Hospital Infections in the Pediatric Intensive Care Unit; 4-Year Evaluation, 2010-2013

Mustafa Hacımustafaoğlu[1], Nilufer Yeğin[2], Solmaz Çelebi[1], Gizem Ergun[2], Benhur Şirvan Çetin[1], Taylan Çelik[1], Enes Salı[1]

[1]Department of Pediatrics and Pediatric Infectious Diseases, Uludağ University Faculty of Medicine, *Bursa, Turkey*
[2]Department of Pediatrics, Uludağ University Faculty of Medicine, *Bursa, Turkey*

Abstract

Objective: The purpose of this study is to evaluate the healthcare-associated infections (HCAIs) in the pediatric intensive care unit (PICU) during a 4-year period.

Material and Methods: Pediatric patients between the age of 28 days and 18 years were included in the study. The Center for Diseases Control 2008 criteria were used for the diagnosis of HCAI. During the 4-year period (2010–2013), the number of children admitted to PICU was 1884, and the total bed-days were 15,082 days.

Results: During the 4-year period, 139 HCAI episodes occurred in 89 children. Of the admitted children, 4.7% had at least one HCAI attack. We found that the HCAI rate and HCAI density were 7.3%, and 9.2 per 1000 patient-days, respectively. Within the two groups, all PICU patients and patients with an HCAI attack, the ages were 75.69±71.24 (median: 48) and 36.85±48.78 (median: 17) months (p<0.001), respectively, and the length of hospital stay was 8.00±16.84 (median: 3) and 109.49±119.98 (median: 75) days (p<0.001), respectively. The percentage of females was 51% (960/1884) and 33% (46/139) (p=0.013) in all children admitted to PICU and those with HCAI attacks, respectively. The duration from admission to HCAI was 61.33±81.51 (median: 36) days. The most common principal accompanying diseases of the patients with HCAI attacks were neurological disease (20.9%; 29/139), solid-tissue malignancy (14.4%; 20/139), heart disease (12.9%; 18/139), chronic pulmonary disease (11.5%; 16/139), and chronic renal disease (8.6%; 12/139). The three most frequent HCAI types were ventilator-associated pneumonia (VAP; 28%), bloodstream infections (22%; with 12% having catheter-related bloodstream infections and 10% having bacteremia), and catheter-related urinary tract infections (15%). There was meaningful culture positivity in 90 of the 139 HCAI episodes (64%).

Conclusion: Our PICU-HCAI rates are lower than those in the other studies in Turkey, and they are comparable with other studies conducted in developed countries. Our HCAIs occurred in the patients with an average age of 3 years. The most frequent HCAIs were pneumonia (including VAP), bloodstream, and urinary tract infections, and many of them were related to catheters. *(J Pediatr Inf 2015; 9: 56-63)*

Keywords: Pediatric intensive care unit, hospital infections, healthcare-associated infections

Received: 27.04.2015
Accepted: 23.05.2015

Correspondence Address:
Mustafa Hacımustafaoğlu, Uludağ Üniversitesi Tıp Fakültesi, Çocuk Sağlığı ve Hastalıkları Anabilim Dalı, Çocuk Enfeksiyon Hastalıkları Bilim Dalı, *Bursa, Türkiye*
Phone: +90 224 442 88 75
E-mail: mkemal@uludag.edu.tr

DOI:10.5152/ced.2015.2098

Introduction

Hospital infections (HI) or nosocomial infections are defined as diseases in the patients without an active or incubation-period infection on admission, local and/or systemic diseases arising from hospital flora comprising pathogenic microorganisms or toxins during hospital stay (1). Because they are the infections developing in the patients who receive healthcare, HIs have also been defined as healthcare-associated infections (HCAI) (2). HCAIs generate a negative impact on the quality of service in units offering modern healthcare and increase the financial burden worldwide. If the infection has been detected within 48 hours or later upon hospitalization, it is accepted as HCAI (3, 4).

However, there are also some published studies still accepting the infections developing after 72 hours as HCAIs (5, 6).

