



Evaluation of 3 Year Surveillance of Device Associated Infections in a Neonatal Intensive Care Unit

Yenidoğan Yoğun Bakım Ünitesinde Alet İlişkili Enfeksiyonların 3 Yıllık Surveyans Değerlendirmesi

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Abstract

Aim: The aim of this study was to determine the rates of healthcare associated infections (HAIs) and device associated healthcare associated infections (DA-HAIs) as well as the rates of invasive device utilization in a neonatal intensive care unit (NICU); and to compare findings with national and international reports.

Material and Method: A total of 1984 patients who admitted to NICU between January 2016 and December 2018 were enrolled. We retrospectively analysed patient's characteristics, etiologic pathogens and antibiotic susceptibility, mortality from medical charts and infection control committee surveillance reports. Infections were defined using the standart Centers for Disease Control and Prevention criteria.

Results: During the 3-year period, total 98 HAI cases 69 of which were DA-HAI were detected. The overall incidence of HAIs was 4.9% and rate was 3.7 per 1000 patient days. The most common HAI was blood stream infection (BSI) (n=64, 65.3%) of those 52 were central line-associated (CLA). The CLA-BSI rate was 8.6 per 1000 central line days with central line utilization ratio of 0.22. Ventilator associated pneumonia (VAP) rate was 5.1 per 1000 ventilator days with ventilator utilization ratio of 0.12. The most common pathogens were Klebsiella pneumonia. (38.9%), Staphylococcus epidermidis (22.1%) and Candida spp. (11.6%). The overall mortality rate was 3%. The HAI-related mortality rate was 9.2%.

Conclusion: Our findings highlight the importance of an surveillance approach in the NICU setting. HAI rates were lower than the rates reported from developing countries. However, with device utilization rates similar to those in developed countries our HAI rates were higher than that of the developed countries. Continous monitoring and implementation of necessary precautions are essential to decrease the rates of HAIs.

Keywords: Healthcare-associated infection, device-associated infection, neonatal intensive care unit, surveillance

Öz

Amaç: Hastanemiz yenidoğan yoğun bakım ünitesinde (YYBU) sağlık bakımı ilişkili enfeksiyon (SBİE), alet kullanımı ilişkili enfeksiyon hızlarını ve alet kullanım oranlarını belirlemek; bu sonuçları ulusal ve uluslararası verilerle karşılaştırmak.

Gereç ve Yöntem: Ünitimizde Ocak 2016 ile Aralık 2018 yılları arasında yatan 1984 hasta değerlendirildi. Hastaların demografik ve klinik özellikleri, etyolojik patojenler ve antibiyotik duyarlılıkları, mortalite verileri hastane kayıtlarından ve enfeksiyon kontrol komitesi surveyans dosyalarından kaydedilerek retrospektif olarak analiz edildi. Enfeksiyonlar, CDC (Centers for Disease Control) standartları esas alınarak tanımlandı.

Bulgular: 3 yıllık çalışma süresinde, 98 SBİE olgusu saptandı ve bunların 69 (%70.4)' u alet ilişkili enfeksiyon idi. SBİE insidansı %4.9 ve hızı her 1000 hasta-yatış günü için 3.7 olarak saptandı. En sık SBİE kan dolaşımı enfeksiyonu (KDE) idi (n=64, %65) ve bunların 52'si santral kateter ilişkili enfeksiyon olarak saptandı. SKİ-KDE hızı her 1000 kateter günü için 8.6 ve kateter kullanım oranı 0.22 idi. Ventilatör ilişkili pnömöni (VİP) hızı her 1000 ventilatör günü için 5.1 ve ventilatör kullanım oranı 0.12 idi. En sık izole edilen patojenler Klebsiella pneumonia. (%38.9), Staphylococcus epidermidis (%22.1) ve Candida spp. (%11.6) idi. Toplam mortalite oranı %3 idi. HKE ilişkili mortalite oranı %9.2 oranında saptandı.

