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Primary Bloodstream Infection in Pediatric Intensive Care Units at Joinville

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Primary Bloodstream Infection in Pediatric Intensive Care Units at Joinville

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Abstract- **A retrospective data collection of patients with primary bloodstream infection diagnosis admitted to the surgical and pediatrics intensive care units of Dr.Jeser Amarante Faria Children's Hospital between March 2016 and March 2020 with 28 days or more of age. In this study, 122 medical records were included. Patients under 1 year of age represent most of the sample (72,95%) and those admitted to the surgical unit were the most affected by bloodstream infection (54,10%). The main comorbidity at admission was heart disease, followed by pneumonia and bronchiolitis. The average time to infection from device insertion was of 14,76 days.Bloodcultures showed microorganism growth, being the main agents found: Serratia marcescens (10,66%), Staphylococcus epidermidis (10,66%) and Pseudomonas aeruginosa (8,20%). In this single-centre study, most children diagnosed with primary bloodstream infection had complex heart diseases and used a central venous catheter. Gram-negative bacteria were the main responsible for these infections.**

Keywords: sepsis · intensive care units, pediatric · catheter-related infections· cross infection· length of stay · pediatrics.

I. Introduction

Healthcare-associated infection (HAI) is an acquired complication by the patient after his hospital admission and it is an important preventable cause of morbidity and mortality among hospitalized patients.[1] Among HAIs causes, the Primary Bloodstream Infection (PBSI) is considered one of the most relevant nosocomial infections in pediatrics. Around 10 to 23% of hospitalized children have hospital-acquired bacteremia and, despite all the advances made in hospital care, PBSI is associated with a high mortality in pediatric intensive care unit (PICU).In addition, PBSI increases hospitalization time and cost.[2,3]

PBSI risk factors are related to severity of underlying illnesses, age, prolonged hospitalization, invasive procedures, medications, parenteral nutrition, steroid exposure, use of central venous catheter (CVC), among others.[3,4,5,6] However, the main risk associated with PBSI is the use of intravascular devices, accounting approximately for 60% of nosocomial bacteria.[7] In the pediatric population, according to the National Nosocomial Infections Surveillance System (NNIS), PBSI rates can reach 7.3 cases per 1000 catheter-days.[8]

PBSI can be diagnosed from laboratory and clinical criteria. Those with positive blood culture have more objective diagnostic criteria. Nevertheless, blood culture sensitivity is variable due to technique variation among different hospitals and laboratories.9PBSIis caused mainly by coagulase-negative Staphylococcus, accounting for 31%.3

As PBSI have important consequences for both the patient and the health service, the analysis of incidence, of epidemiological profile and of the inpatient outcomes with PBSI are important to evaluate the need for prevention, identify possible improvements to be made in healthcare and achieve better and rationalized treatment, aiming for lower complications, morbidity, mortality, and healthcare-related costs.

II. Methods

Descriptive, observational and cross-sectional study between March 2016 and March 2020, with retrospective data collection from medical records on the PHILIPS Tasy system (Philips Healthcare, Cambridge, MA, USA) at Dr. Jeser Amarante Faria Children's Hospital (HJAF) in Joinville-state of Santa Catarina, Brazil.

In this study were included patients diagnosed from laboratory or clinical criteria with PBSI admitted to the general pediatrics and surgical PICU of the HJAF. The laboratory diagnostic criteria for PBSI was laboratory confirmed infections, with at least one positive blood culture not related to infection at another site. The clinical diagnostic criteria for PBSI used was clinical sepsis, more precisely, when treatment for sepsis was instituted and there was no apparent infection at another site, and the blood culture was negative.

Were excluded from the study children under 28 days of age, patients whose diagnosis has changed during the period of hospitalization and patients whose medical records were missing data or with incorrect or insufficient completion.

The collected variables are age, sex, diagnosis on admission, use of invasive devices, type of device - CVC or PICC (Peripherally Inserted Central Catheter),

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puncture site, previous comorbidities, and length of PICU stay.

To build the database Microsoft Excel software was used. The collected data were tabulated and its analysis was performed using IBM SPSS, version 21.0. Descriptive (absolute and relative frequency) and inferential analysis (Spearman Correlation Test, Kruskal Wallis Comparison Test and Mann-Whitney Comparison Test) were used.

The choice of non-parametric tests was based on the result of the Kolmogorov Smirnov normality test, in which the variables showed a tendency towards non-normality. In this way, data referring to the median and interquartile range were displayed. For all tests, a significance level of 5% (p-value < 0,05) was adopted.

This study complies with the guidelines for research involving human beings, contained in resolution 466/2012 of the National Health Council and was approved by the Ethics Committee in Research with Human Beings of the Hans Dieter Schmidt Hospital under number 4.365.075.

