ORIGINAL ARTICLE

The Prevalence of Nosocomial Infection in Medical and Surgical Pediatric ICUs in a Tertiary Referral Hospital in the South of Iran

Amir Saeed[1], MD; Navid MoradiKashkooli[2], MD; Anahita Sanaeidashti[1], MD; Zahra Seratishirazi[1], MD; Mahvash Alirahimi[2], MD

[1]Department of Pediatrics, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence:
Navid Moradikashkooli, MD;
Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran
Tel: +98 9308702525
Email: navidmoradikashkooli@gmail.com
Received: 29 January 2023
Revised: 16 February 2023
Accepted: 30 March 2023

Abstract

Background: Nosocomial infection (NI) has always been considered a significant problem around the world. Due to the special conditions of the admitted patients, NI is of significant importance in the pediatric intensive care unit (PICU). The present study was an attempt to study the prevalence of NI in PICU and its effects on hospital stay and mortality rate.

Methods: The present research is a retrospective cross-sectional study in which the clinical and laboratory data of 693 patients admitted to the PICU of Namazi Hospital in 2018 was studied. Then, the information was entered into SPSS and analyzed.

Results: Of 693 admitted patients, 101 developed a nosocomial infection in the PICU, accounting for 14.57% of patients. Pneumonia, urinary infection, and septicemia were reported as the most frequent nosocomial infections. The most common pathogen responsible was Staphylococcus aureus and Acinetobacter in pneumonia, Enterococcus in urinary infection, and Stenotrophomonas in septicemia. The present study showed that nosocomial infection was associated with increased hospital stay and mortality rate.

Conclusion: Nosocomial infection is considered an important challenge in the health system; its prevalence in different parts of the world is different, and it was not high in the present study. Nosocomial infection increases mortality and hospital stay and imposes a heavy burden on the health system; therefore, it is vital to decrease its prevalence. These findings can be used to plan for better infection control strategies and decrease nosocomial infection, hospital stay, and mortality rate.

Please cite this article as: Saeed A, MoradiKashkooli N, Sanaeidashti A, Seratishirazi Z, Alirahimi M. The Prevalence of Nosocomial Infection in Medical and Surgical Pediatric ICUs in a Tertiary Referral Hospital in the South of Iran. J Health Sci Surveillance Sys. 2023;11(2):360-364.

Keywords: Nosocomial infection, Pediatric intensive care unit (PICU), Mortality rate, Iran

Introduction

Nosocomial infection (NI) is considered a significant problem worldwide, specifically in the pediatric intensive care unit (PICU), leading to an increased hospital stay, medical costs, mortality, and morbidity. The children admitted to intensive care unit (ICU) are considered a high-risk population for NIs due to their risk factors. Due to the recurrent use of central catheters, mechanical ventilation, and invasive monitoring procedures, nosocomial infection is more prevalent in ICUs than in other hospital wards.[1-4]

Categorizing NIs in any infection control program is very difficult. In practice, there usually is a time interval of 48 hours to differentiate between nosocomial infection and community-acquired infection, and ICU-acquired infections.[5] Nevertheless, some physicians believe that infections

develop after 48 hours in the ICU, caused by the microorganisms imported by the patient at the time of admission, could not be regarded as a true ICU-acquired infection. Obviously, the infection is a nosocomial one, but it could be categorized into ICU-acquired infections. For example, a patient is admitted to PICU due to an underlying disease, such as an immunodeficiency disease, and requires further care. Then, the patient develops an infection in the ICU. The responsible microorganism does not belong to the ecology of the ICU because the patient has imported the microorganism into the ICU among the admission flora.

The novel categorization method for nosocomial infection is recommended based on career status. This method classifies the differentiation between potentially pathogenic microorganisms (PPMs) into three groups: Imported, primary, and secondary.[6]

The spectrum and amount of bacterial causes of bloodstream infection (BSI) are different in countries with different incomes. Pathogens such as Salmonella enterica and Burkholderia are not common in high-income countries, but they form a significant share of pathogens in Africa and Southeastern Asia. The common pathogens in children in high-income countries, where vaccination programs are more available, include Haemophilus influenzae and Streptococcus pneumonia, which are also more commonly seen in low-income countries.[7] Diagnosing the origin of infection is a priority because it would lead to proper antibiotic treatment. In the study of Kumar Ajit et al., it is reported that each hour delay in prescribing antibiotics is accompanied by a decrease by 6-7% in survival rate.[8]

