Original Article

The Rate of Device-Associated Nosocomial Infections in a Medical Surgical Intensive Care Unit of a Training and Research Hospital in Turkey: One-Year Outcomes

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SUMMARY: In the present study, we aimed to assess the rate and effect of device-associated nosocomial infections (DANIs), as well as the rate of antibiotic resistance, in the medical-surgical intensive care unit (ICU) of a research and training hospital in Turkey, and to compare our results with those reported by the National Nosocomial Infections Surveillance (NNIS) system and International Nosocomial Infection Control Consortium (INICC). A total of 509 patients were followed up within a 1-year period from 1 November 2007 to 1 November 2008. The total patient days were 4,087, the number of DANIs was 181. The ventilator-associated pneumonia rate in 1,000 ventilator days was 27.1, the rate of central venous catheter (CVC)-associated blood circulation infections in 1,000 CVC days was 11.8, and the rate of urinary catheter-associated urinary tract infections in 1,000 urinary catheter days was 9.6. The most frequently isolated microorganisms were *Pseudomonas aeruginosa* and *Acinetobacter* spp. Of the infections caused by *Staphylococcus aureus*, 81.2% were due to methicillin-resistant strains. Of the *Enterobacteriaceae* isolates, 53.5% were found to be resistant to ceftriaxone, while 29% of the *P. aeruginosa* isolates were found to be resistant to ciprofloxacin. The rates of use of devices such as ventilators, CVCs, and urinary catheters were 0.87, 0.93, and 0.98, respectively, which are higher than the rates reported by NNIS and INICC. On the other hand, the present DANI rate was higher than that reported by NNIS, but close to that reported by INICC. We conclude that the indications for and duration of device use should be reviewed.

INTRODUCTION

Nosocomial infections are frequently encountered in intensive care units (ICUs) because of the severity of underlying diseases, the frequency of invasive interventions, and the frequent use of wide-spectrum antibiotics (1). It has been reported that ICUs account for 25% of nosocomial infections, even though they occupy only approximately 10% of the bed capacity of a hospital (2). The frequency of such infections, particularly in ICUs, and the agents and their resistance rates should be identified in order to better control infection. Studies examining nosocomial infections for the purpose of assessing the nosocomial infection rate are one of the most important indicators of the quality of health services. In the present study, we aimed to determine the 1-year device-associated nosocomial infection (DANI) rate, as well as to identify the infectious agents involved and their resistance rates against certain antibiotics, in the medical-surgical ICU of our hospital between 1 November 2007 and 1 November 2008; we then compared our results with data from the National Nosocomial Infections Surveillance (NNIS) system, Turkey and International Nosocomial Infection Control Consortium (INICC).

MATERIALS AND METHODS

We examined DANIs that occurred in both adult and child patients who had been followed up between 1 November 2007 and 1 November 2008 in a 16-bed medical-surgical ICU affiliated with the anesthesiology and reanimation clinic of the Goztepe Research and Training Hospital. An active prospective surveillance was performed by infectious disease specialists and infection control nurses following the recommendations of the NNIS system and using laboratory data. Nosocomial infections were defined according to the diagnostic criteria of the Centers for Disease Control and Prevention (CDC) (3). The DANI rate was calculated as (device-associated nosocomial infection/patient day) $\times 1,000$ and the device use rate as device day/patient day. After first stage tests like the Gram-stain test, coagulase test, and catalase test, BBL Crystal Identification Systems, GP-E/NF (Becton Dickinson, Baltimore, Md., USA) were used to identify the microorganisms. Antibiotic susceptibilities were assessed by the Kirby-Bauer disc diffusion method according to the standards of the Clinical and Laboratory Standards Institute (CLSI). Bacterial isolates were identified by infectious disease specialists.

RESULTS

Five hundred and nine patients were hospitalized and followed between 1 November 2007 and 1 November 2008 in the ICU of the anesthesiology and reanimation clinic. The distribution of the patients by age is shown in Figure 1. The

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mean age of the patients was 41.0 ± 24.9 years (range, 2 months–91 years). Two hundred and nineteen (43.0%) of the patients were female. At the end of the 1-year period, there were 4,087 total patient days and the mean hospital stay in the ICU was 8.0 days. A total of 181 DANIs were identified during this period of time; their distribution is shown in Figure 2.

