Evaluation and Monitoring of Device-Associated Infection Rates in Anesthesiology Intensive Care Unit

Anesteziyoloji Yoğun Bakım Ünitesinde Alet ile İlişkili Nozokomiyal Enfeksiyon Hızlarının İzlenmesi ve Değerlendirilmesi

Meltem AVCI, MD,[a]
Onur ÖZGENÇ, MD,[a]
Levent B. KIDAK, MD,[b]
Ayten COŞKUNER, MD[a]

[a]Department of Infectious Diseases and Clinical Microbiology,
[b]Deputy of Head Physician of İzmir Teaching and Research Hospital, İzmir

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Yazışma Adresi/*Correspondence:*
Meltem AVCI, MD
İzmir Teaching and Research Hospital, Department of Infectious Diseases and Clinical Microbiology, Bozyaka, İzmir, TÜRKİYE/TURKEY
meltema1@hotmail.com

ABSTRACT Objectives: To evaluate the incidence of device-associated nosocomial infections, device utilization ratios and the isolated pathogens in the Anesthesiology Intensive Care Unit (ICU). **Material and Methods:** A prospective surveillance study was performed from January 2006 through December 2007 in the Anesthesiology ICU of the hospital. Nosocomial device-associated infections were defined according to the Centers for Disease Control and Prevention (CDC) criteria. **Results:** During the two-year period, 510 patients with a total of 5924 patient-days were analyzed. The rate of ventilator-associated pneumonia (VAP) was 15.4 infections per 1000 ventilator-days, the rate of central venous catheter-associated bloodstream infection (CVC-BSI) was 4.3 infections per 1000 central venous catheter-days, and the rate of catheter-associated urinary tract infection (CA-UTI) was 3.9 infections per 1000 urinary catheter-days. Ventilator, central venous catheter, and urinary catheter utilization ratios were 0.89, 0.86, and 1.00, respectively. Overall, the most common microorganisms were *Klebsiella pneumoniae* (20%), *Pseudomonas aeruginosa* (17%), and *Escherichia coli* (10%) among patients with device-associated nosocomial infections according to the clinical samples. **Conclusions:** Although the device utilization rates were high in the ICU of our hospital, the rates of device-associated infection were lower than those reported by the Turkish overall rates from the International Nosocomial Infection Control Consortium. For control of patient safety in ICUs, the parameters regarding device-associated infections should be continuously monitored and evaluated in all hospitals. In addition, prevention of nosocomial infections require interdisciplinary cooperation between hospital administrators, unit/ward/service directors, and other healthcare staff.

Key Words: Cross infection, intensive care units

ÖZET Amaç: Anesteziyoloji Yoğun Bakım Ünitesi (YBÜ)'nde gelişen alet ile ilişkili nozokomiyal enfeksiyonların sıklığının, alet kullanım oranlarının ve enfeksiyon etkenlerinin değerlendirilmesidir. **Gereç ve Yöntemler:** Ocak 2006-Aralık 2007 tarihleri arasında hastanemiz Anesteziyoloji YBÜ'de ileriye dönük bir sürveyans çalışması gerçekleştirildi. Alet ile ilişkili nozokomiyal enfeksiyon tanıları "Centers for Diseases Control and Prevention (CDC)" kriterlerine göre konuldu. **Bulgular:** İki yıllık dönemde 510 hasta 5924 hasta gününde izlendi. Bin ventilatör gününe göre ventilatör ile ilişkili pnömoni (VİP) hızı 15.4, 1000 santral venöz kateter (SVK) gününe göre SVK ile ilişkili kan dolaşımı enfeksiyon (SVK-KDE) hızı 4.3 ve 1000 üriner kateter (ÜK) gününe göre ÜK ile ilişkili üriner sistem enfeksiyon (ÜK-ÜSE) hızı 3.9 olarak saptandı. Ventilatör, SVK ve ÜK kullanım oranları sırasıyla 0.89, 0.86 ve 1.00 olarak bulundu. Alet ile ilişkili enfeksiyonlardan elde edilen klinik örneklerde en sık saptanan mikroorganizmalar, *Klebsiella pneumoniae* (%20), *Pseudomonas aeruginosa* (%17) ve *Escherichia coli* (%10) idi. **Sonuç:** Hastanemiz YBÜ'de alet kullanım oranları yüksek saptanmasına karşın, alet ile ilişkili enfeksiyon hızlarımız "International Nosocomial Infections Control Consortium (INICC)" Türkiye ortalama hızına göre düşük bulundu. Hastanelerde YBÜ'de hasta güvenliğinin kontrolü için alet ile ilişkili enfeksiyonlarla ilgili tüm parametreler sürekli olarak izlenmeli ve değerlendirilmelidir. Ayrıca, nozokomiyal enfeksiyonların önlenmesi, hastane yönetimi, servis şefleri ve diğer hastane çalışanları arasında iş birliği gerektirmektedir.

