



Evaluation of Properties, Pathogens, and Mortality-Related Risk Factors of Nosocomial Infections in Pediatric Cardiovascular Surgery Intensive Care Unit

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ABSTRACT

Introduction: The aim of this study was to evaluate the properties, pathogens, mortality-related risk factors, and mortality rates of nosocomial infections (NIs) in the pediatric cardiovascular surgery intensive care unit.

Patients and Methods: The files of 838 children, aged 0-16 years, who underwent cardiovascular surgery between January, 2014 and January, 2016 in Kartal Koşuyolu Research Hospital were evaluated in this retrospective study. NI was diagnosed according to the Center for Disease Control criteria. The correlations between several risk factors and NI were statistically analyzed.

Results: Fifty-four children out of 838 (6.4%) had NI. 29 of them (53.9%) had respiratory tract infections, 14 (24.8%) had urinary tract infections, 8 (15.7%) had bacteremia and 3 (5.6%) had wound site infections. The isolated pathogens were *Klebsiella pneumoniae* (20.4%), *Pseudomonas aeruginosa* (18.6%), *Candida albicans* (18.6%), *Stenotrophomonas maltophilia* (13.8%), *Acinetobacter baumannii* (10.5%), coagulase-negative staphylococci (9.1%), methicillin-resistant *Staphylococcus aureus* (MRSA, 3.6%), *Serratia marcescens* (1.8%), *Citrobacter freundii* (1.8%), and *Providencia rettgeri* (1.8%). The mortality rate due to NI was 13.7% (11/80). There was a statistically significant relationship between NIs and age and duration of mechanic ventilation ($p < 0.05$), but not between NIs and gender, accompanying abnormalities, and nasogastric feeding ($p > 0.05$).

Conclusion: Gram-negative bacteria were the most common pathogens of NI, which caused mortality. Assessing the responsible pathogens and determining the risk factors will help us to develop effective infection control measures for reducing the morbidity and mortality rates.

Key Words: Nosocomial infection; pediatry; cardiovascular surgery; intensive care unit

Pediyatrik Kardiyovasküler Cerrahi Yoğun Bakım Ünitesinde Görülen Nozokomiyal İnfeksiyonların Özellikleri, Patojenler ve Mortalite ile İlgili Risk Faktörleri Açısından Değerlendirilmesi

ÖZET

Giriş: Bu çalışmanın amacı, pediyatrik kardiyovasküler cerrahi yoğun bakım ünitesinde görülen nozokomiyal infeksiyonları (Nİ) özellikleri, patojenler, mortaliteyle ilgili risk faktörleri ve mortalite sıklığı açısından değerlendirmektir.

Hastalar ve Yöntem: Bu retrospektif çalışmada, yaşları 1 ay ila 16 yıl arasında değişen, Kartal Koşuyolu Eğitim ve Araştırma Hastanesinde Ocak 2014-Ocak 2016 tarihleri arasında kardiyovasküler cerrahi geçirmiş 838 çocuğun dosyaları değerlendirilmiştir. Hastalık kontrol merkezi kriterlerine göre Nİ tespit edilmiş hastalar çalışmaya alınmıştır. Nİ prevalansı ve çeşitli risk faktörleriyle Nİ arasındaki ilişkiler istatistiksel olarak analiz edilmiştir.

Bulgular: Toplam 838 hastadan 54 (%6.4)'ünde Nİ [(solunum sistemi (%53.9), idrar yolu (%24.8), bakteremi (%15.7) ve yara yeri infeksiyonları (%5.6)] mevcuttu. İzole edilen patojenler: *Klebsiella pneumoniae* (%20.4), *Pseudomonas aeruginosa* (%18.6), *Candida albicans* (%18.6), *Stenotrophomonas maltophilia* (%13.8), *Acinetobacter baumannii* (%10.5), koagülaz negatif stafilokok (9.1%), metisilin dirençli *Staphylococcus aureus* (MRSA) (3.6%), *Serratia marcescens* (1.8%), *Citrobacter freundii* (%1.8) ve *Providencia rettgeri* (1.8%) ve Nİ nedeniyle mortalite oranı %13.7 (11/80) bulunmuştur. Çocukların yaşı ve mekanik ventilasyon süresi ile Nİ arasında anlamlı bir ilişki saptanmış ($p < 0.05$); cinsiyet, nazogastrik beslenme ve eşlik eden anomaliler ile Nİ arasında anlamlı bir ilişki bulunamamıştır ($p > 0.05$).

