

Evaluation of healthcare associated infections at pediatric critical care units

Çocuk yoğun bakım ünitesinde saptanan hastane enfeksiyonlarının retrospektif olarak değerlendirilmesi

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SUMMARY

Objective: Health-care associated infection (HAI) constitutes a major health care problem resulting in prolonged hospital stay with increased medical costs. The burden is much greater by accompanying risk factors among intensive care admissions. The incidence is reported 30% of all ICU admissions in developed countries; however the estimated rates are clearly higher in developing countries³.

In order to prevent HAIs, the health-care facilities should determine their own risk factors, analyse the microorganisms isolated from the body fluids and provide the necessary precautions accordingly⁵. Despite all the efforts and the advances at preventive protocols, the HAI burden still exists.

The pediatric intensive care unit (PICU) of Sivas Cumhuriyet University Hospital is a tertiary critical care unit serving to a broad range of population under 18 years with highly advanced technology within a considerably populated territory. The demographic profiles of the admissions account a wide range of childhood sicknesses from trauma to neurological disorders. The aim of this retrospective study was to examine the microorganism profiles isolated from the body fluids (blood, urine, tracheal aspirates, wound cultures, spinal fluid) of all PICU admissions during the past five years. Hence we decided to obtain our local surveillance data, deploy the necessary precautions to decline HAIs and administer the appropriate antimicrobial therapy accordingly.

Method: In this retrospective descriptive study, we searched the medical records of all PICU admissions between January 2014 and December 2018. Children with i) PICU admission lasting over 48 hours, ii) culture positivity at body fluids, iii) presenting clinical signs of infection were enrolled in the study. Patient demographics, initial complaints, admission diagnosis, the underlying chronic conditions, the source of PICU admission (admission from an indoor clinic, emergency service or an outdoor clinic) and previous hospitalizations were all recorded. We recalled HAI subgroups according to the definitions of centers for disease control and prevention (CDC)⁶ such as: ventilator-associated pneumonia (VAP), blood stream infection (BSI), central line-associated bloodstream infections (CLABSIs), catheter-associated urinary tract infections (CAUTI) and surgical site infections (SSI).

SPSS-23 (Statistical Package for Social Sciences for Windows 23) was used for statistics of the study. Descriptive analyses were expressed as percentages, mean±standard deviation (SD), median with minimum and maximum values. Chi square and Fischer exact test were used for comparison of categorical variables. Normal and non-normal distributions of continuous variables were assessed by Student's t-test, Mann Whitney U test and Wilcoxon rank sum test. P-value < 0.05 was considered significant.

Results: Investigation of 1566 PICU admissions between the periods January 2014 and December 2018, presented 56 children with 71 culture positivity at body fluids (infection rate:4.5%). The median age was 15 months (2 months-17 years) and male gender occupied 58.9% of the study population. We observed respiratory distress and acute pneumonia as the major complaint and the diagnosis at admission (48.5% and 35.7% respectively). 76.7% of the children manifested previous hospitalizations. Forty-three children presented an underlying chronic condition; mainly involving the central nervous system. The sources of PICU admission were identified as: first admission from the emergency service (44.6%), an outdoor clinic (28.6%) and an indoor clinic (pediatric ward) (26.8%).

In terms of culture positivity, we observed PICU-infections as (in decreasing order): VAP (26/71, 36.6%), BSI (18/71, 25.4%), CAUTI (18/71, 25.4%), SSI (7/71, 9.9%) and CLABSIs (2/71, 2.8%). Infections with gram-negative bacteria constituted the major infection group (54/71, 77.1%); *Acinetobacter baumannii* and *Klebsiella pneumoniae* seemed as the

most frequent isolated microorganisms (25.3% and 14.1%). Fungi infections incapsulated 12.6% of the infections overall. Among the thirty (42.2%) antibiotic resistant-culture positivity, carbapenem resistant and ESBL positive bacteria occurred as the common strains (21.1% and 12.7% respectively). We observed Carbapenem resistant strains mostly at SSI (5/15, 33.3%), while ESBL positive strains were developed at BSI and CAUTI.