Anahtar Kelimeler: Nozokomiyal enfeksiyon, yoğun bakım üniteleri

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Nosocomial infections with significant additional morbidity, mortality, length of stay, and economic burden are among the major problems of hospital management and a threat to patient safety throughout the world.[1-3]

Although patients in intensive care units (ICUs) are a small subgroup of all hospitalized patients, nosocomial infection rates among ICU patients are higher than those among the general ward patients. Intensive care unit patients are at greater risk of developing nosocomial infections for several reasons, such as the presence of underlying diseases, performed invasive diagnostic and therapeutic procedures and impaired host defences.[3-8]

Most nosocomial infections in ICUs are related to device use.[3,5,8] It has been reported that intra-hospital and inter-hospital comparison of ICU infection rates may best be shown by comparing ICU type-specific and device-associated infection rates and device utilization ratios.[5,9]

To date, only a few reports have been published on device-associated infection rates and device utilization ratios in ICUs from Turkey in the literature.[10-13] In this study, we aimed to evaluate the incidence of device-associated nosocomial infections, device utilization ratios and the isolated pathogens in the anesthesiology ICU of a teaching and research hospital.

MATERIALS AND METHODS

The Hospital is a 732-bed teaching hospital with about 30.000 admissions annually. This prospective study was performed in the anaesthesiology ICU of our hospital between January 2006 and December 2007. Our anesthesiology ICU, which has ten beds, cares for critically ill medical, surgical, neurosurgical, and trauma patients.

During the study period, infection control nurses visited the ICU patients every day. They recorded data such as age, gender, date of hospitalization, cause of admission, underlying diseases, use of H2 receptor antagonists, surgical operations and invasive procedures, such as central and/or peripheral intravenous access, nasogastric tube, endotracheal intubation, mechanical ventilation, urinary catheter, tracheotomy, etc. In addition, patients were visited by an intensive care physician and infectious disease specialists. When a patient was determined to have a nosocomial infection, the date of onset, infection site, isolated microorganisms and their susceptibility patterns were also recorded. Nosocomial infections were defined according to the standart definitions of Centers for Disease Control and Prevention (CDC).[14] The overall nosocomial infection rates per patient and per patient-day were calculated by dividing the total number of nosocomial ICU infections by the total number of ICU patients x 100 and patient-days x 1000, respectively. Device utilization ratios were calculated by dividing the total number of device-days by the total number of patient-days. Rates of ventilator-associated pneumonia (VAP), central venous catheter-related bloodstream infections (CVC-BSI), and catheter-associated urinary tract infections (CAUTI) per 1000 device-days were calculated by dividing the total number of infections by the total number of specific device-days and multiplying the result by 1000.[15]

RESULTS

During the two-year study period, data on 510 patients with a total of 5924 patient-days, were analyzed. A total of 127 device-associated infections occurred. The distribution of invasive device-associated infections was 64.6%, 17.3%, and 18.1% for VAP, CVC-BSI, and CAUTI, respectively. Rates of device-associated infections per 1000 device-days and device utilization ratios were listed in Table 1. The overall nosocomial infection rates were 24.9 infections per 100 patients and 21.4 infections per 1000 patient-days.