Sonuç: PKVC sonrası Nİ sıklığı %6.4 ve en sık Nİ morbidite ve mortalite etkeni gram-negatif bakteriler olmuştur. Yoğun bakımda takip edilen hastalarda endotrakeal aspirat, kan, idrar ve yara kültürlerinin gönderilmesi ve Nİ ile ilişkili risk faktörlerinin zamanında değerlendirilmesi, gerekli infeksiyon kontrol önlemlerinin alınarak postoperatif morbidite ve mortalitenin azaltılmasını sağlayacaktır.

Anahtar Kelimeler: Nozokomiyal infeksiyon; çocuklar; kardiyovasküler cerrahi; yoğun bakım

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INTRODUCTION

Nosocomial infections (NIs) are important causes of morbidity and mortality, particularly in the pediatric cardiovascular surgery units globally⁽¹⁾. Their incidence range between 7.7%-39%⁽²⁾. Infections of the respiratory and urinary tracts, blood stream, and wound site are the most commonly encountered NIs^(1,2). Few studies have been conducted on the incidence, responsible pathogens, risk factors, and mortality rates of NIs in children undergoing cardiovascular surgeries⁽³⁾. Mechanical ventilation, prolonged hospital stay, accompanying diseases, and aspiration of nasogastric contents are other risk factors for NIs, particularly in children. Studies have reported that it is crucial to take effective infection control measures against etiologic agents and risk factors of NIs⁽⁴⁾. We designed this study to evaluate the incidences, pathogens, risk factors, and mortality rates of NIs in our pediatric cardiovascular surgery intensive care unit (PCVS-ICU) to promote our infection control measures.

PATIENTS and METHODS

The files of 838 children, between 1 month and 16 years of age (mean, 5.02 ± 2.93 years) who underwent cardiovascular surgery between January 2014 and January 2016 in the Kartal Koşuyolu Research and Training Hospital were retrospectively evaluated. Of the total 838 children, 54 children who had postoperative NI according to the Center for Disease Control criteria were included in the study. Presence of clinical features (fever, pallor, increased acute phase reactants, and purulent endotracheal secretions), pneumonic infiltration on the chest roentgenogram, colony count ≥ 10⁵ cfu/mL in semi-quantitative endotracheal aspirate culture (ETA) assay or in urine culture, and/or positive blood cultures after at least 48 h of hospital stay in the PCVS-ICU were accepted as the evidences of NI. Clinical evaluations and chest X-Rays were routinely performed; ETA, blood, and urine cultures were obtained at the postoperative first day. ETA cultures were then regularly obtained at the beginning of each week until extubation; blood and urine cultures were repeated if the patient had a fever ≥ 38°C, and an additional blood culture was obtained for patients with positive ETA culture. Wound cultures were obtained from the purulent site of the wound using sterile cotton swabs to prevent the contamination of specimens with normal microbial skin flora. These specimens were labeled and immediately transferred to the laboratory. They were then inoculated into blood agar, nutrient agar, chocolate agar, and mannitol salt agar plates. Sterile disposable mucus collector apparatus was used to collect the respiratory samples, and original sterile sample box was used for the transfer. Gram staining was performed for all samples, which were then immediately plated on two blood and two endo agar plates. The plates were daily checked for growth and routine laboratory techniques were used to identify organisms. Culture with a colony count > 10⁵ cfu/mL was accepted as a positive culture. Disk diffusion technique was used to conduct antibiotic sensitivity test for

all isolated microorganisms. Blood cultures were evaluated using BACTEC system, and the antibiotic susceptibility tests for positive cultures were performed using MIC/ID panels⁽⁵⁾. The C-reactive protein (CRP) was measured using a nephelometer by immunophelometric method. CRP level < 0.3 mg/dL was accepted as normal.