Sonuç: Bulgularımız YYBU'nde surveyans çalışmasının önemini vurgulamaktadır. Ünitemiz HKE hızları gelişmekte olan ülkelerden düşük olmakla birlikte benzer alet kullanım oranına sahip gelişmiş ülkelerden daha yüksek saptanmıştır. Sürekli monitorizasyon ve gerekli önlemlerin alınması hastane kaynaklı enfeksiyonları azaltacaktır.

Anahtar Kelimeler: Hastane enfeksiyonları, alet ilişkili enfeksiyonlar, yenidoğan yoğun bakım, surveyans



INTRODUCTION

Healthcare-associated infections (HAIs) are significant cause of morbidity and mortality as well as increased cost all over the world. The HAI incidence in neonatal intensive care units (NICUs) has been observed in the range of 1.8% to 57.7% in several reports.^[1-3] Prematurity, low birth weight, invasive procedures including catheterisation and mechanical ventilation, prolonged hospitalisation, use of wide spectrum antibiotics are important factors related to HAIs in neonates.^[4,5] The majority of HAIs are device-associated healthcare-associated infections (DA-HAIs) because of insufficient immune system, mechanical barriers and protective flora of newborn infants.^[6]

Active surveillance is well established method to determine the HAI rates, identify risks and problems and evaluate the necessary precautions to reduce frequency of HAIs.^[7,8] Surveillance of DA-HAIs and device utilization are important to assess the infection rate according to with device utilization. The characteristics and rates of HAIs, and device utilization has been shown to be different between developing and developed countries.^[9]

The aim of this study was to determine incidence of HAI; evaluate DA-HAIs rates and device utilization ratios in a NICU. In addition, we compared our results with the current national and international data.

MATERIALS AND METHODS

Our NICU is a tertiary care NICU with 35 incubators and 20 ventilators. The NICU staff consist of 2 neonatology specialists, 5 pediatric residents, one nurse per 3 level III infants and one nurse per 5-6 level I-II infants. Our unit admits inborn neonates from the Obstetric Department (approximately 2500 births per year) and outborns transported from different hospitals.

This study was a retrospective analyses of neonates admitted to our NICU between January 1, 2016 and December 30, 2018. Infants who were discharged or died 48 hours after admission were excluded. This study was approved by Medeniyet University, Goztepe Training and Research Hospital, Ethics Committee on November 20, 2019 with decision number: 2019/0332.

Active surveillance of HAIs was carried out by infection control committee including an infectious disease specialist and trained nurses. During the hospitalization period, infection control nurses recorded patient information on daily basis. The diagnosis of HAI was made based on criteria of CDC.^[10] Blood stream infection (BSI) was defined as one or more positive blood cultures with no identified source. BSI was categorized as central line associated (CLA) in case of a central catheter was in place within ± 2 days of positive blood culture. Pneumonia was categorised as ventilator associated pneumonia (VAP) that developed during or within 48 hours after mechanical ventilation.

The following calculated parameters were used to evaluate HAIs:^[11,12]

HAI incidence: number of HAIs / number of patients x 100

HAI rate: number of HAIs / patient-days x1000

CLA-BSI rate: number of CLA-BSI / central line days x 1000

Central line utilization ratio: Central line days / patient-days

VAP rate: number of VAP / ventilator days x 1000

Ventilator utilization ratio: Ventilator days / patient-days

We compared the results of our study with the National Infection Surveillance and Control Unit (UHESA) report (2017), the International Nosocomial Infection Control Consortium (INICC) report (2010-2015) as well as the United States National Healthcare Safety Network (NHSN) report (2013).^[12-14]

The data were analysed with SPSS for Windows 22.0. The chi square test was used. Mean \pm standart deviation and percentages were presented. Chi-square test and Fisher's exact test were performed to find differences between groups. A p value <0.05 was considered as sinificant.

RESULTS

During 3-year study period, 1984 patients which represents 26554 patient days were enrolled. Total of 98 HAI cases were detected in 81 patients of which 13 had multiple HAIs. The overall HAI incidence was 4.9% and rate was 3.7 per 1000 patient days. The most common HAI was BSI (65.3%) followed by VAP (17.3%). The distribution of HAIs according to infection sites are presented in **Table 1**.

