



Healthcare-associated Infections at a Tertiary Level Pediatric Intensive Care Unit From Turkey

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Balıkesir Atatürk City Hospital, Clinic of Pediatric Infectious Diseases, Balıkesir, Turkey

ABSTRACT

Aim: Healthcare-associated infections are important conditions, as they may increase morbidity and mortality, prolong hospital stay and increase costs. A higher incidence of healthcare-associated infections has been reported in developing countries, but data on its epidemiology in pediatric patients are limited. The aim of this study was to determine the rate and distribution of health care-associated infections and antimicrobial susceptibility patterns in a pediatric intensive care unit.

Materials and Methods: Demographic and clinical details, microbiological findings, antibiotic susceptibility results and the outcomes of all hospitalized pediatric intensive care unit patients were collected for one year (September 2017 to September 2018).

Results: The health care-associated infections rate was 5.6 per 100 admissions and the incidence density was 7.2 per 1,000 patient-days. Bloodstream infections (50%) were the most common type and *Klebsiella* species (40.9%) was the most common cause of health care-associated infections. All of the *Klebsiella* spp. were resistant strains producing extended-spectrum beta-lactamases (77.7%) and the remaining were resistant to carbapenem. *Acinetobacter* species and colistin resistance was not detected in any isolates.

Conclusion: This study demonstrated a low prevalence of health care-associated infections but a high rate of antibiotic resistance in *Klebsiella* species in a pediatric intensive care unit. In addition to improved surveillance, consultation with infectious disease specialists will allow the development of interventions to reduce healthcare-associated infections, in order to regulate both empirical treatment and ongoing management, and also to provide appropriate targeted therapy.

Keywords: Healthcare-associated infections, antimicrobial resistance, children

Introduction

Healthcare-associated infections (HAI) continue to be an important source of morbidity and mortality worldwide, but especially in developing countries such as our country (1). They cause a major public health problem with prolonged hospitalization, broad spectrum antibiotic requirement, increased resistance patterns and consequent additional healthcare costs. Although intensive care units (ICUs) account for fewer than 10 percent of the total beds in most hospitals, the incidence of HAI is higher in ICUs than any

other hospital units. More than 20 percent of all nosocomial infections are acquired in ICU (2,3). Patients hospitalized in an ICU are more prone to HAI due to their severe clinical conditions and the consequent invasive procedures (4).

Although the rate of HAI in pediatric intensive care units (PICUs) in developed countries is lower than in adult ICUs, this situation is different in developing countries (1). Also, the rate of HAI is higher in PICUs than in other children's units. In a multicenter study conducted in Europe, the incidence of HAI in general pediatric units was reported to

Address for Correspondence

Gülhadiye Avcu, Balıkesir Atatürk City Hospital, Clinic of Pediatric Infectious Diseases, Balıkesir, Turkey
Phone: +90 505 310 95 51 E-mail: gul_akbas@yahoo.com.tr ORCID: orcid.org/0000-0002-0562-3544

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be 1% while it was 23.6%. in PICU (5). In a study from our country, the HAI rate was reported to be 22.24% in a PICU (1).

Infections and sepsis are the leading cause of death in non-cardiac ICUs. The most important nosocomial infections in ICUs are bloodstream infections (BSIs), ventilator-associated pneumonia (VAP), and urinary tract infections (UTIs).

In this study, we aimed to determine the incidence of HAIs, the distributions of the pathogens and the antimicrobial susceptibility in a PICU, in a city hospital in Turkey.

Materials and Methods

Balikesir City Hospital is a non-tertiary state hospital which was opened with the aim of providing health service to a wide region. The hospital started admitting patients in 2017. The pediatric ICU, which is the only one in the area, consists of nine tertiary level beds. Each nurse has to care for two patients. Two pediatric infectious diseases specialists work and participate in the active surveillance of HAI with the infection control team.

In this study, the data of the patients, aged 1 month to 18 years and hospitalized between September 2017 and September 2018 in the PICU, were collected retrospectively. The information of the patients (age, gender, disease, period of hospital stay, ventilator or device use, antibiotic treatment, clinical and laboratory findings) and their culture results were investigated. The definition of HAI was made according to the "Centers for Disease Control and Prevention" criteria (6), and HAI was defined as an infection occurring 48 hours after hospitalization or 10 days after discharge. The rate of HAI was calculated according to the following formula; the number of HAIs/the number of all hospitalized patients x100.

The incidence density was calculated according to the formula; the number of HAIs/total patient-days x 1,000 in a given period. This research was made with the approval decision of Balikesir University Clinical Research Ethics Committee dated 05.12.2018 and numbered 2018/199.