Optimized use of antibiotics is crucial in ICUs, specifically in increasing antibiotic-resistant periods, accompanied by the lack of growth in novel antimicrobial drugs. The results of studies show that 30-60% of antimicrobial drugs in ICUs are unnecessary.[9] Excessive and improper prescription of antibiotics undoubtedly contributes to the developing challenges of antibiotic-resistant bacteria. Epidemiological studies have clearly shown the direct association between taking antibiotics and developing and spreading resistant strains in hospitals and ICUs.[10]

The results obtained in the study of Becerra et al. have shown that nosocomial infection increases the mortality rate and hospital stay. Moreover, they observed that increased hospital stay is associated with an increased risk of developing hazardous nosocomial infections.[11] The results of Garcia et al.'s study on 443 patients showed that NI was accompanied by increased costs on the patient and the healthcare system.[12] Therefore, the present study aimed to determine the prevalence of NI and its effects, such as increased hospital stay and PICU mortality rate in 2018.

Methods

The present research is a descriptive-analytical cross-sectional study. The statistical population included patients admitted to the PICU of Namazi Hospital during 2017-2018 that showed clinical symptoms of hospital-acquired infection and tested for blood culture, urine culture, endotracheal tube (ETT) culture, etc. The inclusion criteria were all the patients who were admitted for more than 48 hours in PICU (1 month to 18 years of age). Also, the exclusion criteria included the patients' dissatisfaction with using their medical information for research projects, admission less than 48 hours in the PICU, presence of clinical and laboratory evidence of infection before admission, and those whose information was missing. 693 eligible patients were studied using convenience and available sampling methods.

Nosocomial infection definition was derived from national nosocomial infection surveillance (NNIS) system. It was stated as an infection with the onset of 48 hours after admission and without any presentation or incubation period at the time of admission. Clinical suspicion for NI in patients admitted to PICU is formed when the patient has one of the following signs: unexplained fever (≤38 °C), leukocytosis (≤10000), new infiltration in chest X-ray, persistent secretions from the incision, cloudy urine color, burning sensation, and suprapubic tenderness. Patients were monitored 3 days after discharge and those who had undergone surgery 30 days after surgery.

The samples were cultured in two central laboratories of Namazi hospital and the laboratory of Dr. Alborzi Microbiology Research Center in Shiraz. Microbial resistance was measured using Beckton Dickinson and Beckton Dickinson, and mast disc antibiotic kits were used. Based on the definition of NI, after investigation of the entire patients' file, para-clinic studies and clinical judgment, patients with NI were separated.

Ultimately, the data were analyzed using SPSS v.19. Normal size distribution, mean and standard deviation were calculated. Then, each of the factors of age, sex, culture response, and antibiotic resistance were evaluated ($P<0.05$).

Results

Data were collected from January 2017 to January 2018. In the present study, 693 eligible subjects were studied for the research objectives. Based on the NNIS guidelines, 101 cases had acquired nosocomial infection; hence, the nosocomial infection rate was 14.57%. Demographic features, nosocomial infection incidence, mortality rate, and mean hospitalization period are shown in Table 1.

Pearson chi-square test did not show any relationship between gender and inflicting nosocomial infection ($P=0.57$). Also, there was no significant

Table 1: Demographic features of the patients admitted in PICU* of Namazi hospital

Variables	Frequency (%)
Confirmed NI** patients	101 (14.57%)
Gender of NI** category (n***=101)	
Male	49 (48.5%)
Female	52 (51.5%)
Age group of NI** category (n***=101)	
Below 1 year	12 (11.9%)
1-3 year	42 (41.6%)
4-12 year	33 (32.7%)
13-18 year	14 (13.9%)
Mortality rate	
NI** category	47 (46.5%)
Non-NI** category	95 (16.04%)
Overall	142 (20.49%)
Mean hospital stay (person-day)	
NI**category (n***=101)	14.2 days
Non-NI**category (n***=592)	7.17 days

*Pediatric Intensive Care Unit; **Nosocomial Infection; ***Number

Table 2: The prevalence of microorganisms by different nosocomial infections agents