In terms of ventilator-associated events, the mean intubation length was 17.5±5.4 days. *Pseudomonas aeruginosa* ve *Acinetobacter baumannii* were the most common bacterias reproduced at tracheal aspirates. For the resistance strains, Colistin-resistant *Acinetobacter baumannii* demonstrated the most prominent resistant strain at a rate of 50%, followed by Carbapenem-resistant strains (15.4%). Colistin-resistant strains seemed to have an escalating trend especially in 2018, on the contrary the frequency of carbapenem-resistant strains have declined over the years.

Length of PICU stay and hospitalization were 38.1±27.6 days and 42.2±27.6 days respectively. Twelve children died of infections (21.4%). Age less than five years and higher PRISM-3 scores were associated with mortality (p=0.004 and p<0.001). Those who died had longer intubation, PICU stay and hospitalization periods with significant nasogastric tube insertion rates (in following order, p=0.007, p=0.010, p=0.045, p=0.001).

Conclusions: Health-care associated infections remain to be a major problem all around the world. What we can do to overcome this challenge is, to initiate local surveillance protocols, educate the health-care staff on hand hygiene, enforce appropriate isolation tactics and practice wise antibiotic administration.

Keywords: Health-care associated infection, pediatric critical care, ventilator-associated pneumonia, central line-associated bloodstream infections, catheter-associated urinary tract infections

ÖZET

Amaç: Hastane enfeksiyonları (HE), hastalarda hastaneye başvuru anında veya inkübasyon döneminde olmayan, hastaneye başvurularından 48-72 saat sonra gelişen enfeksiyonlar olarak tanımlanmaktadır. Bu çalışmada çocuk yoğun bakım ünitemizin HE açısından lokal surveyans verilerinin elde edilmesi, HE sıklığının azaltılması ve uygun tedavinin gecikmeden uygulanabilmesi amaçlanmıştır.

Yöntem: Sivas Cumhuriyet Üniversitesi Hastanesi Çocuk Yoğun Bakım(ÇYB) servisine Ocak2014-Aralık2018 tarihleri arasında yatan hastaların geriye dönük dosyaları incelendi. HE tanımlamaları "Centers for Disease Control and Prevention" kriterlerine göre değerlendirildi.

Bulgular: Çalışma süresince yatmış olan 1566 hastanın (7651 yoğun bakım yatış günü) toplam 56'sında, 71 HE saptandı (enfeksiyon hızı:%4.5). Ortanca yaş 15 ay (2ay-17yaş), E/K:1.43 olarak gözlemlendi. Solunum sıkıntısı ve pnömoni en sık başvuru şikâyetini ve yatış tanısını oluşturdu (%48.5,%35.7). HE yeri olarak, azalan sıklıkla VİO (26/71, %36.6), KDE (18/71, %25.4), ÜSE (18/71, %25.4), CAE (7/71, %9.9), SVK-KDE (2/71, %2.8) görüldü. Gram negatif bakteri enfeksiyonlarının belirgin olduğu çalışmada (54/71, %77.1), *Acinetobacter baumannii* ve *Klebsiella pneumoniae* en sık bakteriyel etkenlerdi (%25.3, %14.1). Çalışmamızda funguslar HE'nin %12.6'sından sorumlu bulundu. Antibiyotik direncinin 30 kültür üremesinde var olduğu (%42.2), karbapenem direnci (%21.1) ile ESBL (%12.7) pozitif bakteri oranının en sık iki antibiyotik direncini oluşturduğu gözlemlendi. On iki hasta enfeksiyona ikincil sebeplerden eksitus oldu (HE mortalite oranı: %21.4). Eksitus olan hastaların 5 yaşından küçük, yüksek PRISM skoruna, uzun entübasyon süresine, sık nazogastrik sonda uygulamasına, uzun yoğun bakım ve hastane yatış sürelerine sahip oldukları görüldü (sırasıyla p=0.004, p<0.001, p=0.007, p=0.001, p=0.010, p=0.045).

Sonuç: Hastane enfeksiyonları, hastane yatış süresini uzatan, tedavi maliyetleri ile morbidite ve mortalitesi yüksek olan enfeksiyonlardır. İnvazif girişimlerin yoğun olduğu, kritik hasta takibinin yapıldığı çocuk yoğun bakım servislerinde ise, diğer risk faktörlerinin de eklenmesi ile HE riski ve sıklığı belirgin olarak artar. Bu nedenle yoğun bakım ünitelerinde surveyans çalışmaları yapılarak uygun tedavinin başlanması sağlanmalı ve gereksiz invaziv girişimleri azaltarak hastane enfeksiyonu nedeniyle oluşan morbidite ve mortalite azaltılmalıdır.

