for each. Isolated gram positive bacteria showed better susceptibility patterns for tigecycline, TMP/SMX, colistin and levofloxacin (Table IV).

Table IV Antibiotic sensitivity patterns of gram-positive bacteria*

Antibiotics	CoNS (n=8)		S. aureus (n=3)		S. hominis (n=1)		Total (n=12)	
	Sen	Res	Sen	Res	Sen	Res	Sen	Res
Amoxicillin	37.5	62.5	33.3	66.7	0	100.0	33.3	67.7
Cefixime	37.5	62.5	66.7	33.3	100.0	0	50.0	50.0
Ceftriaxone	37.5	62.5	66.7	33.3	100.0	0	50.0	50.0
Imipenem	62.5	37.5	66.7	33.3	100.0	0	50.0	50.0
Azithromycin	37.5	62.5	100.0	0	100.0	0	25.0	75.0
TMP/SMX	62.5	37.5	100.0	0	0	100.0	66.7	33.3
Ciprofloxacin	37.5	62.5	66.7	33.3	100.0	0	50.0	50.0
Gentamycin	50.0	50.0	33.3	66.7	100.0	0	50.0	50.0
Tigecycline	62.5	37.5	66.7	33.3	100.0	0	66.7	33.3
Colistin	62.5	37.5	100.0	0	100.0	0	75.0	25.0
Levofloxacin	62.5	37.5	100.0	0	100.0	0	75.0	25.0
Pip/Taz	50.0	50.0	100.0	0	100.0	0	66.7	33.3

*Data were expressed as a percentage, CoNS: Coagulase-Negative Staphylococcus, Sen: Sensitive, Res: Resistant, TMP/SMX: Trimethoprim + Sulfamethoxazole; Pip/Taz: Piperacillin / Tazobactam.

In the current study, isolated gram-negative bacteria were also highly resistant to commonly used empiric antibiotics (Table V). Klebsiella species showed better sensitivity to ceftraixone, imipenem, ciprofloxacin, gentamycin and levofloxacin. On the other hand it was extremely resistant to azithromycin. Burkholderiacepacia was highly sensitive to imipenem and highly resistant against gentamycin, tigecycline, collistin, levofloxacin, piperacillin/ tazobactam.

Table V Antibiotic sensitivity pattern of gram-negative bacteria*

Antibiotic	Klebsiella spp. (n=4)		B. cepacia (n=3)		E. coli (n=2)		Pseudomonas spp. (n=2)		Acinetobacter spp. (n=2)		E. menin (n=1)		Total (n=14)	
	Sen	Res	Sen	Res	Sen	Res	Sen	Res	Sen	Res	Sen	Res	Sen	Res
Amoxicillin	50.0	50.0	0	100.0	0	100.0	100.0	0	100.0	0	0	100.0	42.9	57.1
Cefixime	25.0	75.0	66.7	33.3	0	100.0	50.0	50.0	50.0	50.0	0	100.0	35.7	64.3
Ceftriaxone	100.0	0	33.3	66.7	0	100.0	50.0	50.0	50.0	50.0	0	100.0	57.1	42.9
Imipenem	100.0	0	100.0	0	100.0	0	100.0	0	50.0	50.0	0	100.0	85.7	14.3
Azithromycin	0	100.0	66.7	33.3	50.0	50.0	100.0	0	50.0	50.0	0	100.0	42.9	57.1
TMP/SMX	50.0	50.0	33.3	66.7	0	100.0	100.0	0	50.0	50.0	100.0	0	50.0	50.0
Ciprofloxacin	100.0	0	33.3	66.7	100.0	0	100.0	0	100.0	0	100.0	0	85.7	14.3
Gentamycin	100.0	0	0	100.0	50.0	50.0	100.0	0	50.0	50.0	0	100.0	57.1	42.9
Tigecycline	50.0	50.0	0	100.0	50.0	50.0	50.0	50.0	100.0	0	0	100.0	42.9	57.1
Colistin	50.0	50.0	0	100.0	50.0	50.0	100.0	0	100.0	0	0	100.0	50.0	50.0
Levofloxacin	100.0	0	0	100.0	0	100.0	100.0	0	100.0	0	100.0	0	57.1	42.9
Pip/Taz	50.0	50.0	0	100.0	100.0	0	100.0	0	100.0	0	100.0	0	64.3	35.7

*Data were expressed as a percentage, B. cepacian: Burkholderia cepacian, E. menin: Elizabethkingiameningoseptica TMP/SMX: Trimethoprim + Sulfamethoxazole, Pip/Taz: Piperacillin/ Tazobactam, Sen: Sensitive, Res: Resistant.

Table VI Antibiotic sensitivity pattern of gram-negative bacteria*

Antibiotic	Klebsiella spp. (n=4)	B. cepacia (n=3)	E. coli (n=2)	Pseudomonas spp. (n=2)	Acinetobacter spp. (n=2)	E. menin (n=1)	Total (n=14)
Amoxicillin	50.0	0	0	100.0	100.0	0	42.9
Cefixime	25.0	66.7	0	50.0	50.0	0	35.7
Ceftriaxone	100.0	33.3	0	50.0	50.0	0	57.1
Imipenem	100.0	100.0	100.0	100.0	50.0	0	85.7
Azithromycin	0	66.7	50.0	100.0	50.0	0	42.9
TMP/SMX	50.0	33.3	0	100.0	50.0	100.0	50.0
Ciprofloxacin	100.0	33.3	100.0	100.0	100.0	100.0	85.7
Gentamycin	100.0	0	50.0	100.0	50.0	0	57.1
Tigecycline	50.0	0	50.0	50.0	100.0	0	42.9
Colistin	50.0	0	50.0	100.0	100.0	0	50.0
Levofloxacin	100.0	0	0	100.0	100.0	100.0	57.1
Pip/Taz	50.0	0	100.0	100.0	100.0	100.0	64.3

*Data were expressed as a percentage, B. cepacian: Burkholderia cepacian, E. menin: Elizabethkingiameningoseptica, TMP/SMX: Trimethoprim + Sulfamethoxazole, Pip/Taz: Piperacillin/ Tazobactam.