Nosocomial infection agents	Microorganism	Frequency (n*)	Relative frequency (%)
BSI**	Pseudomonas	3	15
	Acinetobacter	3	15
	Klebsiella	2	10
	Stenotrophomonas	10	50
	Staph	2	10
UTI***	Ecoli	6	20.7
	Klebsiella	2	6.9
	Strep,Enterococci	11	37.9
	Yeast (Albicans)	6	20.7
	Yeast (non-Albicans)	4	13.8
Pneumonia	Pseudomonas	2	4
	Acinetobacter	12	24
	Klebsiella	2	4
	Stenotrophomonas	6	12
	NFB****	10	20
	MSSA*****	6	12
	MRSA******	6	12
	Yeast (non-Albicans)	6	12
Wound infection	Enterobacter	2	100

*Number; **Blood Stream Infection; ***Urinary Tract Infection; ****Non-Fermented Bacilli; *****Methicillin-Sensitive Staphylococcus Aureus; ******Methicillin-Resistant Staphylococcus Aureus

relationship between age and nosocomial infection (P=0.17). Our study showed that the average hospital stay in patients with NI was 14.2 days, while it was 7.17 days in other patients admitted to PICU. Moreover, our study assessments showed that developing NI led to an increased hospital stay (P≤0.05).

In sum, 142 patients passed away due to diverse etiologies; 101 of them were labeled as NI. Mortality rates among NI-patients and non-NI-patients were 46.5% and 16.04%, respectively. Also, the relationship between acquiring NI and increased mortality was statistically significant and patients with NI were 4.55 times more likely to die (OR 4.55, P<0.05).

According to our investigations, pneumonia (49.5%), urinary infection (28.7%), and septicemia (19.8%), and wound infection (2%) were reported as the most common nosocomial infections. The most prevalent pathogen responsible was S. aureus and Acinetobacter in pneumonia, Enterococcus in urinary infection, and Stenotrophomonas in septicemia (Table 2).

Discussion

Nosocomial infections have always been considered a major problem in all healthcare centers in the world. Given that the attempt to decrease nosocomial infection is an important and notable goal, there has been significant effort to achieve this goal.

Hospitals, particularly ICUs, are the most susceptible areas for developing resistant strains of microorganisms. Numerous measures have been taken in recent years, including the rational prescription of antibiotics by physicians. Being aware of the results from different sample cultures and microbial

sensitivity analysis could provide beneficial and effective information to control NIs.

Among the 693 patients admitted in this section, 101 had NI according to the assessments, thus making NI account for 14.57% of cases in the hospital. Compared to other studies, our study showed lower rates than that of Becerra (19.5%), but higher rates than that of NI in Spain (11.3%).[12]

The microorganisms responsible for NI were separated and consisted of 59.4% gram negatives, 25.8% gram positives, and 15.8% fungi. Among them, stenotrophomonas, fungi, and Acinetobacter (15.8%, 15.8%, and 14.9%, respectively) had the highest share. Staphylococcus aureus, Enterococcus, non-fermented bacilli (NFB), Escherichia coli, Klebsiella, Enterobacter, and Staphylococcus epidermis were in the next ranks.

As a matter of most prevalent nosocomial infection, in the study of Urrea et al., the most common infections were septicemia, pneumonia, and urinary infection.[13] However, according to the study by Masoumi Asl, the most common infections in Tehran were pneumonia, urinary infection, and septicemia, which was consistent with our study.[14] Moreover, the results obtained in a study with similar goals with ours showed that the most common NI agent was candida in septicemia, Pseudomonas in pneumonia, and candida in urinary infection.[11] On the other hand, the study of Porto et al. in Brazil showed that the common agents in septicemia were Enterococcus, Escherichia coli, and Staphylococcus aureus; in pneumonia and urinary infection, it was Staphylococcus aureus and yeasts, respectively.[15] It should be noted that differing microorganisms could be interpreted by differing times, geographical areas, and therapeutic wards.

Based on our collected data, there was no statistically significant relationship between patient age and nosocomial infection, but the rate of nosocomial infection in the age group of 1 to 3 years was higher than in other groups. Moreover, the data showed that there was no significant relationship between the patients' gender and development of a nosocomial infection. These data are consistent with the results obtained by Masumi Asl, who reported that NI wais more common in patients below two years of age and that gender did not affect developing an infection.[14]

Our assessments showed that developing NI would increase the hospital stay; in fact, the mean hospital stay in patients with NI was 14.2 days, while it was 7.17 days in other patients. This result is consistent with those of the study conducted by Urrea, which reported 22.5 days and 9 days for these values, respectively.[13]

Moreover, our assessments showed that NI increased the mortality rate, which was 46.5% and 16.04% in patients with nosocomial infections and other patients respectively. This is in line with Becerra's study, which reported that nosocomial infections increased mortality. Our study showed that the risk of death in patients with NI was 4.55 times that of others.