Statistical Analysis

The study was registered with IBM SPSS 20.0 for Windows. In statistical analysis; for the analysis of numerical data, arithmetic mean \pm standard deviation with minimum and maximum values were used while in categorical data, the number (n) and percentage (%) are given.

Results

During the one-year study period, 398 patients were hospitalized in the tertiary level PICU and HAI developed in 22 of these patients. Only two of them died because of underlying chronic diseases, namely severe hydrocephalus and cerebral palsy. The mean age of the patients was 81.9 months (range: 3-190 months). Half of the patients who developed HAI (n=11, 50%) were female. When the patients were evaluated according to their primary diagnosis, neurological disorders were the largest group (81.8%) with 18 patients (11 cerebral palsy, 3 epilepsy, 2 hydrocephalus, 2 spinal muscular atrophy). Two (9%) had genetic syndrome with tracheostomy, 1 (4.5%) patient had acute diarrhea-dehydration and 1 (4.5%) patient had glioma (Table I).

The HAI rate was 5.6 per 100 admissions and the incidence density was 7.2 per 1,000 patient-days. The most frequently detected HAI types were BSI (50%), VAP (40.9%) and UTI (9.1%), respectively. *Klebsiella* species (40.9%) was the most common cause of HAI, followed by *Candida* species (18.1%), *Pseudomonasaeruginosa* (13.6%), *Serratiamarcescens* (9.1%), *Enterobacter cloacae* (9.1%), *Stenotrophomonas maltophilia* (4.5%) and coagulase-negative *Staphylococcus* (methicillin-resistant) (4.5%) (Table II). Four of the BSIs were central line-associated BSI (CLABSI); it was detected in patients who had been hospitalized for more than 30 days and diagnosed with cerebral palsy. The microorganisms were determined to be *Candida* spp. in three cases, while in one case it was *Stenotrophomonas maltophilia*. All of the isolated *Klebsiella* species were resistant strains; 77.7% of them produced Extended spectrum betalactamases (ESBLs) and the remaining were resistant to carbapenem. Carbapenem susceptibility was detected in 66.6% of

Gender	
Female	11 (50%)
Male	11 (50%)
Median age	81.9 months (3-190 months)
Underlying disease	18 (81.8%)
Neurological disorders	
Cerebral palsy	11 (50%)
Epilepsy	3 (13.6%)
Hydrocephalus	2 (9%)
Spinal muscular atrophy	2 (9%)
Genetic syndrome	2 (9%)
Glioma	1 (4.5%)
Acute gastroenteritis	1 (4.5%)

Pseudomonas aeruginosa and 100% of *Serratia marcescens* and *Enterobacter* spp. (Table III). Colistin resistance was not detected among the microorganisms produced in cultures. The only coagulase-negative *Staphylococcus* was methicillin-resistant.

Discussion

HAIs in PICUs are an important problem resulting in prolonged hospital stay, increased medical costs, and increased morbidity and mortality (7). Most of the HAIs occurring in ICUs are associated with the use of invasive devices such as central line or mechanical ventilators (8). In developing countries, it has been reported that the incidence of HAI is higher than in developed countries due to the high

number of patients, limited staffing and poor compliance with infection control measures (9-10). In developed countries, HAI rates are lower among children than among adults. In the United States, 5-10% of hospitalized adult patients are reported to have HAIs, while the rate is 1.5% to 4% for ten-year-olds and 7% -9% for infants younger than 1 year old (5). In our country, it was reported that the rates of HAIs in pediatric and adult patients varied between 1.3% and 16% in 2009 (10).

HAIs from PICU are reported to range 6% to 13.7% according to one study (11). Some previous studies have shown that the prevalence of PICU-acquired HAIs ranged from 9.1% to 42.5% (11-13). In our study, the HAI rate was lower than most of the similar reports with a rate of 5.6 per 100 admissions.

The incidence of the HAI type may differ according to the characteristics of the department, hospital and region. In the United States, the most common HAI types were reported to be BSI (28%), pneumonia (21%) and UTI (15%) in PICUs (14). In our study, the most common HAI type was BSI (50%), VAP (40.9%) and UTI (9.1%). Similarly, from our country, Atici et al. (1) reported that the most commonly observed HAIs were BSI (37.5%), pneumonia (21.4%), and UTI (20.5%) while Kepenekli et al. (15) reported that the most common HAIs were pneumonia (55%), BSI (27%) and UTI (7%), respectively. In another study with HAI ratios between 1.4% and 2.4%, the most commonly observed infections were UTI, surgical site and BSIs, and the most frequently isolated pathogens were *E. coli*, *Klebsiella pneumoniae*, *Enterococcus* spp. and *Staphylococcus aureus* (16).