III. Critical Analysis

As it is an observational and descriptive study, it does not pose a risk to the patients. Likewise, there was no need for informed consent forms. The study also did not influence any change in patients' conduct and/or treatment. All collected data regarding patients are the sole responsibility and confidentiality of the researchers.

PBSI incidence analysis and PICU admitted patients' profile make it possible to assess the need for improvement in healthcare, aiming to reduce the mortality and morbidity resulting from disease complications and, consequently, the reduction of hospitalization time and hospital costs.

IV. Results

122 children were diagnosed with PBSI between March 2016 and March 2020. Their sociodemographic and clinical characteristics can be observed in Table 1. It also presents the data about length of stay of the CVC until infection with age, location, year and diagnosis variables. Length of stay of the CVC stay until infection presented a distribution with tendency to non-normality, therefore, non-parametric tests were used, and the median and interquartile range of the respective variables are shown.

Absolute and relative frequencies of PICU admission diagnoses and comorbidities can be seen in Table 2. Heart disease is the most common diagnosis at admission and/or comorbidity. Diagnoses such as multiple traumas, oncological pathologies, encephalitis, acute abdomen, among others, accounts for 19.67% of PICU admission diagnoses. Other comorbidities, such as encephalopathy and chronic lung diseases, added up to 17.21%.

Regarding central device usage, 96.97% of patients had at least one catheter, of which 75.0%were CVC and 21.97% were PICC. Only 3.03% of the evaluated patients did not have any type of central catheter and 8.2% had both devices simultaneously. Insertion sites and its statistically significant relation with central device type can be observed in Table 3.

Regarding microbiological profile, 101 blood cultures (82.79%) showed microorganisms growth, these are shown Table 4.

V. Discussion

When evaluating the characteristics of patients diagnosed with PBSI in the PICU, it was observed that most of them are infants. This age predominance is in line with other studies, it is due to the fact that this group has an immune system still in formation and many have underlying medical conditions that increase the risk of acquiring an infection.[8,10] There is not a specific pattern regarding sex as it is not a determining characteristic for infection.[2,4,8,11]

Patients with complex surgical conditions, mainly from heart diseases, have a great propensity to acquiring PBSI. This is due to the risk increase intrinsic to this population, such as: prolonged hospitalization, major surgical procedure, pro-inflammatory status, need for invasive devices, among others.[3,12,13]

As evidenced by Hatachi et al., PBSIs were associated with a longer length of PICU stay, a fact that demonstrates the severity of the patient condition and, as consequence, a greater need for healthcare.[14]

Hospitalization time until infection also varies significantly according to the population under study, as some groups have aggravating characteristics for acquiring PBSI. There are reports in literature of groups with similar profiles that converged to a median of 13.4 days of length of PICU stay until PBSI, a result slightly below the median of 14.76 days found in the sample studied in this present work.15 There were no correlations found of age and duration of CVC use until infection, therefore this comparison could not be performed.

Regarding the place where PBSI diagnoses were made, a study carried out in a cardiac PICU found most PBSI diagnoses were made in postoperative surgical patients.[12] These data corroborate the findings of this sample, since most surgical PICU patients have a heart disease.

Central device use is an important risk factor for PBSI.[2,5,7,10,15] The majority of the patients assessed in this study had a central device (96.97%) and, of these, 75% had a CVC. In relation to the device site, unlike this study, two studies show there is an infection predominance in femoral vein inserted catheters.[16,17] This discrepancy may occur due to unusual performance of the procedure in this site at HJAF.

Woods-Hill et al. described a significant risk increase of infection in patients with multiple central devices.[11] This present work, in contrast with the literature, found only 8.2% of patients with more than one central venous catheter, this fact is probably due to the population studied, in which only one central catheter was sufficient.

Gram-negative bacteria were the predominant etiological agents in this study (48.36%), specially Serratia marcescens, responsible for 10.66% of all PBSIs. This is different from many studies, mainly from developed countries, that have shown gram-positive bacteria prevail.[3,8,15,17,18]

Infections by gram-negative bacteria are closely related to healthcare assistance since these pathogens colonize the gastrointestinal tract and oropharynx. Several Serratia marcescens outbreaks have been described in literature, many of them related to devices and solutions contamination, being the hands of health professionals a major vehicle of transmission.[19]

Jang et al. published a study in which, by performing pulsed-field gel electrophoresis in the hands of health professionals from a neonatal Intensive Care Unit, strains of Serratia marcescens involved in an infectious outbreak were isolated, showing that the absence of basic care, such as hands hygiene, can negatively impact on several sectors of hospital care.[20]

In conclusion, it was observed that the profile of children with PBSI admitted to the HJAF PICUs from 2016 to 2020 was of infants with complex surgical conditions, mostly being heart diseases. Most of the patients had a CVC, and the jugular vein was the most prevalent puncture site. Regarding the PBSI microbiological profile, gram-negative bacteria were responsible for the highest number of infections recorded, and the median length of PICU stay until PBSI were 14.76 days.