Anahtar sözcükler: Çocuk yoğun bakım, hastane enfeksiyonu, antibiyotik direnci

INTRODUCTION

Health-care associated infection (HAI) constitutes a major health care problem resulting in prolonged hospital stay with increased medical costs¹. The burden is much greater by [accompanying](#) risk factors among intensive care admissions²⁻⁴. The incidence is reported 30% of all ICU admissions in developed countries; however the estimated rates are clearly higher in developing countries³.

In order to prevent HAIs, the health-care facilities should determine their own risk factors, analyse

the microorganisms isolated from the body fluids and provide the necessary precautions accordingly⁵. Despite all the efforts and the advances at preventive protocols, the HAI burden still exists.

The pediatric intensive care unit (PICU) of Sivas Cumhuriyet University Hospital is a tertiary critical care unit serving to a broad range of population under 18 years with highly advanced technology within a considerably populated territory. The demographic profiles of the admissions account a wide range of childhood

sicknesses from trauma to neurological disorders. The aim of this retrospective study was to examine the microorganism profiles isolated from the body fluids (blood, urine, tracheal aspirates, wound cultures, spinal fluid) of all PICU admissions during the past five years. Hence we decided to obtain our local surveillance data, deploy the necessary precautions to decline HAIs and administer the appropriate antimicrobial therapy accordingly.

MATERIAL AND METHODS

In this retrospective descriptive study, we searched the medical records of all PICU admissions between January 2014 and December 2018. Children with i) PICU admission lasting over 48 hours, ii) culture positivity at body fluids, iii) presenting clinical signs of infection were enrolled in the study. Patient demographics, initial complaints, admission diagnosis, the underlying chronic conditions, the source of PICU admission (admission from an indoor clinic, emergency service or an outdoor clinic) and previous hospitalizations were all recorded. In case of multiple culture positivity at different body fluids, each one of the isolated microorganisms were enlisted separately (they were referred as children with multiple culture positivity). We recalled HAI subgroups according to the definitions of centers for disease control and prevention (CDC)⁶ such as: ventilator-associated pneumonia (VAP), blood stream infection (BSI), central line-associated bloodstream infections (CLABSIs), catheter-associated urinary tract infections (CAUTI) and surgical site infections (SSI). The microorganisms with antibiotic resistance were categorized as: *methicillin-resistant Staphylococcus aureus (MRSA)*, *methicillin-resistant coagulase negative Staphylococcus (CoNS)*, *bacteria producing extended-spectrum beta-lactamases (ESBL)*, *Carbapenem-resistant bacteria*, and *Colistin-*

resistant Acinetobacter baumannii. We determined the infection rate by dividing the number of culture-positive children to the total number of PICU admissions, then multiplied with 100.

We obtained approval of the noninvasive clinical research ethics committee of Sivas Cumhuriyet University.

SPSS-23 (Statistical Package for Social Sciences for Windows 23) was used for statistics of the study. Descriptive analyses were expressed as percentages, mean±standard deviation (SD), median with minimum and maximum values. Chi square and Fischer exact test were used for comparison of categorical variables. Normal and non-normal distributions of continuous variables were assessed by Student's t-test, Mann Whitney U test and Wilcoxon rank sum test. P-value < 0.05 was considered significant.

RESULTS

Investigation of 1566 PICU admissions between the periods January 2014 and December 2018, presented 56 children with 71 culture positivity at body fluids (infection rate:4.5%). The median age was 15 months (2 months-17 years) and male gender occupied 58.9% of the study population. We observed respiratory distress and acute pneumonia as the major complaint and the diagnosis at admission (48.5% and 35.7% respectively). Table 1 represents the initial complaints and admission diagnosis. 76.7% of the children manifested previous hospitalizations. Forty-three children presented an underlying chronic condition; mainly involving the central nervous system (Table 2). The sources of PICU admission were identified as: first admission from the emergency service (44.6%), an outdoor clinic (28.6%) and an indoor clinic (pediatric ward) (26.8%).

