

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

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ABSTRACT

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

Materials and Method: The files of 838 children, 1/12-16 years old, who underwent cardiovascular surgery between January, 2014-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 analyzed statistically.

Results: 54out of 838 children (6.4%) had NI (respiratory tract (53.9%),urinary (24.8%), bacteremia (15.7%) and wound site infections (5.6%)). The isolated pathogens were Klebsiella pneumonia (20.4%), Pseudomonas aeruginosa (18.6%), Candida albicans (18.6%), Stenotrophomonas maltophilia (13.8%), Acinetobacter baumannii (10.5%), coagulase-negativeStaphylococci (9.1%), methicillin resistant Staphylococcus aureus (MRSA) (3.6%), Serratia marcescens (1.8%),Citrobacter freundii (%1.8) and providencia rettgeri (1.8%). The mortality due to NI was 13.7% (11/80). There was a statistically significant relationship between the age, duration of mechanic ventilation and NI ($p<0.05$), but not with gender, accompanying abnormalities and nasogastric feeding ($p>0.05$)

Conclusion: Gram negatives were the most common pathogens of NI and mortality. Assessment of responsible pathogens and determining risk factors of NI will help us develop effective infection control measures to reduce the morbidity and mortality.

Keywords: Nosocomial infection, Children, Cardiovascular surgery, Intensive care unit

Pediyatrik Kardiyovasküler Cerrahi Yoğun Bakım Ünitesinde Görülen Nozokomiyal Enfeksiyonların Özellikleri, Patojenler ve Mortaliteyle İlgili Risk Faktörleri Açısından Değerlendirilmesi

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ÖZET

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

Hastalar ve Metod: Bu retrospektif çalışmada, yaşları 1 ay-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 NKE tespit edilmiş hastalar çalışmaya alınmıştır. NKE prevalansı ve çeşitli risk faktörleriyle NKE arasındaki ilişkiler istatistiksel olarak analiz edilmiştir

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

Sonuç: PKVC sonrası NKE prevalansı %6.4 ve en sık NKE etkeni gram negatif bakteriler olmuştur. Yoğun bakımda takip edilen hastalarda endotrakeal aspirat, kan, idrar ve yara kültürlerinin gönderilmesi ve NKE ile ilişkili risk faktörlerinin zamanında değerlendirilmesi, gerekli enfeksiyon kontrol önlemlerinin alınarak postoperatif morbidite ve mortaliteyi azaltacaktır.

Anahtar Kelimeler: Nozokomiyal enfeksiyon, Çocuklar, Kardiyovasküler cerrahi, Yoğun Bakım Ünitesi

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INTRODUCTION

Nosocomial infections are important causes of morbidity and mortality especially in the pediatric cardiovascular surgery units all over the world⁽¹⁾. Its incidence ranges between 7.7- 39%⁽²⁾. Respiratory system, blood stream, urinary system and wound site infections are the most commonly encountered NI^(1,2). There are only a few studies about the incidence, responsible pathogens, risk factors and mortality rates of NI in children undergoing cardiovascular surgeries⁽³⁾. Mechanic ventilation, prolonged hospital stay, accompanying diseases, aspiration of the nazogastric contents are other risk factors for NI especially in children. It is crucial to take effective infection control measures according to the outcomes of studies about the etiologic agents and risk factors of nosocomial infection⁽⁴⁾. We designed this study to evaluate the incidence, pathogens, risk factors and mortality rate of nosocomial infection in our PCVS-ICU to promote our infection control measures.

PATIENTS AND METHODS

The files of 838 children who had had cardiovascular surgery between January, 2014-Jauary, 2016 in Kartal Koşuyolu Research and Training Hospital, were evaluated retrospectively. They were between 1 month and 16 years of age (mean 5,02 ±2,93 years). 54 of these children who had nosocomial infection postoperatively according to the CDC criteria were included in the study. Presence of clinical features (fever, pallor, increased acute phase reactants, purulent endotracheal secretions), infiltration on the chest roentgenogram, colony count $\geq 10^5$ cfu/ml in semiquantitative ETA assay or in urine culture and/or positive blood cultures after at least 48 hours of hospital stay in the PCVS-ICU were accepted as the evidences of nosocomial infection. Clinical evaluation and chest X-rays were performed daily; ETA, blood and urine cultures were obtained initially on the first post-operative day. Then ETA cultures were repeated at the beginning of each week regularly until extubation; blood and urine cultures were repeated if the patient had a fever ≥ 38 centigrade degree ($^{\circ}\text{C}$) and an additional blood culture was obtained from the patients with positive ETA culture. Wound cultures were obtained from the purulent site of the wound by using sterile cotton swabs to prevent the contamination of the specimens with normal microbial skin flora. These specimens were labeled and transferred immediately to the laboratory. They were inoculated to blood agar, nutrient agar, chocolate agar plates and mannitol salt agar. Sterile disposable mucus collector apparatus was used to collect the respiratory samples and original sterile sample box for the transport. Gram stain was