The rate of ventilator use was 0.87, the rate of central venous catheter (CVC) use was 0.93 and the rate of urinary catheter use was 0.98. The ventilator-associated pneumonia
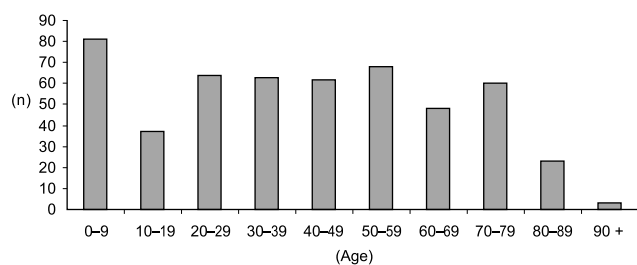

Fig. 1. Distribution of the patients who hospitalized in the ICU of anesthesiology and reanimation clinic by age. Total no. of patients, 509.
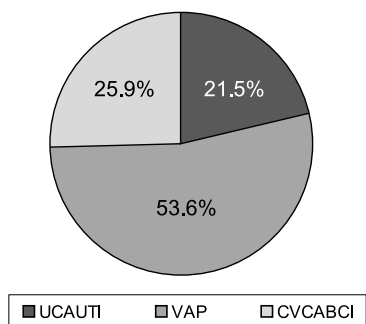

Fig. 2. Distribution of device-associated nosocomial infections (DANIs) in the ICU of Goztepe Research and Training Hospital. UCAUTI, urinary catheter-associated urinary tract infection; VAP, ventilator-associated pneumonia; CVCABCI, central venous catheter-associated blood circulation infection.

Table 1. Distribution of the microorganisms cause DANI in the ICU of Goztepe Research and Training Hospital

	VAP	CVCABCI	UCAUTI	Total (%)
Pseudomonas aeruginosa	29	8	1	38 (18.5)
Acinetobacter spp.	26	5	1	32 (15.6)
Escherichia coli	9	3	16	28 (13.7)
Candida spp.	13	1	11	25 (12.2)
MRCNS	7	10	1	18 (8.8)
Enterococci	4	5	8	17 (8.3)
MRSA	8	4	1	13 (6.3)
Stenotrophomonas maltophilia	5	4	–	9 (4.4)
Enterobacter spp.	3	5	–	8 (3.9)
Klebsiella spp.	3	–	2	5 (2.4)
MSCNS	2	3	–	5 (2.4)
MSSA	2	–	1	3 (1.5)
Proteus spp.	1	1	–	2 (1.0)
Streptococci	2	–	–	2 (1.0)
Total (%)	114 (55.6)	49 (23.9)	42 (20.5)	205 (100) (100)

MRCNS, methicillin-resistant coagulase-negative staphylococcus; MRSA, methicillin-resistant *Staphylococcus aureus*; MSCNS, methicillin-susceptible coagulase-negative staphylococcus; MSSA, methicillin-susceptible *S. aureus*.

Table 2. Antibiotic-resistant percentages of most frequently isolated *Pseudomonas aeruginosa* bacteria that are responsible for DANIs in ICUs

Antibiotic	Resistance (%)
Piperacillin-tazobactam	15.8
Amikacin	21.1
Imipenem	26.4
Ciprofloxacin	29.0
Ceftazidime	47.4
Cefepime	63.2

(VAP) rate in 1,000 ventilator days was 27.1, CVC-associated blood circulation infection (CVCABCI) rate in 1,000 CVC days was 11.8, and the urinary catheter-associated urinary tract infection (UCAUTI) rate in 1,000 urinary catheter days was 9.6. A total of 205 microorganisms were isolated in the 181 DANIs that developed within the study period. The most frequently detected agents were *Pseudomonas aeruginosa*, methicillin-resistant coagulase-negative staphylococcus (MRCNS) and *Escherichia coli* in VAP, CVCABCI, and UCAUTI, respectively. Furthermore, we detected more than one agent in 17.5% of the VAPs. Resistance against vancomycin was identified in an enterococcus strain responsible for one of the UCAUTIs. The distribution of isolated microorganisms as the agents of DANIs is shown in Table 1.

The bacterium that cause the most infection overall in the DANIs in the present study was *P. aeruginosa* (18.5%). The antibiotic-resistant percentages of *P. aeruginosa* bacteria are summarized in Table 2.

DISCUSSION

Nosocomial infections are one of the most important causes of mortality and morbidity as well as of the increase in health expenditures (4–6). Studies performed approximately 30 years ago in the United States show that surveillance in combination with an infection control program lowered nosocomial infections by 30% (7,8). It is now possible to compare the rate of invasive device use, nosocomial infections, agent pathogens, and resistance characteristics in ICUs using the NNIS and INICC databases as reference points (9,10).

When compared with NNIS data, the rates of invasive device use and DANIs in the present study were found to be at the 90th percentile or above for all ICUs in general, and the rates of VAP, CVCABCI, and UCAUTI were 2- or 3-fold higher than those reported by NNIS. When the present data were compared with those from INICC, it was determined that the rate of invasive device use was higher in the present study, while the rates of VAP and CVCABCI were similar to the mean values reported by INICC and the rate of UCAUTI was slightly higher. The antibiotic-resistance rates of DANI agent pathogens were higher than NNIS rates, but similar to INICC rates except for vancomycin-resistant enterococci (VRE), whose rates were lower than those reported by NNIS and INICC (9,10).

The rates of invasive device use and DANIs in the ICU of our hospital, as well as the resistance rates of certain microorganisms, were compared with the data from NNIS and INICC, and the results are shown in Table 3.