Although 5%–10% of hospitalized cases have HCAIs in developed countries, this ratio is between 2 to 20 times more exceeding over 25%, in developing countries (7). Despite the fact that intensive care units have less than 10% of the beds in hospitals, more than 20% of HCAIs occur in intensive care units (8). Infections and sepsis are responsible for 40% of non-cardiac deaths in intensive care units (9).

In the USA, Europe, and some other countries the rates of HCAIs in PICUs are between 6.1% and 23.5%, while HCAI densities are 14.1–27.2/1000 patient-days (9-11). There are only a few studies on HCAI incidence in PICUs in Turkey (12-14) and are usually 1-year studies, in most of which HCAI density has not even been reported; in some of them, the rates were given with the sum of other wards. Moreover, in these studies, the rates of HCAIs in PICUs varied between 3.5% and 32.7% (12-15). In Turkey, we found only one study that reported HCAI densities in PICU, and the rate was 18.5/1000 patient-days (13).

The purpose of this descriptive study is to evaluate the HCAI incidence and system and agent distribution of the patients hospitalized in PICUs within the framework of the assessment of the accompanying diseases.

Material and Methods

The Department of Pediatrics of the Medical School at Uludag University provides critical healthcare services for the patients, in addition to Bursa, in provinces such as Balikesir, Kütahya, Çanakkale, and Yalova in the south Marmara region. According to the 2014 national census data, it was reported that all the abovementioned provinces had approximately a total population of 5,200,000 and 1,400,000 (age group, ≤18 years), and the Bursa province had a population of 2,787,000, of whom 380,000 were children at the age of <18 years (16).

Patients are admitted to the PICU on the basis of age, i.e., from 28 days to 18 years. The PICU officially has a total of 10-bed capacity with four of them being isolated, single rooms. However, the existing capacity is sometimes exceeded by extra beds for patients with high risk because of other hospitals lacking PICU beds. In this study, the relevant data of the patients hospitalized in the PICU between January 01, 2010 and December 31, 2013 was retrospectively investigated. The approval of the Ethics Committee of Uludag University Faculty of Medicine was received for this study (November 05, 2013; No: 2013-18/13).

The information relevant to the study, such as admittance/discharge, was obtained as follows: the information regarding the clinical monitoring periods of the patients was obtained from the daily follow-up notes and the consultation notes of the Department of Pediatric Infectious Diseases and the Information Processing Secretariat of the Department of Pediatrics. The 4-year hospital-stay period of all the patients was evaluated with regard to their ages at the time of hospitalization, gender, total hospital stay, prediagnosis upon hospitalization (major primary disease), the presence of community-based infection during hospitalization, clinical and laboratory data, risk factors, and prognosis. During this period, admitted patients who were evaluated for HCAI diagnosis with regard to the clinical or laboratory observations and for the presence or absence of culture reproduction were included into the study. In the study, the Center for Diseases Control (CDC; 2008) criteria were used for the diagnosis of HCAI (17).

The BACTEC Peds Plus/F (BD, Sparks, MD) culture bottles were used for the blood samples. Tracheal aspirate fluid (TAF) samples were plated onto the 5% sheep blood agar and eosin–methylene blue (EMB) agar plates. Identification of $\geq 10^5$ colonies (CFU/ml) in TAF cultures was regarded as positive. Automatized Phoenix culture system was used to identify the microorganism and establish antibiotic sensitivity. Culture sites and culture type were also evaluated. The clinical, radiological, and laboratory data of patients suspected of or diagnosed with HCAI was taken from the routine, daily recorded data by a specialist in pediatric infections. All these recorded data were clinically and microbiologically evaluated in daily routine clinic visits by the Department of Pediatric Infectious Diseases and by the Pediatric Hospital Infection Control Committee within the framework of active surveillance on a weekly basis. In this study, only HCAI infection prevalence and system-based distribution characteristics were evaluated.