Table 1. Distribution of HAI diagnosis according to sites of infections (2016-2018)

	n	%	Rate per 100 patients	Rate per 1000 patient-days
BSI	64	65.3	3.22	2.41
VAP	17	17.3	0.85	0.06
CNS Infections	6	6.1	0.30	0.02
Skin and soft tissue infections	4	4.1	0.20	0.01
Surgical site infections	4	4.1	0.20	0.01
Urinary tract infections	3	3.1	0.15	0.01
Total	98	100	4.93	3.69

BSI, bloodstream infection; VAP, ventilator associated pneumonia; CNS, central nervous system

52 of 64 (81%) BSI episodes were related to central catheter use and overall CLA-BSI rate was 8.6 per 1000 central line days with central line utilization ratio of 0.22. The VAP rate was 5.8 per 1000 ventilator days with ventilator utilization ratio of 0.12. The annual rate of CLA-BSI were found to vary whereby VAP rate did not change wthiin 3-year study period. Central catheter and ventilator utilization ratios in each year were similar (0.22, 0.21, 0.25 and 0.13, 0.12, 0.13, respectively). The highest CLA-BSI rate (11.5 per 1000 catheter days) was observed in 2016 and decreased to 5.5 per 1000 catheter days in 2017 (**Figure 1**).

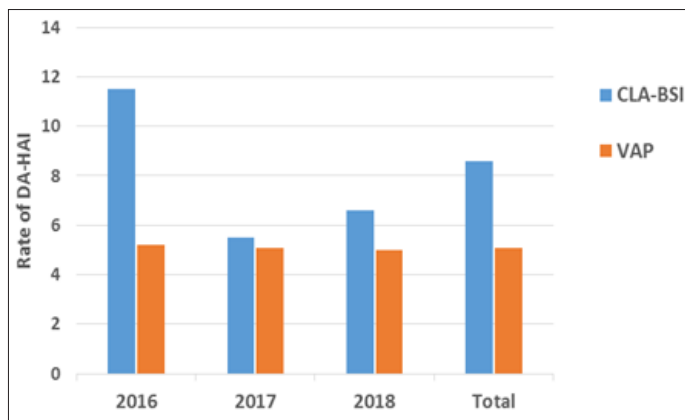


Figure 1. The rates of device-associated nosocomial infections over the 3-year period.

CLA-BSI, central line-associated blood stream infections; VAP, ventilator-associated pneumonia

Table 2 summarizes the CLA-BSI rate and central line utilization ratio of study group and the results national and international reports. Central lines were most commonly used in patients with birth weight less than 1500 g. Of 52 CLA-BSI cases, 50 (96%) were preterm and 45 (86.5%) were very low birth weight (<1500 g) infants. Infection was diagnosed averagely on 20.2±8.4 (10-54) days after catheter insertion.

Table 3 summarizes the VAP rate and ventilator utilization ratio of study group and the results national and international reports. The highest VAP rate and ventilator utilization was observed in ≤750 g birth weight class. All VAP cases were preterm infants. VAP was detected averagely on day 28.3±17.2 (4-75) of mechanical ventilation.

The distribution of isolated microorganisms from HAIs were shown in **Table 4**. The most common organisms were *Klebsiella pneumoniae* (38.9%), *Staphylococcus epidermidis* (22.1%) and *Candida* spp. (11.6%). Resistance rates of *Klebsiella pneumoniae* to the antimicrobial agents, respectively, were as follows: gentamicin 52%; carbapenem 33%; colistin 20%; ciprofloxacin 24%, trimethoprim-sulfamethoxazole 20%; ESBL production of *Klebsiella* spp. was found as 64%. All strains were susceptible to tigecycline. Of the *Staphylococcus* spp. 68% were resistant to methicillin and cephalothin. There was no vancomycin resistant strain in Gram positive pathogens. *Candida* spp. were susceptible to amphotericin B, and ekinokandins.

