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Healthcare-associated Infections in Pediatric Cardiovascular Surgery Intensive Care Unit Between 2016-2020

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ABSTRACT

Introduction: Healthcare-associated infections are the most common problem in intensive care unit worldwide. Children with congenital heart diseases have many complications such as developmental problems, respiratory tract infections, endocarditis, pneumonia and after long-term hospital and intensive care stays and surgeries patients become vulnerable to healthcare-associated infections.

Patients and Methods: The study presents the frequency of infection, microorganisms in patients hospitalized at Kartal Koşuyolu High Specialization Training and Research Hospital Pediatric Cardiovascular Surgery Intensive Care Unit between 2016-2020.

Results: One hundred-eight healthcare-associated infections episodes were seen in 83 of 1920 patients hospitalized in Pediatric Cardiovascular Surgery Intensive Care Unit between 2016-2020. Healthcare-associated infections rates varied between 4.8% and 7.77% over the years. In the 5-year period, a total of 118 microorganisms were detected. Among all microorganisms, *Candida* species (n= 43, 36.4%) ranked first. Central line-associated bloodstream infections 53 (49%), ventilator-associated pneumonia 40 (37%), surgical site infection 8 (6.5%), catheter-associated urinary tract infection 7 (6%).

Conclusion: Healthcare-associated infections requires special attention in pediatric cardiovascular intensive care units. In order to prevent, innovations such as bundle applications should be implemented as well as personnel training.

Key Words: Cardiovascular surgery; healthcare-associated infections; intensive care unit, pediatrics.

Çocuk Kalp ve Damar Cerrahisi Yoğun Bakım Ünitesinde 2016-2020 Yılları Arasında Sağlık Bakımı ile İlişkili Enfeksiyonlar

ÖZ

Giriş: Sağlık bakımı ile ilişkili enfeksiyonlar tüm dünyada yoğun bakım ünitelerinde en sık görülen sorundur. Konjenital kalp hastalığı olan çocuklarda gelişimsel sorunlar, solunum yolu enfeksiyonları, endokardit, pnömoni gibi birçok komplikasyon görülmekte ve uzun süreli hastane ve yoğun bakım yatışları ve ameliyatlar sonrasında hastalar sağlık bakımı ile ilişkili enfeksiyonlara karşı savunmasız hale gelmektedir.

Hastalar ve Yöntem: Çalışmada, 2016-2020 yılları arasında Kartal Koşuyolu Yüksek İhtisas Eğitim ve Araştırma Hastanesi Çocuk Cerrahisi Kalp ve Damar Yoğun Bakım Ünitesinde yatan 1920 hastanın retrospektif olarak incelenerek sağlık bakımı ile ilişkili enfeksiyonlar ve üremeleri analiz edildi.

Bulgular: 2016-2020 yılları arasında hastaneye yatırılan 1920 hastanın 83'ünde 108 sağlık bakımı ile ilişkili enfeksiyon atağı görülmüştür. Sağlık bakımı ile ilişkili enfeksiyon oranları yıllara göre %4.8 ile %7.77 arasında değişmektedir. Beş yıllık süreçte toplam 118 farklı mikroorganizma tespit edilmiştir. Tüm mikroorganizmalar arasında *Candida* türleri (n= 43, %36.4) ilk sırada yer almıştır. Santral venöz kateter ile ilişkili kan dolaşımı enfeksiyonları 53 (%49), ventilatörle ilişkili pnömoni 40 (%37), cerrahi alan enfeksiyonu 8 (%6.5), kateterle ilişkili idrar yolu enfeksiyonu 7 (%6) saptanmıştır.

Sonuç: Sağlık bakımı ile ilişkili enfeksiyonlar pediatrik kardiyovasküler yoğun bakımlarda özellikle dikkat edilmesi gereken durumlardandır. Önlemek için personel eğitiminin yanı sıra bundle uygulamaları gibi yenilikler de hayata geçirilmelidir.

Anahtar Kelimeler: Çocuk hastalıkları; kalp ve damar cerrahisi; sağlık bakımı ile ilişkili enfeksiyonlar; yoğun bakım ünitesi.