In previous years, gram-positive factors were the most common causes of hospital infections. Today, *Pseudomonas*, *Klebsiella* and *Acinetobacter* species are among the leading factors in both adult and pediatric patients, in addition to coagulase-negative *Staphylococcus* strains (17,18). *Pseudomonas aeruginosa* is reported to be the most common agent of infections in PICUs in Europe (5). In our study, consistent with the literature, gram-negative agents were the most common agents in HAIs. *Klebsiella* spp. were the most often isolated microorganisms in all types of HAIs including BSI and VAP. *Acinetobacter* species, which are a common and important agent of HAIs in the world, were not detected in our study but interestingly, *Candida* species were the second most common, especially in BSIs. This was due to long-term hospitalized patients with cerebral palsy and respiratory failure, who had central venous catheter and a history of treatment with broad spectrum antibiotics.

Table II. Distribution of the healthcare-associated infection (HAI) pathogens

Microorganism	BSI n (%)	VAP n (%)	UTI n (%)
<i>Klebsiella</i> spp. <i>K. pneumoniae</i> <i>K. oxytoca</i>	3 (13.63) -	5 (22.7) -	- 1 (4.55)
<i>Pseudomonas aeruginosa</i>	1 (4.55)	2 (9.09)	-
<i>Candida</i> spp. <i>C. parapsilosis</i> <i>C. albicans</i>	2 (9.09) 1 (4.55)	-	- 1 (4.55)
<i>Enterobacter</i> spp. <i>E. cloacae</i> <i>E. aerogenes</i>	1 (4.55) 1 (4.55)	-	-
<i>Serratia marcescens</i>	1 (4.55)	1 (4.55)	-
<i>Stenotrophomonas maltophilia</i>	1 (4.55)	1 (4.55)	-
Coagulase-negative <i>Staphylococcus</i>	1 (4.55)	-	-
Total	11 (50)	9 (40.9)	2 (9.1)

BSI: Bloodstream infection, VAP: Ventilator-associated pneumonia, UTI: Urinary tract infection

Table III. Distribution of antibiotic susceptibility of the gram-negative pathogens

Pathogens	n (%)
<i>Klebsiella</i> spp. ESBL (+) CRE (+)	7 (77.7) 2 (22.3)
<i>Pseudomonas aeruginosa</i> Carbapenem susceptibility (+) Carbapenem susceptibility (-)	2 (66.6) 1 (33.4)
<i>Enterobacter</i> spp. Carbapenem susceptibility (+) Carbapenem susceptibility (-)	2 (100) 0 (0)

ESBL: Extended spectrum beta-lactamases, CRE: Carbapenem resistant *Enterobacteriaceae*

The resistance characteristics of microbiological agents responsible for hospital infections also vary over the years (19). There has been a rapid rise in the rate of resistance among bacterial pathogens in ICUs. The widespread use of antibiotics is associated with the development of resistance to antimicrobial agents. An international, multicenter study reported that the 78% of *Klebsiella pneumoniae* isolates produce ESBLs (17). In a study from our country, 50% of *Klebsiella* spp. and *E. coli* isolates were reported to be ESBL positive (1). The resistance rates found in our study were consistent with the literature; 77.7% of *Klebsiella* spp. produced ESBLs and 22.3% were resistant to carbapenem. In some previous studies, it was reported that the susceptibility rate to carbapenem ranged from 48% to 71% (20,21). It was reported to be 63% among *Pseudomonas aeruginosa* isolates in a national study (1). In our study, carbapenem susceptibility was detected in 66.6% of *Pseudomonas aeruginosa* and colistin resistance was not detected in any isolate.

The low number of patients and the retrospective nature are the most important limitations of our study.

Conclusion

In conclusion; we report a low rate of HAIs in our study but most were resistant bacteria. The low rate may be due to the unit being newly opened and the good condition of the hospital as well as the daily intensive care visits provided by pediatric infectious diseases specialists. Active surveillance is required for effective infection control, and pediatric infectious disease consultation leads to appropriate antibiotic use, reduced HAI rates, and finally improved PICU patient outcomes.

Ethics

Ethics Committee Approval: This research was made with the approval decision of Balıkesir University Faculty of Medicine Clinical Research Ethics Committee dated 05.12.2018 and numbered 2018/199.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: G.A., Design: G.A., Data Collection or Processing: G.A., B.Y.A., Analysis or Interpretation: G.A., Literature Search: G.A., B.Y.A., Writing: G.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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