applied on all samples which were then immediately plated on two blood and two endo agars. The plates were checked daily for the growth and routine laboratory techniques were used to identify the organisms. The colony count $>10^5$ cfu/ml was accepted as positive culture. Disc diffusion technique was used to conduct antibiotic sensitivity test to all isolated microorganisms. Blood cultures were evaluated by BACTEC system and the antibiotic susceptibility tests of the positive cultures were performed by MIC/ID panels⁽⁵⁾. C-reactive protein (CRP) was measured by nephelometry device by immunophelometric method. CRP level < 0.3 mg/dl was accepted normal.

Statistical Analysis

The data analysis was performed by Statistical Packages for Social Sciences (SPSS) 14.0 Windows. Quantitative parameters were identified as the mean \pm standard deviation and qualitative parameters were identified as the frequency distribution and percentage. Nosocomial infection rate was determined and the correlations between several risk factors (age, gender, duration of mechanic ventilation, presence of accompanying abnormalities, nasogastric feeding) and nosocomial infections were analyzed statistically by chi-square test. A p value <0.05 was accepted as significant.

RESULTS:

Nosocomial infection was diagnosed in 54 (31 males (57.4%), 23 females (42.6%)) out of 838 children (6.4%). Their mean age was $5,02\pm 2,93$ years, mean duration of mechanical ventilation was 12.3 ± 7.6 days and the mean duration of hospital stay was 13.4 ± 4.6 days. Their mean leucocyte count was $12895\pm 6392/\text{mm}^3$ and mean CRP level was 5.4 ± 4.2 mg/dl. The distribution of nosocomial infection with respect to the infection sites were as follows: respiratory tract infections (53.9%), urinary tract infections (24.8%), blood stream infections (15.7%) and wound site infections (5.6%). The isolated pathogens were *Klebsiella pneumonia* (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%) (Figure1). *Klebsiella pneumonia* were isolated from ETA (7/11)(63.6%), blood (2/11)(18.2%) and urine cultures (2/11)(18.2%); *Pseudomonas aeruginosa* from ETA(7/10)(70%) and blood (3/10)(30%) cultures; *Candida albicans* from ETA (2/10)(20%), blood (1/10)(10%) and urine (7/10)(70%) cultures; *Stenotrophomonas maltophilia* all from ETA cultures (8/8)(100%); *Acinetobacter baumannii* from ETA

(5/6)(83.4%) and blood(1/6)(16.6%) cultures; coagulase-negative Staphylococci all from blood cultures (4/4)(100%); MRSA from ETA(1/2)(50%) and blood(1/2)(50%) cultures; *Serratia marcescens*(1/1) and *Citrobacter freundii* from wound culture (1/1)(100%) and *Providencia rettgeri* from ETA culture (1/1)(100%) (Figure1.) There was a statistically significant relationship between the age, duration of mechanic ventilation and nosocomial infection.($p<0.05$) However, correlations between the gender, accompanying abnormalities (renal, endocrine, genetic), use of antacids for stress ulcer prophylaxis , nasogastric feeding and nosocomial infection were nonsignificant.($p>0.05$) (Table1). The overall mortality was 9.5% (80/838) and the mortality due to nosocomial infection was 13.7%(11/80) (Table 2).

DISCUSSION

One of the most important life threatening medical problems of the intensive care units all over the world is nosocomial infection⁽⁶⁾. Patients undergoing cardiovascular surgery had the highest hospital acquired infection rate of 23 per 1000 patient days. In several studies it has been reported that the prevalence of nosocomial infection in pediatric intensive care units ranges between 6.1% and 29.6%^(1,7). Nosocomial infection was present in 54 out of 838 patients undergoing cardiac surgery, so the nosocomial infection rate was 6.4% in our study. As compared with the limited number of reports from other PICUs (6.1-29.6%) as well as the reports from National Nosocomial Infection Surveillance System (6.1%) that contains data from over 50 PICUs in the United States, it is acceptable⁽⁸⁾. The most common type of nosocomial infection in our PCVS-ICU was respiratory tract infections and the most commonly isolated pathogens were gram-negative bacteria (*Klebsiella pneumonia* (20.4%) and *Pseudomonas aeruginosa* (18.6%)), findings similar to the results of previous studies^(9,10). This points out that we should promote our infection control measures about the intensive care unit equipments and be more careful about our respiratory care practices and hygienic conditions. Moreover, several studies have showed that age of the patient and duration of mechanic ventilation are important risk factors for development of nosocomial infection^(11,12). In this study a positive correlation was found between the age and duration of mechanical ventilation and development of nosocomial infection. As the age decreases and/or the duration of mechanical ventilation and hospital stay is prolonged, the immunity of the child becomes more vulnerable to the assaults of microorganisms^(12,13). Dasgupta et al. also found a positive correlation between use of antacids, nasogastric tube insertion and accompanying diseases of the patients and nosocomial infection,

however there was no such a relation in the present study⁽¹⁴⁾. Kaouter et al.⁽¹⁵⁾ reported 26.6%, Vincent et al.⁽¹⁶⁾ 25% and Dasgupta et al.⁽¹⁴⁾ reported 11.9% mortality rate of nosocomial infection in their studies. The mortality rate due to nosocomial infection in our study was %13.7.