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INTRODUCTION

Healthcare-associated infections (HAI) are the most common problem in intensive care unit (ICU) worldwide. HAI defined as the infection which develops 48 hours after hospital admission or within 48 hour after being discharged, that was not incubating at the time of hospital admission. HAIs cause significant mortality and morbidity, are particularly associated with prolonged hospital stay and increasing health care costs[1].

Congenital heart diseases (CHD) seen at a rate of 9 per 1000 live births, are an important health problem in developed and developing countries[2]. Prolonged hospital or intensive care stay to make them vulnerable to HAI when previous operations are added. Children with CHD have many complications such as developmental problems, respiratory tract infections, endocarditis,pneumonia, pulmonary hypertension[3].

For these reasons, the management of HAI can be difficult compared to a standard pediatric intensive care unit. In order to make effective empirical treatment in the management of HAI, the clinician should know the frequency and resistance of microorganisms are grown in the intensive care unit.

The current study presents the frequency of infection, microorganisms in patients hospitalized at Kartal Kosuyolu High Specialization Training and Research Hospital Pediatric Cardiovascular Surgery Intensive Care Unit (PCVS-ICU) between 2016-2020.

PATIENTS and METHODS

Data for patients who followed up after congenital heart surgery in the Kartal Kosuyolu High Specialization Training and Research Hospital, Turkey, PCVS-ICU, between 1 January 2016, and 31 December 2020, were evaluated, retrospectively. Patients who developed HAI were recorded by culture based surveillance method. Of all the patients required for the diagnosis of HAI, blood, urine, sputum, tracheal aspirate, wounds and/or samples were taken from areas that could be the focus of infection. Blood culture was taken in case of fever (38°C) or increased white blood cell count. Deep tracheal aspirate or bronchoalveolar lavage were obtained when respiratory infection was suspected, such as changes in chest radiograph or evidence of worsening respiratory performance. When infection was suspected clinically, appropriate empirical antibiotic therapy was administered immediately after sample collection for microbiology. Identification of microorganisms was performed using conventional methods in the microbiology laboratory. Blood cultures were evaluated using BACTEC system™, and the antibiotic susceptibility tests for positive cultures were performed according to European Committee on Antimicrobial Susceptibility Testing (EUCAST). Bacterial identification was performed using the VITEK 2 (bioMe´rieux, Inc. Hazelwood, MO) method. Contamination and colonization growths were excluded from the study. We diagnosed HAI by evaluating according to the national health-care associated infections surveillance guide[4]. HAI follow-up, registration and examination were carried out by the infection control committee. The type of infection, microorganisms, and antibiotic and/or antifungal susceptibility results were evaluated, and the data were entered into the national nosocomial infections surveillance system (INFLINE) of the Ministry of Health, with information on age, gender, underlying disease, presence of invasive intervention, an operation performed, and prophylactic antibiotic use. The data were presentedin the form of numbers and percentages. The infection rates were calculated as cumulative incidence rate (the number of infections per 100 admitted patients) and incidence density (number of infections per 1000 patient days).

Data analysis was performed using Statistical Packages for Social Sciences (SPSS) 14.0 Windows software. Quantitative parameters were represented as mean ± standard deviation and qualitative parameters were represented as frequency distribution and percentage. The study was approved by the ethics committee at 09.02.2021 and numbered 112/465 and performed in accordance with the Declaration of Helsinki.

RESULTS

Pediatric Cardiovascular Surgery Intensive Care Unit is the 3rd level consisting of 12 beds. In our unit, patients are followed up after cardiac surgery. Patient follow-ups are carried out by the pediatric cardiovascular surgeons, anesthesiologists, pediatricians, and infectious diseases specialists. All of the patients had undergone an operation related to congenital heart diseases and received prophylactic antibiotic treatment.

One hundred-eight HAI episodes were seen in 83 of 1920 patients hospitalized between 2016-2020. Of the 83 patients diagnosed with HAI, 43 (51.8%) were female and the median age was 218 (35-503) days, with a mortality rate of 35.7% (n= 30). The age distribution was 24.1% (n= 20) 0-1 month, 42.1% 1 month-1 year, and 33.7% (n= 28) 1-18 years old.