Table 4. Distribution of causative agents in HAI (2016-2018)

Microorganism types	n	%
<i>Klebsiella pneumoniae</i>	37	38.9
<i>Staphylococcus epidermidis</i>	21	22.1
<i>Candida</i> spp.	11	11.6
<i>Enterobacter</i> spp.	5	5.3
<i>Staphylococcus aureus</i>	4	4.2
<i>Acinetobacter baumannii</i>	6	6.3
<i>Serratia marcescens</i>	4	4.2
<i>Enterococcus faecium</i>	3	3.2
<i>Pseudomonas aeruginosa</i>	4	4.2
Total	95	100

HAI, healthcare-associated infection; n, number

Table 2. Comparison of central line utilization ratios and CLABSI rates of our hospital NICU with national and international data

Birth-weight category	Patient number	Patient days	Central-line days	CLABSI (n)	Central line utilization ratio				CLABSI rate			
					Our NICU (2016-2018)	UHESA (2017)	INICC (2010-2015)	NHSN (2013)	Our NICU (2016-2018)	UHESA (2017)	INICC (2010-2015)	NHSN (2013)
Total	1984	26554	6069	52	0.22	0.16	0.29	0.26	8.6	2.2	12.7	1.5
≤ 750 gr	44	2575	1479	13	0.57	0.40	0.45	0.39	8.8	3.3	18.3	2.1
751-1000 gr	39	1798	868	10	0.48	0.32	0.44	0.33	11.5	2.9	14.5	1.3
1001-1500 gr	119	4496	1661	22	0.36	0.23	0.33	0.26	13.2	2.4	15.3	0.8
1501-2500 gr	372	6044	990	4	0.16	0.13	0.21	0.17	4.0	2	7.7	0.6
>2500 gr	1410	11641	1071	3	0.09	0.11	0.22	0.23	2.8	1.7	9.3	0.7

CLABSI, central line associated blood stream infection; UHESA, National Hospital Infection Surveillance and Control Unit; INICC, International Nosocomial Infection Control Consortium; NHSN, National Healthcare Safety Network

Table 3. Comparison of our ventilator utilization ratios and VAP rates with national and international data

Patient number	Patient days	MV days	VAP (n)	Ventilator utilization ratio				VAP rate			
				Our NICU (2016-2018)	UHESA (2017)	INICC (2010-2015)	NHSN (2013)	Our NICU (2016-2018)	UHESA (2017)	INICC (2010-2015)	NHSN (2013)
1984	26554	3346	17	0.12	0.19	0.23	0.21	5.1	1.1	7.5	0.6
44	2575	1265	8	0.49	0.49	0.48	0.38	6.3	1.8	3.3	1.0
39	1798	350	1	0.19	0.37	0.32	0.22	2.8	1.4	4.9	1.1
119	4496	736	6	0.16	0.24	0.20	0.10	8.1	1.1	13.2	0.7
372	6044	511	2	0.08	0.17	0.18	0.06	3.9	0.8	6.4	0.5
1410	11641	484	0	0.04	0.15	0.23	0.10	0	1	5.5	0.1

VAP, ventilator associated pneumonia; UHESA, National Hospital Infection Surveillance and Control Unit; INICC, International Nosocomial Infection Control Consortium; NHSN, National Healthcare Safety Network

During 3-year study period, the overall mortality rate was 3% in our NICU. The all HAI-related mortality rate was 9.2%. Mortality rate was 11.5% for CLA-BSI and 17.6% for VAP cases. The crude rates for excess mortality associated with HAIs, CLA-BSI and VAP were determined as 6.1%, 7.7% and 11.8%, respectively.

DISCUSSION

Advances in neonatal care have increased survival rates of premature, low birth weight but HAIs are still significant and unsolved problem in NICUs. Monitoring the HAI rates is an significant part of high quality healthcare, especially in NICUs. Therefore, we evaluated infection surveillance of our NICU and compared it with values in national and international reports.