Statistical analysis

For the statistical analysis, Number Cruncher Statistical System (NCSS) 2007 and Power Analysis and Sample Size (PASS) 2008 Statistical Software (Utah, United States) programs were used. While

Table 1. Some characteristics of HCAIs detected in the PICUs in 4 years

n=139	Min-Max (Median)	Mean±SD
Age (month)	1-221 (17)	36.85±48.78
Length of hospital stay (day)	7-600 (75)	109.49±119.98
Length of hospitalization, when diagnosed with HCAI (day)	2-526 (36)	61.33±81.51
	n	**%**
Gender		
Female	46	33.1
Male	93	66.9
Underlying Disease		
Neurological disease	29	20.9
Solid-organ malignancy	20	14.4
Cardiac disease	18	12.9
Chronic lung disease	16	11.5
Renal failure	12	8.6
Metabolic disease	12	8.6
Genetic disorder	10	7.2
Immunodeficiency	8	5.8
Liver failure	4	2.9
Prematurity complication	3	2.2
Urogenital system disease	2	1.4
Collagen tissue disease	2	1.4
Hematological malignancy	1	0.7
No underlying disease	2	1.4
Presence of community-based infection during hospitalization	46/139	33.1
HCAI with culture positivity	90/139	64.7

working with the data obtained in the study, in addition to descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum and maximum), Pearson's chi-square test, and Mann–Whitney U-test were used for the comparison of quantitative and continuous data. In this study, real p values were used, and significance was accepted at $p<0.05$.

Results

There were 1884 patients admitted to our PICU between January 01, 2010 and December 31, 2013. Of them, 24.4% (459/1884) patients were admitted in 2010; 26.1% (491/1884), in 2011; 26.4% (497/1884), in 2012; and 32.2% (437/1884), in 2013. Fifty-one percent (960/1884) of the patients were females. The mean patient age was 75.69±71.24 (median: 48) months, and the average length of hospital stay was 8.00±16.84 (1–365 days; median: 3) days. Presence of community-acquired infection was detected in 41.5% (781/1884) of the patients before hospitalization (Table 1).

Of 1884 hospitalized patients, there were 139 HCAI episodes in 89 patients. For a total of 139 HCAIs in the PICU, the average age was 36.85±48.78 months (1–221 months; median: 17 months) and the mean length of hospital stay was 109.49±119.98 days (7–600 days; median: 75 days). The average length of hospital stay from the day of admission to the day of HCAI attack were 61.33±81.51 days (1–526 days; median: 36 days). Female to male ratio of the HCAIs was 1:2 (46:93; Table 1).

In the patient group with HCAI attacks, the average age was significantly lower, the length of hospital stay was longer, and the male gender ratio was higher than all PICU patients. The mean age was 75.69±71.24 (median: 48) months and 36.85±48.78 (median: 17) months ($p<0.001$), the average length of hospital stay was 8.00±16.84 (median: 3) days and 109.49±119.98 (median: 75) days ($p<0.001$), and the percentage of

females was 51% (960/1884) and 33% (46/139) (p=0.013) in all children admitted to PICU and in children with HCAI attacks, respectively (Table 1).

In 33.1% (46/139) of the HCAI-diagnosed cases, a community-acquired infection was also present before their hospitalizations. During admission, the patients with HCAIs had the diagnoses of accompanying primary diseases as follows: 20.9% (29/139) had neurological disease; 14.4% (20/139), solid-organ malignancy; 12.9% (18/139), cardiac disease; 11.5% (16/139), chronic lung disease; and 8.6% (12/139), chronic renal failure (Table 1).

The distribution of 139 HCAIs is illustrated in Table 2; accordingly, the most prevalent systems were as follows: 31.9% pneumonia (28.3% ventilator-associated pneumonia (VAP), 3.6% pneumonia), 23% (32/139) bloodstream infections (BSIs) (12.2% catheter-related bloodstream infections CR-BSIs, 10.8% bacteremia), and 20.8% (29/139) urinary tract infections (UTIs) (15.8% catheter-related urinary tract infections (CR-UTIs), 5% symptomatic UTIs).