In 127 device-associated infections, 177 pathogens were isolated from clinical samples. Thirty of VAPs, and four CAUTIs were polimicrobial. In CVC-BSIs, 22 were blood-related samples, and 16 were CVC-related samples. Overall, polimicrobial isolates were mostly gram-negative species.

Pathogens isolated from device-associated infections according to the clinical samples were listed in Table 2.

TABLE 1: Rates of device-associated infections per 1000 device-days and device utilization ratios.

	Device-associated infections					
Infection site	No.	%	Device-days	Device utilization ratio	Rate per 1000 device-days	Rate per 100 patients
VAP	82	64.6	5326	0.89	15.4	16.1
CVC-BSI	22	17.3	5101	0.86	4.3	4.3
CAUTI	23	18.1	5924	1	3.9	4.5

VAP: Ventilator-associated pneumonias, CVC-BSİ: Central venous catheter-bloodstream infection, CAUTI: Catheter-associated urinary tract infections.

From the clinical samples, the most commonly isolated pathogens were *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* among patients with VAPs, methicillin-resistant coagulase-negative (CN) staphylococci and *Candida* species among patients with CVC-BSIs, and *P. aeruginosa,* and *K. pneumoniae* among patients with CAUTIs (Table 2). Overall, the most common microorganisms were *K. pneumoniae* (20%), *P. aeruginosa* (17%), and *Escherichia coli* (10%). Gram-negative isolates (71%) were the predominant pathogens.

TABLE 2: Pathogens isolated from device-associated infections according to the clinical samples.

				Total	
Pathogens	VAP*	CVC/BSI**	CAUTI***	No	%
Klebsielb pneumonia	27	1/1	7	36	20.3
Pseudomonas aeruginosa	22	0	8	30	16.9
Escherichia coli	14	0	4	18	10.2
Acinetobacter baumannii	15	0/1	1	17	9.6
Staphylococcus aureus	12	2/2	1	17	9.6
Proteus mirabilis	12	0/1	3	16	9
CN staphylococci	2	6/7	-	15	8.5
Candida spp.	-	5/7	-	12	6.8
Enterococci	-	1/2	3	6	3.4
Enterobacter spp.	5	0	-	5	2.8
Stenotrophomonas maltophilia	2	1/1	-	4	2.3
Streptococcus pneumonia e	1	0	-	1	0.6
Total	112	16/22	27	177	100

*VAP: Endotracheal aspirates

** CVC/BSI: central venous catheter / bloods tream infections

*** CAUTI: cetheter-associated urinary tract infections.

DISCUSSION

This was the first study comparing device-associated infection rates and device utilization ratios in the medical-surgical anesthesiology ICU of our hospital with the results of earlier studies in the literature. Rates of healthcare-associated infections are reported to vary between countries and within the same country depending on resources, interest of caregivers and healthcare staff, and the socioeconomic status of the patient.[1]

In the present study, the rate of device associated infections (DAI) per 100 patients and per 1000 patient-days were 24.9 and 21.4, respectively. Although our DAI rate per 100 patients was higher than the rate in the National Nosocomial Infections Surveillance System (NNISS) report from the United States, and the International Nosocomial Infection Control Consortium (INICC), with an overall rate of 6.1 and 14.7, respectively, it was lower than the overall DAI rate reported from Turkey (38.3/100 patients) in the INICC study.[11,16,17] The rate per 1000 patient-days was also lower than the overall rate of Turkey in the INICC study, which was 33.9/1000 patients-days, but was similar to the data of INICC.[11,17]

The distribution of DAI types tends to vary between different ICU studies.[11,12,17-19] The DAI distribution in the Indian study of the INICC[18] was 61.3%, 29.6% and 9% for CVC-BSI, VAP, and CAUTI, respectively.[18] These findings were in accordance with the results of the Colombian data from the INICC.[19] In our study, VAP (64.6%) was the most frequent DAI, followed by CAUTI (18.1%), and CVC-BSI (17.3%), similar to those reported in the previous studies.[11,17]