Healthcare-associated infections rates varied between 4.8% and 7.77% and the infection density rate was between 5.34 and 7.77/1000 days, respectively. All HAI and density rates are shown in Table 1. Of 108 episodes, HAI's were determined as central line-associated bloodstream infections (CLABSI) 53 (49%), ventilator-associated pneumonia (VAP) 40 (37%), surgical site infection (SSI) 8 (6.5%), catheter-associated urinary tract infection (CAUTI) 7 (6%) (Table 1).

Table 1. Features of patient hospitalized with healthcare-associated infections

	2016	2017	2018	2019	2020	5 years
Number of patients	438	382	381	410	309	1920
Number of hospital day	3343	2998	2761	3285	3090	15477
Number of infection	21	16	23	24	24	108
HAI rate (%)	4.8	4.19	6.04	5.85	7.77	5.6
Incidence density (‰)	6.28	5.34	8.33	7.31	7.77	6.9
CLABSI	10	10	11	15	7	53
VAP	5	6	9	6	14	40
SSI	1	0	1	3	3	8
CAUTI	5	0	2	0	0	7
Total HAI	21	16	23	24	24	108

HAI: Healthcare-associated infection, CLABSI: Central line-associated bloodstream infection, VAP: Ventilator-associated pneumonia, CAUTI: Catheter-associated urinary tract infection, SSI: Surgical site infection.

In the 5-year period, a total of 118 microorganisms were detected. Among all microorganisms, *Candida* spp. (n= 43, 36.4%) ranked first. *Candida* spp. was followed by *Klebsiella* spp. (n= 25, 21.2%), *Stenotrophomonas maltophilia* (n= 21, 17.8%), *Pseudomonas aeruginosa, Enterococcus* spp,. *Acinetobacter baumannii* and *Enterobacter* spp. (n= 7, 6%) and one coagulase negative staphylococcus. The most common microorganisms were *Candida* spp. in CLABSI and *S. maltophilia* in VAP. Species distribution according to HAI types is given in Table 2.

Table 2. Microorganism causing healthcare-associated infections

	CLABSI	VAP	CAUTI	SSI	Total
Candida spp.	34	2	4	3	43
Klebsiella spp.	9	12	1	3	25
Stenotrophomonas maltophilia	4	17	0	0	21
Pseudomonas aeruginosa	0	7	0	0	7
Enterococcus faecalis/faecium	4	0	2	1	7
Acinetobacter baumannii	0	7	0	0	7
Enterobacter spp.	5	1	0	1	7
CNS	1	0	0	0	1
Total	57	46	7	8	118

CLABSI: Central line-associated bloodstream infection, VAP: Ventilator-associated pneumonia, CAUTI: Catheter-associated urinary tract infection, SSI: Surgical site infection, CNS: Coagulase-negative staphylococcus.

Table 3. Number and rates of device related infections between 2016-2020

	2016		2017		2018		2019		2020	
	n	‰	n	‰	n	‰	n	‰	n	‰
CLABSI	10	2.54	10	2.49	11	2.91	15	4.02	7	2.25
VAP	5	0.7	6	1.03	9	1.26	6	0.62	14	2.35
CAUTI	5	1.27	0	0	2	0.48	0	0	0	0

CLABSI: Central line-associated bloodstream infection, VAP: Ventilator-associated pneumonia, CAUTI: Catheter-associated urinary tract infection.

Central line-associated bloodstream infections rates between 2.25 to 4.02 and VAP rates 0.62 to 2.35. CLABSI rate was highest in 2019 and 2020 for VAP. CAUTI has not been seen in recent years. Invasive device-associated infection rates are shown in Table 3.

DISCUSSION

A total of 1920 patients who underwent cardiac surgery were included in the study, and 108 infection episodes were seen in 83 patients. CLABSI was the most common infection, and *Candida* spp. was the most common cause of HAI. HAI rate was found to be between 4.8% and 7.77%. Especially in 2019 and 2020, an increase in hospital infection rates was observed. Despite the decreasing the number of patients in 2020, the increase in infection rate and density draws attention. In this regard, the Coronavirus disease 2019 pandemic, which has affected the whole world in recent years, may affect. None of the patients had COVID-19 and seconder bacterial infection.