Annual and total HCAI data of a 4-year period in PICU was evaluated (Table 3). In 2010, HCAI developed in 22 of 459 (4.8%) hospitalized PICU patients (6.1% HCAI rate and 6.9/1000 patient-days HCAI density); in 2011, 18 of 491 (3.7%) hospitalized patients (6.1% HCAI rate and 7.8/1000 patient-days HCAI density); in 2012, 22 of 497 (4.4%) hospitalized patients (8.8% HCAI rate and 11.9/1000 patient-days HCAI density); in 2013, 27 of 437 (6.2%) hospitalized patients (8.4% HCAI rate and 10.6/1000 patient-days HCAI density). In the 4-year period, HCAI developed in 89 of 1884 (4.7%) hospitalized PICU patients (7.38% HCAI rate and 9.2/1000 patient-days HCAI density).

Table 2. Distribution of 139 HCAIs detected in the PICU during a 4-year period

	n	%
Ventilator-related pneumonia	39	28.3
Catheter-related urinary infection	22	15.8
Catheter-related bloodstream infection	17	12.2
Bacteremia	15	10.8
Clinic sepsis	13	9.4
Symptomatic urinary infection	7	5.0
Conjunctivitis	6	4.3
Pneumonia	5	3.6
Skin infection (subcutaneous abscess)	5	3.6
Gastroenteritis	4	2.9
Meningitis	3	2.2
Peritonitis	2	1.4
Asymptomatic bacteriuria	1	0.7
Total	139	100

Discussion

HCAI is a global problem threatening patient safety that is prevalent both in developed and developing countries. In an article published by the WHO in 2002 regarding the prevention of healthcare infections that includes 55 hospitals in Europe, East Mediterranean, Southeast Asia, and West Pacific, it was reported that HCAI developed in 8.7% of the hospitalized patients (18). In 2011, in an HCAI-oriented study involving 11,000 randomly selected children in the United States of America, HCAI was found in 4% of the patients (19). In a multi-centered study involving European countries (France, Greece, Italy, Sweden, Holland, Slovenia, Switzerland, and the United Kingdom), it was found that HCAI developed in 2.5% of the patients, with the highest HCAI rate of 23.5% in PICUs and the lowest HCAI rate of 1% in the general pediatric clinics (20).

It is important to be careful while comparing different HCAI-associated rates with each other. For example, the HCAI-developed patient rate (the number of patients who developed HCAI/the number of hospitalized patients×100) is different from the HCAI rate (the number of HCAIs/the number of hospitalized patients×100), and both are different from HCAI density (the number of HCAIs/the number of patient-days×1000). To compare the different studies/or hospitals with regard to HCAIs, only the same infection rate should be used. For example, in our study, we found that 4.7% of PICU patients developed HCAI, and HCAI rate was 7.38%. Although they are different HCAI rates of the same study, if one mistakenly compares these two rates, the differences can be significantly different at p=0.001.

In a 5-year national study conducted in the United States between 1992 and 1997, it was found that HCAI rate in PICUs was 6.1% and HCAI density was 14.1/1000 patient-days (9). Similarly, in another multicentered point surveillance study in the USA, it was revealed that HCAI rate of PICUs was 14.9% and 12.2% (21). In a study conducted in Lithuania, a developing country, it was reported that PICU-HCAI rate was 13.6% and HCAI density was 24.5/1000 patient-days (10). The patients included in that study were investigated in four groups (17%, from 1 month to 1 year; 37%, 1–5 years; 21%, 6–12 years; and 24%, >12

Table 3. Annual distribution of HCAI data, HCAI rates, and HCAI density in the PICU