The infections rates, which are high compared to those reported by NNIS, might be attributed to the higher use of invasive devices and to surveillance and infection control programs, which were initiated many years ago in the United

Table 3. Comparison of invasive-device use, DANI and resistance rates of certain microorganisms in ICU of our hospital with data from NNIS and INICC

	ICU of our hospital	NNIS (1992–2004)	INICC (2002–2005)
Invasive-device use rate			
Ventilator use rate	0.87	0.43	0.38
Central venous catheter use rate	0.93	0.57	0.54
Urinary catheter use rate	0.98	0.78	0.73
In 1,000 device days			
VAP	27.1	5.4	24.1
CVCABCI	11.8	4.0	12.5
UCAUTI	9.6	3.9	8.9
Resistance rates of DANI agents (%)			
MRSA	81.2	59	84
Ceftriaxone-resistant *Enterobacteriaceae*	53.5	19	55
Ciprofloxacin-resistant *P. aeruginosa*	29	29	59
Vancomycin-resistant enterococcus	2.9	29	5

NNIS, National Nosocomial Infections Surveillance; INICC, International Nosocomial Infection Control Consortium.

States, but have only recently begun to be implemented in our country and in the countries contributing data to the INICC report. The high rate of invasive device use may be due to the fact that our ICU service is generally offered to traumatic patients. Data from NNIS indicating higher rates of invasive device use in ICUs for traumatic patients as compared to those in other ICUs corroborates this opinion.

An additional factor contributing to these high rates may be the fact that our hospital is a large training hospital. Richard et al. demonstrated that device use and DANI rates are high in training hospitals compared to non-training hospitals (11), and Inan et al. also report that their device use and DANI rates being higher than those reported by NNIS might have been related to their being a training hospital with high number of patient beds (12).

In studies performed by Leblebicioglu et al. (21) and Inan et al. (12) device use and infection rates were found to be similar with to each other, but higher than NNIS rates. When the present results were compared with those of these studies, it was noted that the rates of device use, except for urinary catheter, were higher, and that there was no significant difference in infection rates or the resistance characteristics of the agents except for the low rate of ciprofloxacin-resistant *P. aeruginosa*. Our results were also consistent with those of other studies performed in Turkey.

In studies performed in Argentina and Peru, VAP rates as high as 51, 46.2, and 31.3 were reported in 1,000 ventilator days (15–17).

In other developing countries as well, DANI results higher than those reported by NNIS have also been reported, though not as high as those from Argentina and Peru (18–20).

The differences and the reasons for the differences among DANIs rates in the ICUs of developed and developing countries were examined by Rosenthal et al. (10) and Leblebicioglu et al. (21) in developing countries and Turkey, respectively. Outdated technology, which is used less in developed countries than in developing countries, has also been shown to be a factor. For example, open intraveneous infusion systems are used almost universally in developing countries, but closed systems are the standard of care in developed countries (10). In studies performed in Turkey, long duration of device use and inappropriateness of the position of urine bags have been determined to be the most significant potential problems (10,21). In the present study as well, the high rates of device use were consistent with those described in the abovementioned study.

In a study performed in India (22), all results were low compared to those from the countries mentioned above, though not as low as those reported by NNIS.

In our ICU, the most frequently detected DANI agents were *P. aeruginosa* and *Acinetobacter* spp. It has been seen in various studies that these two microorganisms appear to be leading causes of VAP (13,23–25).

Studies performed on protected brush specimen (PBS) and bronchoalveolar lavage (BAL) specimens show that 20 to 50% of the etiology of VAPs is polymicrobial (26,27). This rate was found to be 17.5% in the present study.

The rate of ciprofloxacin-resistant *P. aeruginosa* in the present study was consistent with that reported by NNIS, but lower than that reported by INICC. These rates are high in Brazil, Peru, and Columbia, and have reached as high as 71.3% (17,18,20). Leblebicioglu et al., reporting on 13 ICUs in Turkey, found a rate of 51.1% (21). When the resistance rates against antibiotics such as imipenem, piperacillin, and tazobactam were evaluated within the scope of INICC, we found that the rates reported in studies performed in Brazil, Turkey, Columbia, Peru, and India were significantly higher than our resistance rates. Our methicillin-resistant *Staphylococcus aureus* (MRSA) rates were below the rates reported from Brazil, India, and Turkey, but slightly above the rates detected in Columbia and Peru. When vancomycin resistance among enterococcus isolates was evaluated, our rates were closer to the rates reported from the study by Leblebicioglu et al., but lower than NNIS rates (17,18,20–22).

In conclusion, DANI rates were evaluated in a prospective study in a large tertiary care hospital in Turkey. The present DANI rates were found to be higher than those reported by NNIS, but close to those reported by INICC. A comparison of data from hospitals with a surveillance program with data from hospitals in other countries will be helpful to reduce the rate of nosocomial infections.

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