Discussion

In this study totally record of 214 PICU patients were reviewed and only 13.6% had positive blood culture result. Previous study by Kumar et al, out of 182 samples 19 (10.44%) were positive in blood culture and growth was detected in 324 blood cultures out of 4239 samples (7.6%) in the study of Ergül et al.[8,9] On the contrary, Putra et al. reported a comparatively higher positivity rate (506/1345, 37.62%) in Blood culture results in a PICU setting.[10] Other than the variation in sample size, the reasons for these discrepancy may be attributed to the aggressive empiric outpatient therapy of infections and early administration of antibiotic therapy before cultures are drawn in patients when severe sepsis is recognized in the PICU. Other potential explanations include increasing infections with viruses, particularly in immunocompromised patients, which may cause severe sepsis, as we investigated only the blood culture for bacterial and fungi in our study.

Regarding the demographic profile of the patients with positive blood culture the current study demonstrated that female was higher than male in distribution gender, with median age 9.0 (1.0-96.0) months. Our study findings were like the previous work by Putra et al and Lanetzki et al where females were dominating than males in the PICU patients with positive culture result, with higher age incidence at less than five years.[10,11]

In the present study, primary disease distribution was dominated with respiratory tract infection pneumonia. Respiratory tract infection, bronchopneumonia was the most frequent disease among the PICU patients with positive blood culture results in previous studies.[10-12]

Gram negative bacteria was the most frequent organism detected in 48.3% of the samples, followed by GPB in 41.3% and fungi in 10.3% samples. However, previous studies were non consistent in their results regarding type of organisms isolated from blood culture samples. The study of Putra et al showed gram negative bacteria as predominant pathogen for blood stream infection (66.01%) but in 60.2% and 57% of the samples showed gram-positive microorganisms, respectively in the study of Ergül et al and Kumar et al.[10,9,8] In our study, the most common organism was CoNS(27.6%) like study conducted by Ergul et al. and Kumar et al.[8,9]In the literature, S. aureus has been reported as the second most common bacteria after CoNS.[13]

Our study is gained commonest gram negative bacteria species was Klebsiella pneumoniae (13.8%), followed by Burkholderiacepacia (10.3%). B. cepacea has emerged as a serious human pathogen in the last two decades, causing fatal necrotizing pneumonia and bacteremia. B. cepacea has been associated with out breaks involving infections of the bloodstream, respiratory tract and urinary tract in intensive care unit setting.[10]

Antibiotics susceptibility pattern of iGram negative bacteria solates in our study finding were resistant to three or more groups antimicrobial agents and therefore consider multidrug resistant, most of the isolate are resistant to, amoxicillin, cephalosporin, azithromycin, ciprofloxacin and gentamicin. Isolated GPB showed better susceptibility patterns for colistin and levofloxacin. Isolated GNB were also highly resistant to commonly used empiric antibiotics in the present study. Klebsiella species and E. coli showed better sensitivity to and were extremely resistant to imipenem and ciprofloxacin. Klebsiella species were also highly sensitive and B. cepacia were highly resistant against Gentamycin. The development of antibiotic resistant in our hospital might be caused by unnecessary, inappropriate or suboptimal prescribed antibiotic therapy from community before, previous health care and our hospital itself. Previous studies also demonstrated that bacteria isolates were highly resistant to first- and second-line empiric antimicrobials used at ICU contracting antimicrobial choices for management.[2,9,14]

Limitation

The limitations of our study included the facts that it was a single-center study and contamination could not be differentiated in positive CoNS growths in blood cultures because of the retrospective design. Limited yield of some pathogens and lack of sensitivity testing to some common and higher antibiotics were other limitations in our study

Conclusion

Gram-positive CoNS were the predominant pathogens among enrolled PICU patients at CMCH. Most of the isolated gram-positive and gram-negative isolates showed high resistance to commonly used antibiotics. In addition some fungi like C.albicans (n=2, 6.9%) and non-albicans candida (n=1,3.4%) were isolated. Growing antibiotic resistance is a matter of great concern. So antibiotic should be used according to culture sensitivity in PICU.

Recommendation

Considering the limitations of the present study, we should consider to do the study in various PICU center. It will help us to start empirical antibiotic therapy considering the microorganism and their sensitivity pattern. We recommend to do blood culture in broad spectrum covering also fungi as we isolate some fungi and their sensitivity pattern. We should make aware our physicians regarding judicious use of antibiotic as well as give a message to the general population regarding avoidance of irrational use of antibiotic to prevent resistance.

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Contribution of authors

MJBAC- Conception, acquisition of data, drafting & final approval.

DC- Design, data analysis, drafting & final approval.

ZC-Interpretation of data, critical revision & final approval.

KN- Acquisition of data, interpretation of data, critical revision & final approval.

AKD- Data analysis, drafting & final approval.

SHH- Interpretation of data, data analysis, drafting & final approval.

PC- Acquisition of data, critical revision & final approval.

RJ-Data analysis, drafting & final approval.

Disclosure

All the authors declared no competing interest.

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