	Total hospitalized patients	Official PICU bed number	Total bed occupancy rate[1] (%)	Total patient-days	Mean hospitalization days	Patients diagnosed with HCAI	HCAI number	HCAI attacks per patient[2]	HCAI-developed patient rate[3] (%)	HCAI rate[4] (%)	HCAI density[5] (per 1000 hospital-days)
2010	459	10	110	4019	8.8	22	28	1.27 (22/28)	4.8 (22/459)	6.1	6.9
2011	491	10	105	3843	7.8	18	30	1.66 (30/18)	3.7 (18/491)	6.1	7.8
2012	497	10	102	3742	7.5	22	44	2.00 (44/20)	4.4 (22/497)	8.8	11.7
2013	437	10	95.2	3478	8.0	27	37	1.37 (37/27)	6.2 (27/437)	8.4	10.6
Total	1884	10	103.3	15082	8.0	89	139	1.56 (139/89)	4.7 (89/1884)	7.38	9.21

[1]: Annual occupancy rate was calculated based on the following formula: bed occupancy rate=(number of hospitalized days×100)/(365×patient bed number). The occupancy rate was more than 100% stemmed from the fact that extra beds were added when the patient density was very high.
[2]: Number of HCAI attacks per HCAI-developed patient (more than one HCAI may develop in a patient)
[3]: The rate of HCAI-developing patients to all the patients hospitalized in the PICU
[4]: HCAI rate was calculated based on the following formula: (HCAIs number/number of hospitalized patients)×100.
[5]: HCAI density was calculated based on the following formula: (number of HCAIs/total patient-days)×1000.

Table 4. HCAI rates and densities in PICUs in various studies

PICU	HCAI rate (%)	HCAI density (per 1000 patient-days)	Reference
Europe	23.5%		20
USA (NNIS)	6.1%	14.1/1000 patient-days	9
USA (point surveillance)	12.2%–14.9%		21
Lithuania	13.6%	24.5/1000 patient-days	10
Peru	19.5%		22
Brazil	22.1%	27.2/1000 patient-days	11
Turkey, UHESA, 59 hospitals, 2013		15.4/1000 patient-days (the sum of CR-BSIs, CR-UTIs, and VIPs)	14
Turkey, Bursa, 2007	16.3%	18.5/1000 patient-days	13
Turkey, Bursa, 2010–2014	7.3%	9.2/1000 patient-days	The present study

years), and the highest HCAI rate was in the age group of 6–12 years (16.2% HCAI rate and 31.2/1000 patient-days HCAI density); however, no significant statistical result was obtained among the age groups with regard to HCAI development (10). In a study conducted in Peru, it was reported that PICU-HCAI rate was 19.5%, and 56% of the patients detected with HCAI were <1 year old (22). In a Brazilian study, it was reported that HCAI rate was 22.1% and HCAI density was 27.2/1000 patient-days (11). Unfortunately, we could find only a few studies about HCAI rates in PICUs (12-15). Regarding only the PICU-HCAI studies conducted in Turkey, the following results were obtained: in the study conducted in the PICU of İzmir Tepecik Training and Research Hospital, during a 1-year period (during the year 2010), 61 of 186 (32.7%) patients admitted to PICU developed HCAI; however, HCAI rates and HCAI density were not calculated (12). In that study, the age of PICU patients with HCAIs (33 months) was lower than other PICU patients without HCAI (12). In addition, other PICU studies revealed that younger age (<1 or 2 years of age) is a risk factor for HCAIs (12, 13, 23-25). In another study conducted in the PICU at the Erciyes Medical Faculty over a 1-year period (2004–2005), 74 of 282 (26.2%) patients admitted to PICU developed HCAI; however, HCAI rates and HCAI density were also not calculated (15). In a study conducted in the PICU of Medical Faculty at Uludag University over a 1-year period (in 2007), PICU-HCAI rate and HCAI density were 16.3% and 18.5/1000 patient-days (13). According to the Turkish National Nosocomial Infection Surveillance Network Report in 2013 (Ulusal Hastane Enfeksiyonlari Sürveyans Ağı Raporu, UHESA) of 59 PICUs in different cities, the HCAI density was reported as approximately 15.4/1000 patient-days (only the sum of CR-BSIs, CR-UTIs, and VAPs) (14). The HCAI data obtained from the studies conducted worldwide and in Turkey are illustrated in Table 4. When our results are compared with the values given above, it is clearly seen that our HCAI-developed

