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Device-associated hospital-acquired infection rates in Turkish intensive care units. Findings of the International Nosocomial Infection Control Consortium (INICC)

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KEYWORDS
Nosocomial infection; Healthcare associated infection; Device associated infection; Rates; Developing country; Europe; Intensive care unit; INICC

Summary We conducted a prospective study of targeted surveillance of healthcare-associated infections (HAIs) in 13 intensive care units (ICUs) from 12 Turkish hospitals, all members of the International Nosocomial Infection Control Consortium (INICC). The definitions of the US Centers for Disease Control and Prevention National Nosocomial Infections Surveillance System (NNISS) were applied. During the three-year study, 3288 patients for accumulated duration of 37 631 days acquired 1277 device-associated infections (DAI), an overall rate of 38.3% or 33.9 DAIs per 1000 ICU-days. Ventilator-associated pneumonia (VAP) (47.4% of all DAI, 26.5 cases per 1000 ventilator-days) gave the highest risk, followed by central venous catheter (CVC)-related bloodstream infections (30.4% of all DAI, 17.6 cases per 1000 catheter-days) and catheter-associated urinary tract infections (22.1% of all DAI, 8.3 cases per 1000 catheter-days). Overall 89.2% of all *Staphylococcus aureus* infections were caused by meticillin-resistant strains, 48.2% of the Enterobacteriaceae isolates were resistant to ceftriaxone, 52.0% to ceftazidime, and 33.2% to piperacilin—tazobactam; 51.1% of *Pseudomonas aeruginosa* isolates were resistant to fluoroquinolones, 50.7% to ceftazidime, 38.7% to imipenem, and 30.0% to piperacilin—tazobactam; 1.9% of *Enterococcus* sp. isolates were resistant to vancomycin. This is the first multi-centre study showing DAI in Turkish ICUs. DAI rates in the ICUs of Turkey are higher than reports from industrialized countries.

Introduction

Industrialized countries such as UK, USA, and others have adopted standards of institutional hospital-acquired infection surveillance and infection control.[1,2] The Centers for Disease Control and Prevention (CDC) Study of the Efficacy of Nosocomial Infection Control (SENIC) have showed the efficacy of surveillance to help to prevent healthcare-acquired infections (HAIs).[3]

A growing body of literature shows that HAIs are the major cause of patient morbidity and mortality in developed countries.[4] Device-associated infections (DAIs) represent the greatest threat in the ICU.[5] Surveillance of HAI has been well standardized by the CDC's Nosocomial Infection Surveillance System (NNISS).[6] Targeted surveillance and calculation of DAI rates per 1000 device-days allow benchmarking between similar institutions. Developed countries are major providers of most of the published studies of ICU-acquired infection,[1,2,7] whereas, developing countries provide relatively little data,[8–10] especially regarding DAI rates using standardized definitions.

The Turkish health system serves a population of 70 million, and hospital size varies from 50 to 1200 beds. Most are public hospitals, and approximately 10% are private. Generally, hospital and doctor-provided medical care are free of charge.[11] Establishing an infection control committee became a requirement in 1974 and regulations for general infection control policies in hospitals were published in 1983.[11,12] Hospital infection control has been performed in Turkey for the last 30 years. The structure and function of infection control committees and surveillance of hospital infections have been well defined, but the implementation of these efforts has not succeeded at a national level.[13] In 2005, hospital infection control committees were set up voluntarily together with the new governmental regulations for hospital infection control. From then on, all hospitals had to have a hospital infection control committee. Additionally, local guidelines, such as prevention of intravascular catheter-related infection[14] and prevention of urinary catheter-related infections,[15] have been published recently. A national project called NosoLINE, which was created in 1996, showed that the incidence of HAI varies from 1.0 to 8.6%, with most HAIs occurring in the ICU.[13] In Turkey a 1-day point prevalence study was carried out in 56 ICUs. A total of 115 patients (48.7%) had

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one or more ICU-related HAI; after a four-week follow-up, 70 (29.7%) patients died.[16]

The findings in Turkey presented in this manuscript are part of the International Infection Control Consortium (INICC) surveillance study, which reports data from 2002 through 2005. The consortium was founded in 1998, when selected hospitals from Latin America were invited to participate in the project.[8–10] Hospitals participating in the consortium provide general medical and surgical inpatient services to adults and children requiring acute care. The INICC has initially concentrated on assessing the effect of HAIs in hospitals level III. Standardized protocols have been used to collect all data from the participating hospitals.[6] Initially, we have focused on DAIs in adult, paediatric, and newborn ICUs.

The objective of the present study was to determine the incidence of DAI in the ICUs of Turkish hospitals in order to compare them with international standards, and to plan targeted infection control activities based on these data.