Statistical Analysis

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. NI rate was determined, and correlations between several risk factors (age, gender, duration of mechanical ventilation, presence of accompanying abnormalities, and nasogastric feeding) and NIs were statistically analyzed using the chi-square test. A p-value < 0.05 was accepted as statistically significant.

RESULTS

NI was diagnosed in 54 [6.4%; 31 males (57.4%), 23 females (42.6%)] out of 838 children. The mean age was 5.02 ± 2.93 years, mean duration of mechanical ventilation was 12.3 ± 7.6 days, and mean duration of hospital stay was 13.4 ± 4.6 days. The mean leucocyte count was 12.895 ± 6.392/mm³ and mean CRP level was 5.4 ± 4.2 mg/dL. The distribution of NI with respect to the infection sites were as follows: respiratory tract (53.9%), urinary tract (24.8%), blood stream (15.7%), and wound site (5.6%) infections. Isolated pathogens were *Klebsiella pneumoniae* (20.4%), *Pseudomonas aeruginosa* (18.6%), *Candida albicans* (18.6%), *Stenotrophomonas maltophilia* (13.8%), *Acinetobacter baumannii* (10.5%), coagulase-negative staphylococci (9.1%), methicillin-resistant *Staphylococcus aureus* (MRSA, 3.6%), *Serratia marcescens* (1.8%), *Citrobacter freundii* (1.8%), and *Providencia rettgeri* (1.8%) (Figure 1). *K. pneumoniae* were isolated from ETA (7/11, 63.6%), blood (2/11, 18.2%), and urine (2/11, 18.2%) cultures; *P. aeruginosa* from ETA (7/10, 70%) and blood (3/10, 30%) cultures; *C. albicans* from ETA (2/10, 20%), blood (1/10, 10%), and urine (7/10, 70%) cultures; *S. maltophilia* from ETA (8/8, 100%) culture; *A. baumannii* from ETA (5/6, 83.4%) and blood (1/6, 16.6%) cultures; coagulase-negative staphylococci from blood (4/4, 100%) culture; MRSA from ETA (1/2, 50%) and blood (1/2, 50%) cultures; *S. marcescens* (1/1, 100%) and *C. freundii* from wound (1/1, 100%) culture; and *P. rettgeri* from ETA (1/1, 100%) culture (Figure 1). A statistically significant positive correlation was found between the duration of mechanical ventilation and NI and a negative correlation was found between age of the child and NI (p < 0.05). However, in this study NI had no statistically significant relationship with the gender, with the presence of accompanying abnormalities (renal, endocrinal, and genetic), with the use of antacids or with nasogastric feeding (p > 0.05) (Table 1). The overall mortality rate was 9.5% (80/838) and mortality due to NIs was 13.7% (11/80) (Table 2).

Table 1. Comparative analysis of risk factors for nosocomial infections

Risk factors	Patients with NI	Patients without NI	Statistical significance (*p value)
Age (years), mean ± SD	3.8 ± 2.3	5.2 ± 4.1	0.01
Gender			
male (n)	31	446	
female (n)	23	338	0.6
Duration of mechanical ventilation (days), mean ± SD	18.4 ± 8.2	6.3 ± 3.4	0.002
Nasogastric feeding (days), mean ± SD	14.8 ± 8.2	8.4 ± 3.6	0.07
Stress ulcer prophylaxis by antacids (days), mean ± SD	13.9 ± 7.1	5.1 ± 2.4	0.06
Accompanying diseases (n) (renal, endocrine, genetic)	6	8	0.4
Leucocyte count/mm ³	16.300 ± 4.560	8.600 ± 3.640	0.04
CRP level (mg/dL)	8.6 ± 5.2	3.1 ± 2.8	0.01

* p< 0.05 was accepted as statistically significant. NI: Nosocomial infection.