VI. Limitations

This present work objective was to study the PBSI prevalence in HJAF PICUs, the infected patients' characteristics and its microbiological profile, being the incidence rate and final outcomes of the patients not analyzed.

Author´s contribuitions

Study design: Wendhausen AR

Data collection: Facchinello CSS, Schulz GW, Horochoski L

Data analysis: Facchinello CSS, Schulz GW, Horochoski L

Manuscript writing: Facchinello CSS, Schulz GW, Horochoski L

Manuscript revision: Facchinello CSS, Wendhausen AR

Study supervision: Wendhausen AR

Declaration: The data underlying the research text are contained in the manuscript in the form of tables. However, the database contains patient records and personal data, which is why they will be available on demand with the corresponding author.

Conflict of interests

The authors declare that they have no conflict of interest.

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Table 1: Statistical results related to length of PICU stay until infection and variables: year, age, gender, location and diagnosis.

Variables	Distribution of sociodemographic and clinical variables.		Length of stay of the CVC until infection			
	N	%	Mean	Median	Interquartile range	p-value
Year						
2016	31	25,41%	15,46	11,5	15,50	
2017	50	40,98%	14,85	11	16,00	
2018	20	16,39%	14,04	9	14,75	0.646*
2019	19	15,57%	15,5	13,5	13,50	
2020	2	1,64%	7	7	0	
Age						
29 days to 1 year old	89	72,95%	15,02	12	13	
1 to 2 years old	13	10,66%	18,3	11	20,50	
2 to 5 years old	10	8,20%	9	6,5	6,25	0.199*
5 to 10 years old	6	4,92%	11	10	12	
10 to 18 years old	4	3,28%	17,5	16	29,5	
Gender						
Male	67	54,92%	14,29	10	12	0.498**
Female	55	45,08%	15,32	12	15	
Location						
PICU	56	45,90%	14,77	11,5	16,75	0.408**

Surgical ICU	66	54,10%	14,75	11	13,50	
Diagnosis						
Surgical	65	53,28%	13,72	10	10,00	0.957**
Clinical	57	46,72%	15,94	13	18,50	
Total	122	100,00%	14,76	11	14,25	

Table 2: Absolute and relative frequencies of diagnosis and comorbidities at admission.

Variables	N	%
Diagnosis at admission		
Cardiopathy	65	53,28%
Pneumonia	23	18,85%
Bronchiolitis	10	8,20%
Others	24	19,67%
Comorbidities		
None	27	22,13%
Cardiopahy	61	50,00%
Genetic Syndrome	14	11,48%
Others	21	17,21%

Table 3: Comparison of PICC and CVC and association with puncture site.

Variables	PICC	CVC	p-value
Insertion Site	**n (%)**	**n (%)**	
Jugular Vein	-	82 (64.06)	
Femoral Vein	-	14 (10.94)	<0.001*
Subclavian Vein	-	3 (2.34)	
Upper and Lower Limbs	29 (22.66)	-	

*Note: CVC: Central Venous Catheter; PICC: Peripherally Inserted Central Catheter; *Fisher's chi-square test.*

Table 4: Microorganisms that cause PBSI at HJAF PICUs.

Microorganism	N	%
None	21	17,21%
Serratia marcescens	13	10,66%
Staphylococcus epidermidis	13	10,66%
Pseudomonas aeruginosa	10	8,20%
Klebsiella pneumoniae	10	8,20%
Enterobacter cloacae	8	6,56%
Staphylococcus aureus	8	6,56%
Candida albicans	6	4,92%
Escherichia coli	5	4,10%
Acinetobacter baumannii	5	4,10%
Enterococcus fecalis	3	2,46%

Candida parapsilosis	3	2,46%
Staphylococcus hominis	2	1,64%
Bulkhoderiacepacia	2	1,64%
Stenotrophomonas maltophilia	2	1,64%
Staphylococcus haemolyticus	2	1,64%
Candida tropicalis	1	0,82%
Enterobacter asburiae	1	0,82%
Enterococcus faecium	1	0,82%
Aeromonas salmonicida	1	0,82%
Haemophilus influenzae	1	0,82%
Klebsiella oxytoca	1	0,82%
Staphylococcus warneri	1	0,82%
Micrococcus luteus	1	0,82%
Streptococcus pneumonie	1	0,82%

Note: PBSI: Primary Blood Stream Infection; PICU: Pediatric Intensive Care Unit; HJAF: Dr. Jeser Amarante Faria Children's Hospital.