Table 1. Initial complaints and the diagnosis of PICU admissions

| Initial complaints | n (66)* | Initial diagnosis | n (56)* |
|------------------------------|----------------|---|----------------|
| Respiratory distress | 32 (48.5%) | Acute pneumonia | 20 (35.7%) |
| Fever | 12 (18.2%) | Sepsis | 9 (16.0%) |
| Seizure | 11 (16.7%) | Status epilepticus | 8 (14.3%) |
| Loss of consciousness | 2 (3.0%) | Ventriculo-peritoneal shunt (VP) dysfunction / shunt infection | 6 (10.7%) |
| Trauma | 4 (6.0%) | Trauma / gunshot injury | 5 (8.9%) |
| Burns | 2 (3.0%) | Postoperative infection | 2 (3.6%) |
| Gunshot injury | 1 (1.5%) | Burns | 2 (3.6%) |
| Intoxicity | 1 (1.5%) | Acute kidney failure | 1 (1.8%) |
| Inability to urinate | 1 (1.5%) | Cardiomyopathy | 1 (1.8%) |
| | | Soft tissue infection | 1 (1.8%) |
| | | Intoxication (Suicide) | 1 (1.8%) |

*In case of multiple complaints, each one them were recorded and categorized separately.

Table 2. The underlying chronic conditions

| | (n=43) |
|--|---------------|
| Cerebral palsy / Epilepsy | 12 (27.9%) |
| Hydrocephalus/ VP shunting | 14 (32.5%) |
| Immune deficiency | 6 (10.7%) |
| Cardiomyopathy | 2 (4.6%) |
| Chronic kidney failure | 2 (4.6%) |
| Congenital hydrops fetalis | 2 (4.6%) |
| Metabolic disease | 2 (4.6%) |
| Genetic anomaly (Pierre Robin syndrome) | 1 (2.3%) |
| Rheumatological disorder | 1 (2.3%) |
| Gastrointestinal system disease | 1 (2.3%) |

In terms of culture positivity, we observed PICU-infections as (in decreasing order): VAP (26/71, 36.6%), BSI (18/71, 25.4%), CAUTI (18/71, 25.4%), SSI (7/71, 9.9%) and CLABSIs (2/71, 2.8%). Table 3 presents the microorganism isolated from the body fluids and the area of infection. Infections with gram-negative bacteria constituted the major infection group (54/71, 77.1%); *Acinetobacter baumannii* and *Klebsiella pneumonia* seemed as the most frequent isolated microorganisms (25.3% and 14.1%). Fungi infections incapsulated 12.6% of the infections overall.

Among the thirty (42.2%) antibiotic resistant-culture positivity, carbapenem resistant and ESBL positive bacteria occurred as the common strains (21.1% and 12.7% respectively). We observed Carbapenem resistant strains mostly at SSI (5/15, 33.3%), while ESBL positive strains were developed at BSI and CAUTI (Table 3).