Table 5. Three most prevalent HCAI types in PICUs in various studies

PICU	HCAI types	Reference
Europe	Pneumonia, 53%; bacteremia, 20%; UTI, 15%	20
USA	BSI, 30%; pneumonia, 20.5%; UTI, 15%	9
Lithuania	Pneumonia, 34%; other LRTIs, 25%; BSI, 9%	10
Peru	BSI, 58%; VIP, 32%; UTI, 10%	22
Turkey, Izmir	BSI, 73%; VIP, 15%; UTI, 12%	12
Turkey, Bursa	BSI, 29%; pneumonia, 24%; UTI, 12%	13
Turkey, UHESA, 59 hospitals, 2013*	BSIs, CR-UTI, and VIP	14
Turkey, Bursa, 2010–2014	VAP, 28%; BSI, 23%; UTI, 20.8%	The present study

*: percentages not mentioned
Abbreviations: UHESA: Turkish National Nosocomial Infection Surveillance Network Report (Ulusal Hastane Enfeksiyonlari Sürveyans Aği Raporu); UTI: urinary tract infection; BSI: blood stream infection; VAP: ventilator associated pneumonia
It is important not to compare the different HCAI rates with each other. For example, the HCAI-developed patient rate (the number of patients that developed HCAI/the number of hospitalized patients×100) is different from HCAI rate (the number of HCAIs/the number of hospitalized patients×100), and both are different from HCAI density (the number of HCAIs/the number of patient-days×1000). Comparison of the different studies/or hospitals with regard to HCAIs should be done only in case of the same infection rate.

patient rate (4.7%), HCAI rate (7.38%), and HCAI density (9.2/1000 patient-days) are lower than the studies in Turkey and similar to or lower than the values of developed countries. Regarding the evaluation of these results, the rate of hospitalized severe/critical patients is important; however, no data came out of those studies, thereby enabling such an evaluation. It is possible to say that all the 10 beds in our PICU are in line with the criteria of 3rd degree PICU. Our hospital and PICU are certified at both national and international levels by The Ministry of Health of Turkey and Joint Committee International. While the highest HCAI rate was in the 6–12-year group in the Lithuanian study (10), and more than half of the cases in the Peru study (22) were patients at an age of <1 year, the average age in our HCAI attack was 36 months. However, given the fact that the average age of all the patients was over 5 years, it is possible to say that our HCAIs relatively occurred in younger patients, and it is compatible that the HCAI rates are usually higher in lower age groups.

In a European-wide study, it was reported that the most prevalent HCAIs in the PICUs were pneumonia, 53%; bacteremia, 20% (62% of them were catheter-related bacteremia); and urinary system infection, 15% (20). In the same study, the prevalence of LRTI in the PICUs in comparison with other clinics was significantly higher, and bacteremia was mainly related to the central venous catheter (20). It was reported in another study conducted in PICUs in the USA that BSIs and pneumonia were responsible for approximately half of the HCAIs; of the HCAIs detected, 30% were BSIs, 20% were pneumonia, and 15% were UTI; all three major infection types were closely related to catheter use (9). In a multi-centered study of PICUs in Lithuania, it was revealed that the most prevalent HCAI types were pneumonia (34%), other LRTIs (25%), and BSI (9%) (10). In a Peruvian study, the most prevalent HCAI types were 57.8% of BSI (77.5% of them were catheter-related BSI), 31.8% of VAP, and 10.6% of UTI (66.7% of them were catheter-related UTI) (22). In a study conducted in the PICU of İzmir Tepecik TRH investigating the HCAIs detected, it was reported that BSI was 73.2% (20% of them were catheter-related BSI), VIP was 14.6%, and UTI was 12.2% (12). In a 2007study in Bursa involving pediatric clinics and PICUs, the most prevalent HCAIs were as follows: BSI of 29%, pneumonia of 24.2%, and UTI and peritonitis in equal rates of 12%, respectively (13). According to the Turkish National Nosocomial Infection Surveillance Network Report (Ulusal Hastane Enfeksiyonlari Sürveyans Aği Raporu, UHESA, 2013), the most three prevalent HCAI types are BSIs, CR-UTI, and VIP (14). The most prevalent types of HCAIs reported in various PICUs are illustrated in Table 5. The most prevalent HCAIs found in our study were as follows: 31.9%, pneumonia (28.3%, VIP; 3.6%, pneumonia); 23%, BSIs (12% CR-BSIs; approximately 11%, bacteremia); 20.8% UTIs (15.8%, CR-UTIs; 5%, symptomatic UTIs). Eighty-nine percent of the pneumonias were ventilator-related pneumonia, 53% of BSIs were catheter-related BSI, and 73% of UTIs were catheter-related UTI. The results of our study are usually compatible with those of the studies conducted worldwide as well as in Turkey.