Previously, in the study covering the years 2014-2016 from our unit, it was seen that the infection rate was 6.4%, VAP was seen at higher rates, and bloodstream infections were in the third place with 15.7%[5].

Similar to our study, the most common HAI sites were the bloodstream and the lower respiratory tract (65.8% and 16.4%, respectively). Age, postoperative complications, and open-heart surgery were reported to be risk factors. The surgical complexity score was not found to be associated with mortality[6]. In a study from India, all of types HAI rates were seen in 49 of 100 patients in PCVS-ICU[7]. In a retrospective study performed on PICU, the HAI rate of 22.839 patients was 2.4% and infection density 3.3 HAI/1000. The CLABSI ratio was 0.70%, UTI 0.31%, and VAP 0.51%. The rate of non-device associated pneumonia was 0.26% and the UTI was 0.46%[8]. According to this study, the hospital infection rates of our unit are seen to be high, VAP and CLABSI. However, UTI rates were found to be lower.

A recent study reported that the total infection rate of PICU in developing countries was 6.9%, with 5.5% bacterial sepsis, 2.1% surgical site infection. In addition, it was observed that the

mortality rate was significantly higher in patients with HAI, and infection rates of newborn patients were higher[9]. In the current study, 64% (n= 54) of 83 patients were one year old or younger.

The incidence of *Candida* spp. is increasing in patients with broad-spectrum antibiotic use and underlying cardiac disease[10]. In our study, the reasons for the increase in *Candida* spp. are other predisposing factors, especially broad-spectrum antibiotics. The decrease in VAP infection rate in the period, early extubation after the postoperative period, and compliance with the VAP prevention rules. CLABSI rates were increased recently[5]. In our unit, despite the bundle application for CLABSI prevention, long-term inpatient admissions from an external center, high central venous catheter use, and the presence of underlying comorbidities of the patients can be cited as reasons for this increase.

In a 4-year PCVS-ICU HAI analysis, 146 episodes were seen in 381 inpatients, and the HAI ratio, and a prevalence of pediatric intensive care unit acquired infection of 24.4% out of a total of 381 admissions. CLABSI was found to be the most common infection. Unlike our study, coagulase negative staphylococcus organism is seen (18.8% more frequently) [6]. The lower number of blood cultures and volumes taken in children increases the frequency of contamination. Although factors vary according to the flora of the hospital, considering the effect of the working year, they can explain the difference in factors.

Healthcare-associated infections are important indicator of service quality in healthcare and an and a significant problem that increases morbidity, mortality, and cost in developed and developing countries. For this reason, more care should be taken in children with congenital heart disease who have already undergone complicated operations. HAIs are required special attention in pediatric cardiovascular intensive care units. In order to prevent, innovations such as bundle applications should be implemented as well as personnel training.

CONCLUSION

Featured units such as PCVS-ICU accept patients from many centers. Most of our patients are diagnosed in an external center, hospitalized in the intensive care unit, and previously undergone various interventions. For these reasons, our patients are fragile and prone to infection. These may be the reasons for our higher infection rates compared to general pediatric intensive care units.

In addition to all these, routine trainings are given to PCVS-ICU employees as the hospital infection control committee. In order to reduce CLABSI and VAP infections, it is also planned to switch to bundle application in our intensive care unit.

Ethics Committee Approval: The study was approved by the ethics committee at 09.02.2021 and numbered 112/465 and performed in accordance with the Declaration of Helsinki.

Informed Consent: Informed consent was obtained.

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Author Contributions: Concept/Design - MI, HC; Analysis/Interpretation - MI, EA; Data Collection - MI, ÖŞ; Writing - MI, EA; Critical Revision - HC, ÖF; Final Approval - MI, HC; Statistical Analysis - MI; Overall Responsibility - MI, EA, ÖV, HC.

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