Materials and methods

Setting

This study was conducted in 13 ICUs from 12 hospitals of ten Turkish cities, 11 of the participating hospitals being university-teaching hospitals (91.6%), and one a municipally-supported public hospital (8.4%). Such ICUs are all medical–surgical units. Each hospital has an infection control team made up of a physician, an infection control practitioner–surveillance nurse (ICP), support personnel, and the person responsible for surveillance at each institution. All of them had at least two years of infection control experience (Table I). Each hospital team has electronic patient records available, and a clinical microbiology laboratory that provides *in vitro* susceptibility testing of clinical isolates using standardized methods.[17]

The study protocol was approved by the Institutional Review Board at each centre. Patient confidentiality was protected by coding the recorded information, which could only be identified by the hospital's infection control team.

Infection control practices

Beds are distributed in an open ward, without siderooms for patients. The nurse-to-patient ratio is one nurse per three patients. Hand hygiene

Table I Features of the 12 consortium hospitals and patients studied

	Hospital												Overall
	A	B	C	D	E	F	G	H	I	J	K	L	
No. of ICUs	1	2	1	1	1	1	1	1	1	1	1	1	13
Experience of ICP (years)	3	13	5	5	7	3	12	3	8	4	6	3	3–13
Surveillance period	10/03 to 04/06	9/03 to 12/05	6/04 to 4/06	1/04 to 1/06	1/04 to 1/06	8/03 to 10/04	1/04 to 2/06	5/05 to 1/06	1/04 to 8/04	9/05 to 12/05	2/04 to 5/04	10/05 to 3/06	8/03 to 04/06
No. of patients	656	479	412	343	337	317	310	220	53	34	21	106	3288
Patients-days	6512	6543	6154	3190	4313	3230	4106	1427	620	490	393	653	37 631
ASIS score, mean	4.47	2.46	3.61	2.55	3.11	4.11	3.59	3.44	3.68	3.47	3.10	3.27	3.47
Male sex (%)	61.4	56.3	73.2	62.2	64.2	53.9	53.0	65.5	50.9	67.6	52.4	61.3	61.0
Mean age (years)	51.9	52.5	42.1	49.2	47.9	59.0	46.1	39.7	58.1	57.5	65.6	59.06	49.86

ICU, intensive care unit; ICP, infection control practitioner; ASIS, average severity of illness score.

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resources vary depending on the hospital and ICU, and the use of sterile dressings on CVC insertion sites also ranges widely.[18,19] Most of the ICUs do not have isolation rooms for respiratory isolation. Poor hand hygiene compliance and ineffective isolation of patients are some of the main problems in Turkish hospitals.[19] Also potentially problematic are the long duration of invasive devices and poor positioning of the urinary collection bag.

Surveillance

An established infection control programme was already in place at each centre. Rates of CVC-associated bloodstream infection (BSI), catheter-associated urinary tract infections (CAUTI) and ventilator-associated pneumonia (VAP) were monthly assessed during the study. CDC NNIS definitions are applied.[6]

Training, validation and reporting

The forms designed and provided by INICC were used to collect surveillance data. Forms allow for internal validation, based on the new onset of fever, initiation of antibiotic therapy, cultures taken, or hypotension 48 h after admission. Previous studies have showed that these indicators statistically are significant predictive markers for the occurrence of HAI.[20]

Personal data as well as demographics, severity of illness score and hospital location were collected when the patient was admitted. The ICP collected data daily regarding mechanical ventilation, placement of CVC and urinary catheters, fever, blood pressure, antibiotic use, as well as the results of all imaging and cultures on each patient admitted to the ICU. If a patient acquired an HAI, the date of onset, site of HAI, infecting micro-organisms and their antimicrobial susceptibilities were also recorded.

The investigators in each member hospital were trained by the Consortium Founder and Director (V.D.R.). The Buenos Aires Central Office telephone and email address were available for investigators and support teams to resolve all their inquiries within 24 h. All queries and responses were further checked by INICC Director.

On a monthly basis, each participating hospital sent completed surveillance forms to the Central Office in Buenos Aires, where the validity of each case was checked against the recorded signs and symptoms of infection, laboratory and radiographic studies and cultures, so as to assure that the CDC NNIS criterion for DAI was met.[6]

Every month, the Central Office team prepared and sent full-performance reports containing charts and tables of their global DAI rates per 100 patients, and per 1000 bed days, DAIs per 1000 device-days, microbiology profile, bacterial resistance, extra mortality by type of DAI, extra length of stay, hand hygiene compliance, and CVC and urinary catheter care compliance to each participating hospital.

Statistical analysis

EpiInfo® version 6.04b (CDC, Atlanta, Georgia, USA) was used for data analysis. Device utilization rates were calculated by dividing the total number of device-days by the total number of patient-days. Rates of VAP, catheter-associated BSI, and 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.[21]

Results

Global rate of healthcare-associated infections

During the three-year study, 3288 patients hospitalized in an ICU for an aggregate 37 631days acquired 1277 DAIs, an overall rate of 38.3% or 33.9 infections per 1000 ICU-days. Distribution by type of DAI and device utilization are listed in Table II. Overall bacterial resistance is listed in Table III.