Table 3. The isolated microorganisms and the location of infections

| Isolated microorganisms | BSI (n=18) | CAUTI (n=18) | VAP (n=26) | SSI (n=7) | CLABSI (n=2) | Toplam n (71) |
|--|---------------|-----------------|---------------|--------------|-----------------|-----------------------|
| Bacterial infections | | | | | | 62 (87.3%) |
| Gram negative bacteria | | | | | | |
| <i>Acinetobacter baumannii</i> | 3 | 4 | 4 | 5 | 2 | 18 (25.3%) |
| <i>Klebsiella pneumonia</i> | 3 | 4 | 3 | - | - | 10 (14.1%) |
| <i>Pseudomonas aeruginosa</i> | 1 | - | 7 | - | - | 8 (11.3%) |
| <i>Stenotrophomonas maltophilia</i> | 2 | - | 4 | - | - | 6 (8.5%) |
| <i>Serratia marcescens</i> | - | 1 | 4 | - | - | 5 (7.1%) |
| <i>Enterobacteriaceae</i> | 1 | 1 | 1 | - | - | 3 (4.2%) |
| <i>Escherichia coli</i> | - | 2 | - | 1 | - | 3 (4.2%) |
| <i>Burkholderia cepacia</i> | 1 | - | - | - | - | 1 (1.4%) |
| Gram positive bacteria | | | | | | |
| <i>Staphylococcus aureus</i> | 1 | - | 1 | - | - | 2 (2.8%) |
| <i>Staphylococcus epidermidis</i> | 1 | - | - | 1 | - | 2 (2.8%) |
| <i>Enterococcus faecium</i> | - | 2 | - | - | - | 2 (2.8%) |
| <i>Streptococcus mitis</i> | 1 | - | - | - | - | 1 (1.4%) |
| <i>Streptococcus salivarius</i> | 1 | - | - | - | - | 1 (1.4%) |
| Fungi | | | | | | infections |
| 9 (16.7%) | | | | | | |
| <i>Candida albicans</i> | 1 | 3 | 1 | - | - | 5 (7%) |
| <i>Candida saprophyticus</i> | 1 | - | 1 | - | - | 2 (2.8%) |
| <i>Candida glabrata</i> | - | 1 | - | - | - | 1 (1.4%) |
| <i>Candida tropicalis</i> | 1 | - | - | - | - | 1 (1.4%) |
| Antibiotic Resistant Strains | | | | | | |
| <i>Carbapenem resistance</i> | 2 | 4 | 4 | 5 | - | 15 (21.1%) |
| <i>ESBLproducing bacteria</i> | 3 | 3 | 2 | 1 | - | 9 (12.7%) |
| <i>Colistin resistant A. baumannii</i> | 1 | - | 2 | - | - | 3 (4.2%) |
| MRSA | 1 | - | 1 | - | - | 2 (2.8%) |
| <i>Meticilline resistant CoNS</i> | | | | 1 | - | 1 (1.4%) |

VAP: ventilator-associated pneumonia (VAP), BSI: blood stream infection, CLABSI: central line-associated bloodstream infection, CAUTI: catheter-associated urinary tract infections, SSI: surgical site infection.

In terms of ventilator-associated events, the mean intubation length was 17.5 ± 5.4 days. *Pseudomonas aeruginosa* ve *Acinetobacter baumannii* were the most common bacterias reproduced at tracheal aspirates (Table 3). For the resistance strains, Colistin-resistant *Acinetobacter baumannii* demonstrated the most prominent resistant strain at a rate of 50%, followed by Carbapenem-resistant strains (15.4%). Colistin-resistant strains seemed to have an escalating trend especially in 2018, on the contrary the frequency of carbapenem-resistant strains have declined over the years (Table 4). The locations of antibiotic resistant infections for *Colistin-resistant Acinetobacter baumannii* and *ESBL*

positive Klebsiella pneumonia were identified as BSI and CLABSI.

Length of PICU stay and hospitalization were 38.1 ± 27.6 days and 42.2 ± 27.6 days respectively. Twelve children died of infections (21.4%). Age less than five years and higher PRISM-3 scores were associated with mortality ($p=0.004$ and $p<0.001$). Those who died had longer intubation, PICU stay and hospitalization periods with significant nasogastric tube insertion rates (in following order, $p=0.007$, $p=0.010$, $p=0.045$, $p=0.001$)(Table 5).