Conclusion

These findings can be used for devising a novel strategy in order to monitor the subjects and diminish nosocomial infection in our PICU setting as a primary line of proper infection control strategy.

Conflict of Interest: None declared.

References

1 Stein F, Trevino R. Nosocomial infections in the pediatric intensive care unit. Pediatr Clin North Am. 1994 Dec;41 (6):1245-57. doi: 10.1016/s0031-3955 (16)38871-x. PMID: 7984384.

2 Allen U, Ford-Jones EL. Nosocomial infections in the pediatric patient: an update. Am J Infect Control. 1990;18 (3):176-93. doi: 10.1016/0196-6553 (90)90183-s.

3 Reymond J, Aujard Y. Nosocomial infections in pediatric patients: A European multicenter prospective study. European Study Group. Infect Control Hosp Epidemiol. 2000;21 (4):260-3. doi: 10.1086/501755. PMID: 10782588.

4 Reymond J. Epidemiology of nosocomial infections in pediatrics. Pathol Biol (Paris). 2000;48 (10):879-84. PMID: 11204918.

5 Spencer RC. Definitions of nosocomial infections. Bailieres Clin Infect Dis. 1996:1;3 (2):237-52.

6 van Saene HK, Damjanovic V, Murray AE, de la Cal MA. How to classify infections in intensive care units--the carrier state, a criterion whose time has come? J Hosp Infect. 1996;33 (1):1-12. doi: 10.1016/s0195-6701 (96)90025-0. PMID: 8738198.

7 Sievert DM, Ricks P, Edwards JR, Schneider A, Patel J, Srinivasan A, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2009-2010. Infect Control Hosp Epidemiol. 2013;34 (1):1-14. doi: 10.1086/668770. PMID: 23221186.

8 Kumar A, Roberts D, Wood KE, Light B, Parrillo JE, Sharma S, et al. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. Crit Care Med. 2006;34 (6):1589-96. doi: 10.1097/01. CCM.0000217961.75225.E9. PMID: 16625125.

9 Daneman N, Sarwar S, Fowler RA, Cuthbertson BH; SuDDICU Canadian Study Group. Effect of selective decontamination on antimicrobial resistance in intensive care units: a systematic review and

meta-analysis. Lancet Infect Dis. 2013;13 (4):328-41. doi: 10.1016/S1473-3099 (12)70322-5. PMID: 23352693.

10 Doyle JS, Buising KL, Thursky KA, Worth LJ, Richards MJ. Epidemiology of infections acquired in intensive care units. Semin Respir Crit Care Med. 2011;32 (2):115-38. doi: 10.1055/s-0031-1275525. PMID: 21506049.

11 Becerra MR, Tantaleán JA, Suárez VJ, Alvarado MC, Candela JL, Urcia FC. Epidemiologic surveillance of nosocomial infections in a Pediatric Intensive Care Unit of a developing country. BMC Pediatr. 2010;10 (1):66. doi: 10.1186/1471-2431-10-66.

12 Morillo-García Á, Aldana-Espinal JM, Olry de Labry-Lima A, Valencia-Martín R, López-Márquez R, Loscertales-Abril M, et al. Hospital costs associated with nosocomial infections in a pediatric intensive care unit. Gac Sanit. 2015;29 (4):282-7. doi: 10.1016/j.gaceta.2015.02.008.

13 Urrea M, Pons M, Serra M, Latorre C, Palomeque A. Prospective incidence study of nosocomial infections in a pediatric intensive care unit. Pediatr Infect Dis J. 2003;22 (6):490-4. doi: 10.1097/01.inf.0000069758.00079.d3. PMID: 12799503.

14 Masoumi Asl H, Nateghian A. Epidemiology of nosocomial infections in a pediatric intensive care unit (PICU). Iran J Clin Infect Dis. 2009;4 (2):83-6.

15 Porto JP, Mantese OC, Arantes A, Freitas C, Gontijo Filho PP, Ribas RM. Nosocomial infections in a pediatric intensive care unit of a developing country: NHSN surveillance. Rev Soc Bras Med Trop. 2012;45 (4):475-9. doi: 10.1590/s0037-86822012005000003. PMID: 22767099.