DAI rates and device utilization ratios are recommended to be examined together to take appropriate preventive measures.[20] Our DAI values were higher than the pooled means reported for medical-surgical ICUs by the NNISS, which were 5.4 for VAP, 3.9 for CVC-BSI, and 4.0 for CAUTI,

and by the National Healthcare Safety Network (NHSN) Report, which were 2.7 for VAP, 2.2 for CVC-BSI, and 3.1 for CAUTI, but were lower than the Turkish data from the INICC study, with an overall rate of 26.5 per 1000 mechanical ventilator-days for VAP, 17.6 per 1000 central venous catheter-days for CVC-BSI, and 8.3 per 1000 urinary catheter-days for CAUTI.[11,16,20]

Our mechanical ventilator, central venous catheter, and urinary catheter utilization ratios were all higher than those in the previous reports.[11,16,21] Possible explanations for our high DAI rates and device utilization ratios, compared to the NNISS and NHSN are: 1) lack of interest of healthcare staff about hospital infections and consequently lack of compliance with basic practices of infection control measures, such as hand hygiene, glove and gown use, barrier precautions during device manipulation, care of devices, timely removal of device and etc.; 2) a high patient: staff ratio; 3) lack of trained nurses, and 4) presence of multi-bed rooms with no barriers.

Although the device utilization ratios were higher, the rates of DAI were lower than the Turkish overall rates reported by INICC.[11] The lower rates obtained in the present study could be attributed to inadequate detection of DAI due to culturing the patient while on antibiotic therapy or cultures. A particularly high ratio of urinary catheter use was observed in our ICU. This was considered to be due to not removing catheters at the earliest possible time.

Distribution of pathogens causing nosocomial infections changes with time and varies between hospitals, even in different parts of the same hospital.[22-24] In the present study, overall, gram-negative bacteria were the most common agents isolated from clinical samples in the ICU. This was in accordance with some previous studies reported from our country.[10,13] Surprisingly, in the study from the Pamukkale University Hospital *Candida* spp. were the most common causative pathogens in DAIs.[12] Richards et al reported that in patients with pneumonia, *S. aureus* (17%), in patients with UTIs, *E. coli* (19%), and in patients with primary BSIs, coagulase-negative staphylococci (39%) were the most frequently isolated pathogens in combined medical-surgical ICUs in the United States between 1992 and 1998.[25] However, in the Turkish study of INICC, overall, *Acinetobacter* spp. was the causative agent in 29.2% of VAP, *Candida* spp. in 44% of CAUTI and *Acinetobacter* spp. in 23.2% and *S. aureus* in another 23.2% of CVC-BSI.[11] In the present study the most frequently isolated pathogens from clinical samples were *K. pneumoniae* (24%), and *P. aeruginosa* (20%) in VAP, *P. aeruginosa* (30%) and *K. pneumoniae* (26%) in CAUTI, and coagulase-negative staphylococci (34%) and *Candida* spp. (32%) in CVC-BSI. Interestingly, *Candida* spp. was the second most common microorganism in CVC-BSIs samples. This may be associated with excessive broad-spectrum antibiotic use and long duration of catheterization.

As mentioned before, for the prevention of DAIs, general recommendations include: 1) staff education; 2) use of a surveillance program with a restrictive antibiotic policy; 3) adequate time for hand washing; and 4) barrier precautions during device manipulation. Moreover, specific control measures must be taken for VAP, CVC-BSI, and CAUTI.[26-29] For example, reports indicate that the use of the VAP prevention bundle or the CVC-BSI prevention bundle results with significant reductions in CVC-BSI rates or VAP rates.[28-30]

In conclusion, the control of patient safety in ICUs depends largely on targeted surveillance and calculation of rates for DAI per 1000 device-days. This would facilitate the comparison of infection rates in similar ICUs, guide our way to detect the problems in our ICUs and to formulate a cont-rol policy. However, it should always be remembered that the control of nosocomial infections requires inter-disciplinary cooperation between hospital administrators, unit/ward/service directors and other healthcare staff.

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