In different studies, male gender tendency were generally reported without significant (12, 13, 26). In our study, a significant male dominancy was observed

in patients with HCAI in comparison with all PICU patients (67% to 49%, respectively, p=0.001).

Conclusion

It was revealed in this study that the HCAIs in our PICU operating with full occupancy were lower than those reported in various studies in Turkey and comparable with those of the developed countries. The HCAIs were mainly seen at the age of 3 years. The most prevalent systems were established as pneumonia (including VAP), BSIs, and UTIs, and majority of these were catheter or device related.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics committee of Uludag University Faculty of Medicine (05 November 2013, No:2013-18/13).

Informed Consent: Written informed consent was not obtained due to the retrospective nature of this study.

Author Contributions: Design - M.H., S.Ç.; Data Collection and/or Processing - N.Y., M.H., S.Ç., G.E., B.Ş.Ç, T.Ç., E.S.; Analysis and/or Interpretation - M.H., N.Y., S.Ç., G.E., B.Ş.C, T.Ç., E.S.; Writer - M.H., S.Ç., N.Y.

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

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Rosenthal VD, Maki DG, Graves N. The International Nosocomial Infection Control Consortium (INICC): goals and objectives, description of surveillance methods, and operational activities. Am J Infect Control 2008; 36: 11-2. [CrossRef]
2. Huskins WC, Goldmann DA. Health Care-Associated Infections. In: Feigin RD, Cherry JD, Demmler GJ, Kaplan SL (eds). Feigin& Cherry's Textbook of Pediatric Infectious Diseases. 6th edition. Philedelphia: WB Saunders Company, 2009, p. 3076-121.
3. Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections, 1988. Am J Infect Control 1988; 16: 128-40. [CrossRef]
4. Mühlemann K, Franzini C, Aebi C, et al. Prevalence of nosocomial infections in Swiss children's hospitals. Infect Control Hosp Epidemiol 2004; 25: 765-71. [CrossRef]
5. Haley RW, Culver DH, White JW, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am J Epidemiol 1985; 121: 182-205.
6. Siegel JD, Rhinehart E, Jackson M, et al. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. Am J Infect Control 2007; 35: 65-164. [CrossRef]
7. Pittet D, Allegranzi B, Storr J, et al. Infection control as a major World Health Organization priority for developing countries. J Hosp Infect 2008; 68: 285-92. [CrossRef]
8. Magill SS, Edwards JR, Bamberg W, et al. Emerging Infections Program Healthcare-Associated Infections and Antimicrobial Use Prevalence Survey Team. Multistate point-prevalence survey of health care-associated infections. N Engl J Med 2014; 370: 1198-208. [CrossRef]
9. Richards MJ, Edwards JR, Culver DH, Gaynes RP. Nosocomial infections in pediatric intensive care units in the United States. National Nosocomial Infections Surveillance System. Pediatrics 1999 ; 103: 39-47. [CrossRef]
10. Asembergiene J, Gurskis V, Kevalas R, Valinteliene R. Nosocomial infections in the pediatric intensive care units in Lithuania. Medicina (Kaunas) 2009; 45: 29-36.
