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RESEARCH ARTICLE

NOSOCOMIAL PNEUMONIA RISK FACTORS AND ENDOTRACHEAL ASPIRATE CULTURES IN ITS PREDICTION: RESULTS OF A PEDIATRIC CARDIOVASCULAR SURGERY INTENSIVE CARE UNIT OF A TERTIARY CENTER IN TURKEY

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ABSTRACT

Hospital acquired infections, nosocomial pneumonia(NP) being the second most common, is the major cause of morbidity and mortality in children undergoing cardiovascular surgeries. In this retrospective study, the data of 875 children, 1/12 to 16 years of age, who underwent cardiovascular surgery between January,2014-February,2016 in Kartal Koşuyolu Research and Training Hospital were detected. 281(168 males, 113 females) of them, mechanically ventilated longer than 3 days postoperatively, were included in the study. NP was diagnosed in 41 of them (14.5%) according to the Center for Disease Control(CDC) criteria. ETA cultures were obtained regularly. The isolated pathogens were Klebsiella Pneumonia(29.2%), Pseudomonas Aeruginosa(24.3%), Stenotrophomonas Maltophilia(21.9%), Acinetobacter Baumannii(17.3%) and Candida Albicans(7.3%). The overall mortality was 28.8%(81/281) and the mortality due to NP was 14.8%(12/81). There was a statistically significant relationship between the age, duration of mechanic ventilation, reintubation and NP. ($p<0.05$) However, the correlation between the gender, use of antacids, accompanying abnormalities, nasogastric feeding and the ETA positivity was nonsignificant. ($p>0.05$) Assessment of responsible pathogens via routine ETA cultures and determining the risk factors of NP will help us promote our infection control measures to decrease the postoperative morbidity and mortality rates. Moreover, these findings may form a base for further studies in other pediatric cardiovascular surgery intensive care units(PCVS-ICU).

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INTRODUCTION

Nosocomial pneumonia (NP) is the second most common infection in the pediatric intensive care units (Patra *et al.,* 2007). Mechanically ventilated infants carry a particular risk of pulmonary infection due to the artificial airways that bypass the defense mechanisms against inhaled pathogens and provide new routes for the nonairborne pathogens (Bozaykut *et al*., 2008). Prolonged hospital stay, accompanying diseases, aspiration of the nazogastric contents are other risk factors for nasocomial infections especially in children (Bozaykut *et al.,* 2008; Tullu *et al.,* 2000). There are only a few studies about the incidence, responsible pathogens, risk factors and mortality rates of NP among children undergoing cardiovascular surgeries. It is crucial to take effective infection control measures according to the outcomes of studies about the pattern of occurrence, etiologic agents and risk factors of NP (Esteban *et al*., 2013).

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Therefore, we designed this study and evaluated the incidence, pathogens, risk factors and mortality rate of NP in our PCVS-ICU.

MATERIALS AND METHODS

The files of 875 children, who underwent cardiovascular surgery between January, 2014-February, 2016 in Kartal Koşuyolu Research and Training Hospital, were evaluated retrospectively. They were between 1 months and 16 years of age (mean 5,02 ±2,93 years). 281 of these children, 168 males and 113 females, who required mechanical ventilation longer than 3 days postoperatively, were included in the study. NP was diagnosed in 41 (14.5%) of them according to the CDC criteria. Presence of infiltration on the chest roentgenogram, clinical features (either fever, positive acute phase reactants or purulent endotracheal secretions) and the colony count $>10^5$ cfu/ml in semiquantitative ETA assay after at least 48 hours of hospitalization are accepted as evidences of NP in CDC criteria. Clinical evaluation and chest X-rays were performed daily; ETA cultures were obtained initially on the third day of

mechanical ventilation and at the beginning of each week regularly until extubation in our PCVS-ICU. Sterile disposable mucus collector aparatus was used to collect the 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 technigues were used to identify the organisms. The colony count $>10^5$ cfu/ml was accepted as positive culture. Discus diffusion technigue (Kirboy Bauer) was used to conduct antibiotic sensitivity test to all isolated microorganisms. The data analysis was performed by Statistical Packages for Social Sciences (SPSS) 10,0 Windows. NP rate was determined and the correlations between several risk factors (age, gender, duration of mechanic ventilation, use of antacids, presence of accompanying abnormalities, nasogastric feeding) and ETA positivity were analyzed statistically by chi-square test and multivariate analysis. A p value <0.05 was accepted as significant.