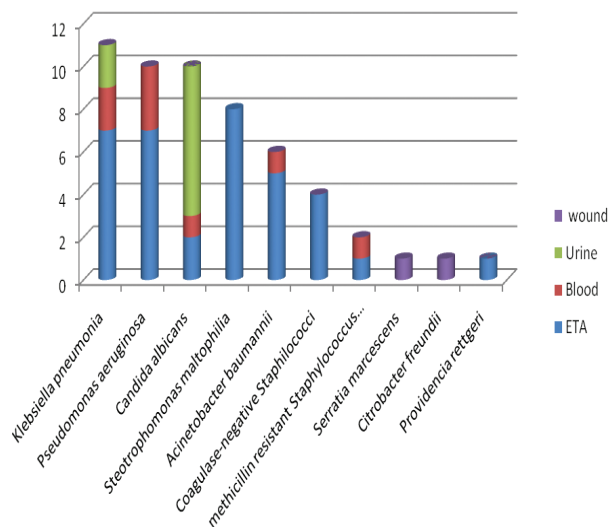


Figure 1. Etiologic agents of the nosocomial infections and their distributions with respect to the cultures.

Table 2. Outcome of the patients with/without nosocomial infections in PCVS-ICU

Outcome	Patients with NI (n= 54)	Patients without NI (n= 784)	Statistical significance (*p value)
Hospital stay (days), mean ± SD	18.4 ± 6.8	8.4 ± 1.6	0.02
Survived (n)	43	715	0.05
Died (n)	11	69	0.06

* p< 0.05 was accepted as statistically significant. NI: nosocomial infection.

DISCUSSION

One of the most important life-threatening medical problems of ICUs globally is NI⁽⁶⁾. Patients undergoing cardiovascular surgery had the highest hospital-acquired infection rate of 23 per 1000 patients. Several studies have reported that the prevalence of NIs in pediatric ICUs ranges between 6.1% and 29.6%^(1,7). The NI rate in our pediatric cardiovascular surgery intensive care unit was found 6.4% (54/838), which was acceptable according to the limited reports from National Nosocomial Infection Surveillance System gathering data from over 50 PICUs in the US⁽⁸⁾. The most common type of NI in our PCVS-ICU was respiratory tract infections, and the most commonly isolated pathogens were gram-negative bacteria, *K. pneumoniae* (20.4%) and *P. aeruginosa* (18.6%); findings similar to those of previous studies^(9,10). For prevention of these infections, we should promote our infection control measures, respiratory care practices, and hygienic conditions. Moreover, several studies have showed that age of the patient and duration of mechanical ventilation are important risk factors for the development of NIs⁽¹¹⁻¹³⁾. Similarly, the present study showed a negative correlation between age and NI and a positive correlation between duration of mechanical ventilation and NI. As the age of child decreases and the duration of mechanical ventilation increases, the NI rate increases. Although Dasgupta et al. found a positive correlation between NIs and the use of antacids, nasogastric feeding, and accompanying diseases of the patients; this study showed no correlation between these factors and NI⁽¹⁴⁾. Dasgupta et al., Kaouter et al. and Vincent et al. reported different NI mortality rates (11.9%, 26.6% and 25% respectively)⁽¹⁴⁻¹⁶⁾. The NI mortality rate in this study was found 13.7%.

In conclusion, hospital-acquired infections are life threatening, but preventable, infections. After defining the major risk factors and responsible pathogens, we can promote infection control measures, thereby decreasing the morbidity and mortality rates.

CONFLICT of INTEREST

The author reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: ATK

Analysis/Interpretation: ATK

Data Acquisition: ATK

Writing: ATK

Critical Revision: ATK

Final Approval: ATK

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