The HAI incidences in literature vary between 1.8 % to 57% with higher rates in developing countries.^[2,9] In a study from Egypt, HAI rate was reported as 21.4%.^[15] In studies from Brazil, reported rate of HAIs ranged between 18.3% to 50.7%.^[16,17] Studies from Europe have reported rates varying between 1.6% to 13.2%.^[19] In a multicenter study from Turkey, HAI rate ranged between 2.1% and 17%.^[20] In studies from Turkish NICUs, HAI rate was varied between 8% to 29.7%.^[21-23] In our study, the overall incidence HAI was 4.9% which was consistent with other studies. Variations in reported HAI rates were considered as a result of differences in clinical practices, demographic factors and resource utilities in NICUs.

BSIs are reported as the most common HAIs worldwide.^[24,25] In our study, the most frequent HAIs were BSIs (65.3%) followed VAP (17.3%). The rates of DA-HAIs differ in terms of sites of infection. In studies from developed countries, CLA-BSIs are the most common DA-HAIs whereas VAPs have been reported as major DAIs in studies from developing countries.^[6,9] Previous studies from Turkey have reported that VAP accounts almost 80% of all DAIs in NICUs.^[20-22,27] In our study, CLA-BSI was the most frequent (75.4%) DAIs followed by VAP (24.6%). These differences can be explained by changes in ventilatory management and central catheter care practices.

The CLA-BSI rate was reported as 2.6-18.3‰ from different Turkish NICUs.^[22,23,27] In INICC study, involving 703 centers from 50 countries, CLA-BSI rate was 12.7‰ with catheter utilization ratio of 0.29.^[13] CLA-BSI rate was 8.6 per 1000 central line days with central line utilization ratio of 0.22. Our CLA-BSI rate was lower than that reported INICC study with similar catheter utilization ratio.^[13] In previous studies from Turkish NICUs, the VAP rate was ranging 6.4-17‰.^[22,23,27] The VAP rate was 7.5‰ with ventilator utilization of 0.23 in the INICC report.^[13] Our VAP rate lower than that reported INICC study with lower ventilator utilization ratio.^[13] When compared to data of NHSN from US, although device utilization ratios were similar, the rates of CLA-BSI and VAP were higher in our study.^[14] The findings our study showed us our rates were lower than the those reported from developing countries but in significant level. In order to decrease the device associated infections, we evaluated our catheter care and ventilator management principles and took urgent precautions.

The risk factors related to HAIs include prematurity, low birth weight, mechanical ventilation, central catheter, use of wide spectrum antibiotics, H2 blockers and steroids.^[25] Low birth weight infants (<1500 g) have 3 times higher risk for nosocomial infections.^[26] In our study, most of the CLA-BSIs and VAPs were diagnosed in infants with birth weight less than 1500 g which was consistent with previous studies. In addition, we observed that prolonged mechanical ventilation and central catheter duration were associated with VAP and CLA-BSI, respectively, accordance with literature.^[6,22,27]

The most common pathogens are Gram positive pathogens especially coagulase negative staphylococcus spp. in developed countries whereas Gram negative pathogens are found to be major causative pathogens in developing countries.^[24,28,29] In our study, the most frequent pathogens isolated from HAI cases were Klebsiella spp, which is consistent with previous studies.^[20,24]

It has been known that HAIs are significantly associated with mortality, especially in low birth weight infants. HAI related mortality was 9.2% of which VAP has the highest rates (17.6%) in our NICU. Our rates were lower than those reported in previous studies.^[13,20,29] On the other hand, since patients without HAI have a lower mortality rate (3%) than those with nosocomial infection, it seems like we should continue to focus on preventive strategies to reduce HAIs such as limiting the use of devices in our NICU.

CONCLUSION

Our study showed that the nosocomial infections was a important problem in our NICU. Reducing HAI rates requires a well-organized infrastructure as well as continuous education of the staff and the unit culture and policies on patient care. Fast turnover of staff, especially of nurses hinders the growth of a unit culture and frequent use of antibiotics mostly within the context of defensive medicine considerations complicates the problem.

ETHICAL DECLARATIONS

Ethics Committee Approval: This study was approved by Medeniyet University, Goztepe Training and Research Hospital, Ethics Committee on November 20, 2019 with decision number: 2019/0332.

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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