Table 4. The isolated microorganisms over the past five years

| | 2014 | 2015 | 2016 | 2017 | 2018 | (n=71) |
|--|------|------|------|------|------|------------|
| Bacteria (n=62) | | | | | | |
| Gram Negative Bacteria | | | | | | |
| <i>Acinetobacter baumannii</i> | - | 7 | 7 | - | 4 | 18 (25.3%) |
| <i>Klebsiella pneumonia</i> | 2 | 1 | 1 | 3 | 3 | 10 (14.1%) |
| <i>Pseudomonas aeruginosa</i> | 5 | 1 | 1 | 1 | - | 8 (11.3%) |
| <i>Stenotrophomonas maltophilia</i> | 2 | 2 | - | 1 | 1 | 6 (8.5%) |
| <i>Serratia marcescens</i> | 2 | 1 | 1 | 1 | - | 5 (7.1%) |
| <i>Enterobacteriaceae</i> | - | 2 | - | 1 | 0 | 3 (4.2%) |
| <i>Escherichia coli</i> | 2 | - | - | 1 | - | 3 (4.2%) |
| <i>Burkholderia cepacia</i> | - | - | - | 1 | - | 1 (1.4%) |
| Gram Positive Bacteria | | | | | | |
| <i>Staphylococcus aureus</i> | - | - | 1 | - | 1 | 2 (2.8%) |
| <i>Staphylococcus epidermidis</i> | 1 | - | - | 1 | - | 2 (2.8%) |
| <i>Enterococcus faecium</i> | - | - | - | 2 | - | 2 (2.8%) |
| <i>Streptococcus mitis</i> | - | - | - | - | 1 | 1 (1.4%) |
| <i>Streptococcus salivarius</i> | - | - | - | - | 1 | 1 (1.4%) |
| Fungi infections (n:9) | | | | | | |
| <i>Candida albicans</i> | 2 | 2 | - | 1 | - | 5 (7.0%) |
| <i>Candida saprophyticus</i> | 1 | 1 | - | - | - | 2 (2.8%) |
| <i>Candida glabrata</i> | - | - | - | - | 1 | 1 (1.4%) |
| <i>Candida tropicalis</i> | 1 | - | - | - | - | 1 (1.4%) |
| Antibiotic Resistance | | | | | | |
| Carbapenem resistance | | 4 | 6 | 2 | 2 | 15 (21.1%) |
| ESBLproducing bacteria | 4 | - | - | 2 | 3 | 9 (12.7%) |
| Colistin resistant A. baumannii | - | 1 | - | - | 2 | 3 (4.2%) |
| MRSA | | - | - | 1 | 1 | 2 (2.8%) |
| Meticilline resistant CoNS | | | | 1 | | 1 (1.4%) |

Table 5. The demographics and the intensive care interventions according to mortality

| Variable | Survivors (n= 44) | Non-survivors (n= 12) | p |
|---|----------------------|--------------------------|------------------|
| Gender | | | |
| Male | 24 (54.5%) | 9 (75%) | 0.202 |
| Female | 20 (45.5%) | 3 (25%) | |
| Underlying chronic condition | 33 (75%) | 10 (83.3%) | 0.210 |
| Multiple culture positivity | 12 (27.3%) | 6 (50%) | 0.135 |
| Age (months), median (min-max) | 15.50 (1-197) | 12 (2-197) | 0.562 |
| Age groups | | | |
| 1 month - 5 years | 29 (65.9%) | 8 (66.7%) | 0.004 |
| 6 - 10 years | 7 (15.9%) | 1 (8.3%) | |
| 11 – 17 years | 8 (18.2%) | 3 (25%) | |
| Years | | | |
| 2018 | 8 (18.2%) | 2 (16.7%) | - |
| 2017 | 5 (11.4%) | 1 (8.3%) | |
| 2016 | 6 (13.6%) | 3 (25%) | |
| 2015 | 11 (25%) | 3 (25%) | |
| 2014 | 14 (31.8%) | 3 (25%) | |
| PRISM-3 score (mean±SD) | 12.65±3.22 | 36.25±5.17 | <0.001 |
| Length of PICU stay (days) (mean±SD) | 31.54±24.67 | 54.91±28.87 | 0.010 |
| Length of hospitalization (days) (mean±SD) | 37.0±25.85 | 54.91±28.87 | 0.045 |
| PICU interventions | | | |
| Endotracheal intubation | 26 (59.1%) | 12 (100%) | 0.007 |
| Central venous catheterization | 24 (54.5%) | 6 (50%) | 0.780 |
| Nasogastric tube insertion | 11 (25%) | 9 (75%) | 0.001 |
| Urinary tract catheterization | 10 (22.7%) | 5(41.7%) | 0189 |
| Tracheostomy | 7 (15.9%) | 3 (25%) | 0.466 |
| Total parenteral nutrition | 4 (9.1%) | 3 (25%) | 0.140 |
| Gastric motility inhibitors | 2 (6.8%) | 2 (16.7%) | 0.289 |
| Gastrostomy | 1 (2.3%) | - | - |
| Chest tube insertion | 1 (2.3%) | - | - |

DISCUSSION

Hospital associated infection was first described in 1843 by Oliver Wendell Holmes. He proposed, the fever in postpuerperal women occurred due to

lack of hand hygiene of the medical staff⁷. In the past decade, the term has shifted to health-care associated infection and many attempts have been

implemented by the health care staff to decline the nosocomial infections all over the world⁶.

HAI prolongs the hospitalization period and increase the health-care related expenses⁸. In addition of chronic underlying disease of the critically ill child, administration of wide-spectrum antibiotics, invasive procedures such as central venous catheterization, urinary tract catheterization, invasive mechanical ventilation and prolonged hospital admission increase the odds of HAI ratio by 5-10 times at intensive care units^{8,9}.