RESULTS

Out of 875 children, 281 (168 males and 113 females) (32.1%) were included in the study. Their mean age was 5,1±4,6 years and the mean duration of mechanical ventilation was 15.3±7.6 days. NP was diagnosed in 41 (14.5%) of them as they had pneumonic infiltration on their chest roentgenogram, mucoid secretions in the nasotracheal aspirations and positive ETA cultures. The most commonly isolated pathogens were gram negatives, Klebsiella pneumonia being the most common (n:12, 29.2%). The other isolated pathogens were: Pseudomonas Aeruginosa (n:10, 24.3%), Stenotrophomonas Maltophilia (n:9, 21.9%), Acinetobacter Baumannii (n:7, 17.3%) and Candida Albicans (n:3, 7.3%) (Figure 1). There was a statistically significant relationship between the age, duration of mechanic ventilation, reintubation and NP. ($p<0.05$) However, the correlation between the gender, use of antacids, accompanying abnormalities, nasogastric feeding and the ETA positivity was nonsignificant ($p>0.05$) (Table 1).

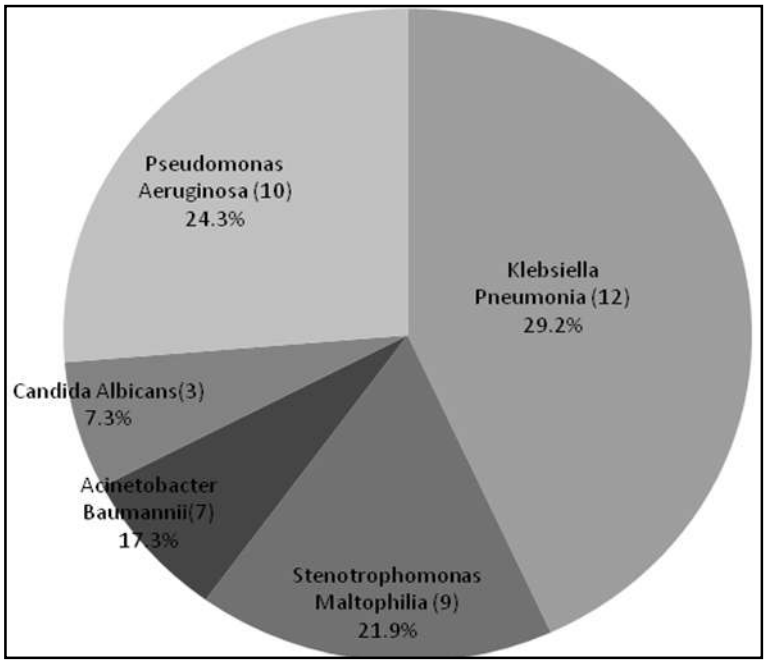

Figure 1. Etiologic Agents of Nasocomial Pneumonia

Table 1. Comparative Analysis of Risk Factors of Nosocomial Pneumonia

Risk Factors	Patients with NP	Patients with no NP	Statistical significance (*p value)
Age (years) mean±SD	3,6±2,5 years	5,1±4,6 years	0.02
Gender Male (n)	27	141	
Female (n)	14	99	0.07
Duration of mechanic ventilation(days) mean±SD	15.3±7.6	6.2±3.1	0.003
Nasogastric feeding (days) mean±SD	14.8±8.2	5.4±2.6	0.08
Stress ulcer prophylaxis by antacids (days) mean±SD	13.9±7.1	5.1±2.4	0.08
Accompanying diseases(n) (Renal, endocrine, genetic etc.)	5	7	0.06
Reintubation (n)	6.2±2.4	2.1±1.5	0.01