11. Porto JP, Mantese OC, Arantes A, Freitas C, Gontijo Filho PP, Ribas RM. Nosocomial infections in a pediatric intensive care unit of a developing country: NHSN surveillance. Rev Soc Bras Med Trop 2012; 45: 475-9. [CrossRef]
12. Anıl AB, Anıl M, Özdemir NÖ, ve ark. Çocuk Yoğun Bakım Ünitesinde Hastane Enfeksiyonu Risk Faktörleri. CAYD 2014; 1: 9-16.
13. Hacımustafaoğlu M, Çelebi S, Tuncer E, Özkaya G, Çakır D, Bozdemir Ş E. Çocuk Kliniği ve Çocuk Yoğun Bakım Ünitesi Hastane Enfeksiyonları Sıklığı. J Pediatr Inf 2009; 3: 112-7.
14. Şencan İ, Kalaycı MZ, Kabasakal E, Callak Oku F, Çetinkaya Şardan Y, Aşçıoğlu S. T.C. Sağlık Bakanlığı, Ulusal Hastane Enfeksiyonları Sürveyans Ağı (UHESA) Raporu Özet Veri, 2013. http://www.sb.gov.tr/DH/dosya/1-88693/h/uhesa-analiz-2013.pdf (Erişim tarihi 26.02.2015).
15. Poyrazoğlu H, Dursun İ, Güneş T, ve ark. Çocuk Yoğun Bakım Ünitesinde Yatan Çocukların Değerlendirilmesi ve Sonuçları. Erciyes Med J 2008: 30: 232-7.
16. http://www.bursa.gov.tr/icerik/240/nufus.html, access date 25.02. 2015.
17. Horan CT, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008; 36: 309-32. [CrossRef]
18. Ben-Ami R, Rodríguez-Baño J, Arslan H, et al. A multinational survey of risk factors for infection with extended-spectrum beta-lactamase-producing enterobacteriaceae in nonhospitalized patients. Clin Infect Dis 2009; 49: 682-90. [CrossRef]
19. Kaye KS, Cosgrove S, Harris A, Eliopoulos GM, Carmeli Y. Risk factors for emergence of resistance to broad-spectrum cephalosporins among Enterobacter spp. Antimicrob Agents Chemother 2001; 45: 2628-30. [CrossRef]
20. Raymond J, Aujard Y. Nosocomial infections in pediatric patients: a European, multicenter prospective study. European Study Group. Infect Control Hosp Epidemiol 2000; 21: 260-3. [CrossRef]
21. Banerjee SN, Grohskopf LA, Sinkowitz-Cochran RL, Jarvis WR; National Nosocomial Infections Surveillance System; Pediatric Prevention Network. Incidence of pediatric and neonatal intensive care unit-acquired infections. Infect Control Hosp Epidemiol 2006; 27: 561-70. [CrossRef]
22. Becerra MR, Tantaleán JA, Suárez VJ, Alvarado MC, Candela JL, Urcia FC. Epidemiologic surveillance of nosocomial infections in a Pediatric Intensive Care Unit of a developing country. BMC Pediatr 2010; 10: 66. [CrossRef]

23. Grisaru-Soen G, Sweed Y, Lerner-Geva L, et al. Nosocomial bloodstream infections in a pediatric intensive care unit: 3-year survey. Med Sci Monit 2007; 13: 251-7.
24. Mireya UA, Martí PO, Xavier KV, Cristina LO, Miguel MM, Magda CM. Nosocomial infections in paediatric and neonatal intensive care units. J Infect 2007; 54: 212- 20. **[CrossRef]**
25. Ford-Jones EL, Mindorff CM, Langley JM, et al. Epidemiologic study of 4684 hospital-acquired infections in pediatric patients. Pediatr Infect Dis J 1989; 8: 668-75. **[CrossRef]**
26. Fayon MJ, Tucci M, Lacroix J, et al. Nosocomial pneumonia and tracheitis in a pediatric intensive care unit: a prospective study. Am J Respir Crit Care Med 1997; 155: 162-9. **[CrossRef]**