As a conclusion, hospital acquired infections are life threatening, but preventable infections. After defining the major risk factors and responsible pathogens, we can be able to promote our infection control measures, thereby decreasing the morbidity and mortality rates.

FIGURE LEGENDS

Figure1. Etiologic agents of the nosocomial infections and their distribution with respect to the cultures

Table 1. Comparative analysis of risk factors for nosocomial infections

Table 2. Outcome of the patients with/out nosocomial infections in PCVS-ICU

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FIGURE LEGENDS

Figure1. Etiologic agents of the nosocomial infections and their distribution with respect to the cultures

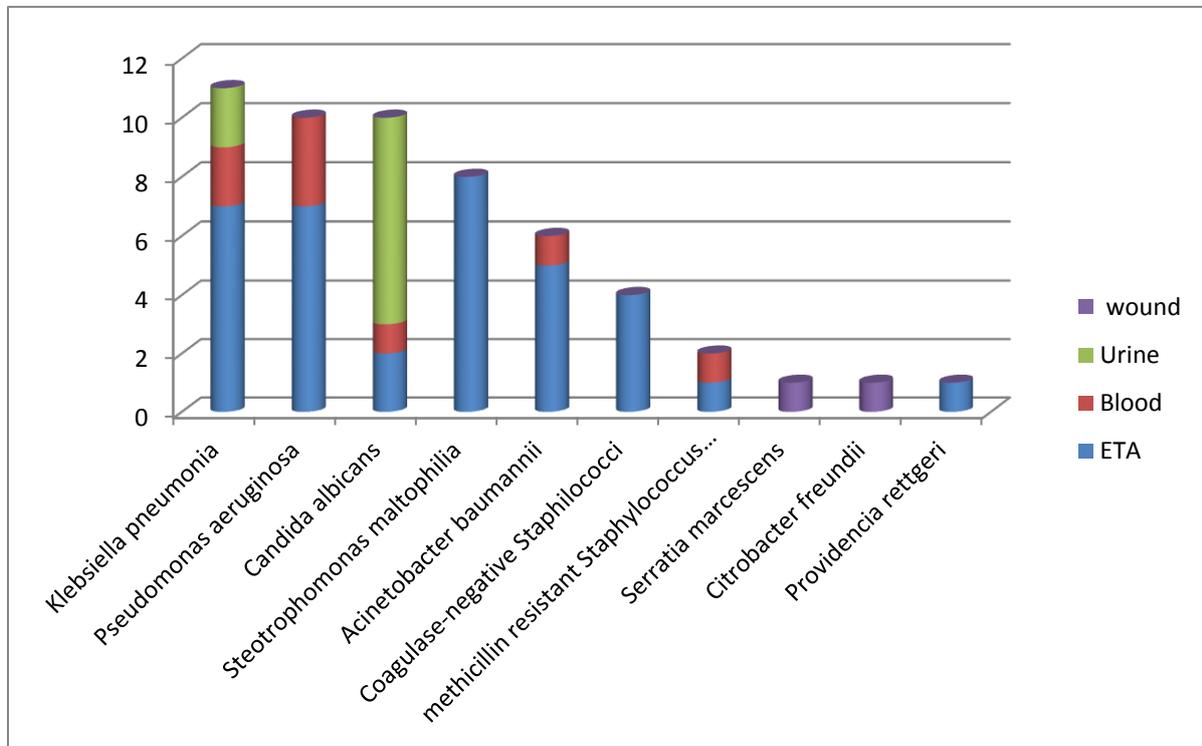


Table 1. Comparative analysis of risk factors for nosocomial infections

Risk Factors	Patients with NI	Patients with no NI	Statistical significance (*p value)
Age (years) mean±SD	3,8±2,3	5,2±4,1	0.01
Gender Male (n)	31	446	0.6
Female(n)	23	338	
Duration of mechanic 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 etc.)	6	8	0.4
Leucocyte count/mm³	16300±4560	8600±3640	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

Table 2. Outcome of the patients with/out nosocomial infections in PCVS-ICU

Outcome	Patients with NI (n=54)	Patients without NI (n=784)	Statistical significance (*p value)
Hospital stay(days)±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