The importance of local PICU surveillance for prevention of HAI have been well documented in 'The Study of the Efficacy of Nosocomial Infection Control and Prevention' (SENIC)¹⁰. This study demonstrated the successful decline in nosocomial infections in presence of appropriate prevention protocols. Therefore, each health-care facility should study on their own local surveillance protocols, determine the profile of prominent microorganisms with resistant strains and arrange the antibiotherapy accordingly. We also constituted our surveillance protocol with the collaboration of the infection control committee.

Numerous articles regarding HAI rates at intensive care units in Turkey have been published over their years¹¹⁻¹⁴; however those encompassing the pediatric ICUs are limited. The HAI incidence vary greatly between 2.36% and 37% depending on the surveillance methods, health-care staff and infection prevention protocols^{5,11-14}. Celiloglu et al. documented the five years HAI rate as 2.36% (60/2545 patients)¹¹; on the contrary the incidence was described as 32.7% at the report of Anil et al⁵, which was significantly higher than the latter.

We detected the VAP incidence as 36.6%, followed by BSI (25.4%) and CAUTI (25.4%), SSI (9.9%) and CLABSI (2.8%). A point prevalence study conducted in 2015, had appointed the upper respiratory tract infections and BSI as the most frequent HAI subgroups (23.5%, 11.6%)¹². We documented the most common source of HAI as VAP, similar to the study of Akyıldız et al¹³.

Pseudomonas, *Klebsiella* ve *Acinetobacter* strains have replaced *S. Aureus* by means of frequent bacterias in the past decade^{15,16}. The results of this study were concordant with literature; we observed gram negative bacterias (77.1%), specifically *Acinetobacter baumannii* (25.3%), *Klebsiella pneumoniae* (14.1%) and *Pseudomonas aeruginosa* (11.3%) as the prominent bacteria

strains. *Pseudomonas aeruginosa* and *Acinetobacter baumannii* are responsible for majority of VAP in several studies^{12,13}. Therefore, in case of empiric antibiotherapy decision for moderate / severe PICU infections, the antibiotic choice should cover the gram negative bacteria with anti-pseudomonal activity.

The microorganism strains and antibiotic resistance might change over the years. Infections with resistant strains of gram negative bacterias have an escalating trend at intensive care units^{5,11-13}. The antibiotic resistance occurred as 42.2% in the present study; of them 21.1% presented carbapenem resistant strains, while 12.5% had ESBL positivity. The search of the infection site for resistant strains demonstrated the carbapenem-resistance mostly observed at SSI (5/15, 33.3%) and ESBL positivity at BSI and CAUTI equally (16,6% for each infection site). Celiloglu documented *Pseudomonas aeruginosa* and *Klebsiella Pneumoniae* as the most frequent bacterias with carbapenem resistance of 65% and 56% respectively¹¹. Our observations on colistin resistant *Acinetobacter baumannii* infections were lower than expected (16.6%)^{12,13}. The intriguing point in the present study was the observation of resistant strains in *Staphylococcus aureus* (MRSA:100%) and *meticilline resistant CoNS bacterias* (50%). The rates of resistant strains at VAP were 50% for colistin-resistant *Acinetobacter baumannii* and 15.4% for carbapenem resistant infections.

The infection outcome over the past five years demonstrates a general incline at Colistin-resistance and a decline at Carbapenem-resistance. Extensive administration of antibiotics at intensive care units results in antibiotic resistant bacteria colonization and infections. Hence, the treatment of such children have become more challenging with significant mortality rates. Despite the advances in antibiotherapy, the mortality rates are varying between 9% and 80%^{11,13,14}. Twelve children died of infections (HAI mortality rate: 21.4%). Age less than five years, higher PRISM-3 score, longer intubation, frequent nasogastric tube insertion were associated with mortality in this study. The mentioned risk factors were similar to those reported in literature¹⁷⁻¹⁹.

CONCLUSION

Health-care associated infections remain to be a major problem all around the world. What we can do to overcome this challenge is, to initiate local surveillance protocols, educate the health-care staff on hand hygiene, enforce appropriate

isolation tactics and practice wise antibiotic administration.

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