*p<0.05 was accepted as statistically significant

Table 2. Outcome of Patients with/out Nosocomial Pneumonia in PCVS-ICU

Outcome	Patients with NP (n=41)	Patients with no NP (n=240)	Statistical significance (*p value)
Hospital stay (days)±SD	16.4±7.8	7.4±3.6	0.03
Survived (n)	29	171	0.08
Died (n)	12	69	0.07

*p<0.05 was accepted as statistically significant

The overall mortality was 28.8% (81/281) and the mortality due to NP was 14.8% (12/81) (Table 2).

DISCUSSION

Nosocomial infections, NP being the second most common, is one of the most important life threatening medical problems of the intensive care units all over the world. (Asembergiene *et al.,* 2009). The incidence of NP in pediatric intensive care units has been reported to range from 6.1% to 29.6% in several studies (Abramczyk *et al.,* 2003; Urrea *et al*., 2003). Patients undergoing cardiovascular surgery had the highest hospital acquired infection rate of 23 per 1000 patient days (Urrea *et al*., 2003). In our study, we included 281 patients mechanically ventilated longer than 72 hours in the PCVS-ICU and diagnosed NP in 41 of them according to the CDC criteria. Although our NP incidence (14.5%) was not high compared with other limited number of reports from PICUs (6.1-29.6%); it was higher than reported by National Nosocomial Infection Surveillance System (6.1%) that contains data from over 50 PICUs in the United States (Patra *et al*., 2007; Stover *et al*., 2006). This points out that we should be more careful about our respiratory care practices, hygienic conditions and re-evalute the infection control measures. We obtained ETA cultures initially on the third day of mechanical ventilation and at the beginning of each week regularly until extubation. Quantitative ETA assay was used to evaluate them and ETA positivity rate was found 14.5%. The quantitative bacteriological methods have increased the reliability of ETA cultures, compared to the conventional qualitative cultures, due to the better collection and dilution methods of sputum (Urrea *et al*., 2003). The most commonly isolated pathogens were Gram-negative bacteria (Klebsiella Pneumonia (29.2%) and Pseudomonas Aerigunosa (24.3%)) in our study, a finding similar to the results of previous studies (Patra *et al*., 2007; Ibrahim *et al*., 2000; Joshi *et al*., 1992). They were evaluated by disc diffusion method and found to be sensitive to the majority of antibiotics as ceftriaxone, meropenem, ciprofloxacin, ceftazidime and colimycin. Several studies have showed that age of the patient, duration of mechanic ventilation, and re-intubations are important risk factors for development of NP (Koulenti *et al*., 2009; Patra *et al*., 2007).

In our study we also found a positive correlation between the age, duration of mechanical ventilation and frequency of re-intubation and development of NP. As the age decreases, the immunity of the child becomes more vulnerable to the assaults of microorganisms especially when the duration of mechanical ventilation is prolonged or frequent re-intubation is performed (Figueiredo *et al*., 2009; Patra *et al*., 2007). However, we couldn't find a relation between the gender, accompanying diseases (renal, endocrinologic, genetic etc.), use of stress ulcer prophylaxis with sucralfate or nasogastric feeding and NP. NP may result in death if it can't be effectively controlled and crude mortality from NP may exceed 50% (Liberati *et al*., 2006). Koulenti *et al*. reported 37.7% and Gastmeier *et al*. 8.9% mortality rate of NP in their studies (Koulenti, 2009; Gastmeier, 2007). The mortality rate due to NP in our study was %14.8. As a conclusion, ETA is a noninvasive diagnostic method and gives a rapid result. Therefore, obtaining regular ETA cultures from the patients with prolonged mechanical ventilation in PCVS-ICU may help us diagnose NP earlier and prevent the development of sepsis and death.

After defining the major risk factors and responsible pathogens of NP, we can be able to promote our infection control measures, thereby decreasing the morbidity and mortality rates.

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