VAP

VAP rates ranged widely from 12–45.8 per 1000 ventilator-days, with an overall rate of 26.5 per 1000 ventilator-days (Table II). Overall, 29.2% of VAP were caused by *Acinetobacter* spp., 26.7% by *Pseudomonas* spp., 24.2% by *Staphylococcus aureus*; 14.9% by Enterobacteriaceae, 2.0% by *Candida* spp. and 3.0% by other micro-organisms.

CVC-associated BSI

BSI rates also ranged widely from 5.3–41.5 per 1000 catheter-days, with an overall rate of 17.6 per 1000 catheter-days (Table III). Overall 23.2% of BSI were caused by *Acinetobacter* spp., 23.2% by *S. aureus*, 19.6% by Enterobacteriaceae, 12.2%, by coagulase-negative *Staphylococcus*, 11.0% by *Pseudomonas* spp., 3.4% of BSI by *Candida* spp. and 7.3% by other micro-organisms.

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Table II Device-associated infections per 1000 devices days

Infection site	Device type	Device-days	Device utilization	Healthcare associated infection	Distribution of device associated HAI (%)	Rate per 100 patients	Rate per 1000 device-days
Ventilator-associated pneumonia	Mechanical ventilator	23 520	0.63	623	47.4	18.9	26.5
Central venous catheter-associated bloodstream infection	Central venous catheter	22 782	0.61	400	30.4	12.2	17.6
Catheter-associated urinary tract infection	Urinary catheter	35 237	0.94	291	22.2	8.9	8.3

CAUTI

CAUTI rates also ranged widely, from 0.7—18.1 per 1000 catheter-days, with an overall rate in the 8.3 per 1000 catheter-days (Table III). Overall 44.9% of CAUTI were caused by *Candida* spp., 24.9% by Enterobacteriaceae, 12.5% by *Pseudomonas* spp., 7.5% of CAUTI by *Acinetobacter* spp., 5.3% of CAUTI by *S. aureus* and 4.9% by other micro-organisms.

Discussion

This is the first multi-centre study showing DAI rates in selected Turkish ICUs. HAIs have been associated with significant patient morbidity and attributable mortality.[22—25] HAIs have also helped to increase healthcare costs.[23,25—27] The incidence of HAIs can be reduced by 30% and can, therefore, lead to a reduction in healthcare costs, as has been shown in studies carried out in the USA.[3]

The overall rate of HAIs of the participating hospitals was lower than those shown in other research performed locally. The present rate was 38.3/100 patients and 33.9/1000 patient-days; whereas the study of Cevik *et al*. in Turkey showed an overall rate of ICU-acquired HAI of 88.9/100 patients and 84.2/1000 patient-days.[28] Yologlu *et al*. showed similar results to the present study, with an overall rate of ICU-acquired HAI of 33/100 patients in the ICUs.[29] The study of Durmaz *et al*. found a lower rate of HAI in ICUs, as the infection rate was 12.5/100 patients.[30] The HAI distribution in the present study was: VAP (47.6%), CVC BSI (30.2%) and CAUTI (22.2%). Similarly, the most frequent HAI observed by Yologlu *et al*. in the ICU was pneumonia (42%).[29]

Although device utilization in the consortium's ICUs was similar to that reported from the USA, ICUs in the NNIS network, rates of DAI were higher than NNIS. The overall rate of CVC-associated BSI in the participating ICUs, which was 17.6 per 1000 CVC days, is nearly five times higher than the 3.4 per 1000 CVC-days reported from similar US ICUs by NNIS. The overall rate of VAP was also higher than pooled NNIS rates, 26.5 versus 5.1 per 1000 ventilator-days, similar to the rate of CAUTI, 8.3 as compared with 3.3 per 1000 catheter-days.[2]

Table III Overall susceptibility of micro-organisms (percentage resistant)

Micro-organisms	Antibiotic to which micro-organism is resistant	Percentage resistant
Staphylococcus aureus (MRSA)	Meticillin	89.2
Enterobacteriaceae	Ceftriaxone	48.2
Enterobacteriaceae	Ceftazidim	52.0
Enterobacteriaceae	Piperacillin—tazobactam	33.2
Pseudomonas aeruginosa	Ciprofloxacin	51.1
P. aeruginosa	Ceftazidim	50.7
P. aeruginosa	Imipenem	38.7
P. aeruginosa	Piperacilin—tazobactam	30.0
Enterococci	Vancomycin	1.9
Acinetobacter	Piperacilin—tazobactam	87.1

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Candida spp. were responsible for 44.9% of CAUTI. The high frequency of *Candida* spp. infection in the urinary tract is possibly related to the long duration of catheterization, and to the fact that most of the patients receive broad-spectrum antibiotics. Meticillin-resistant *S. aureus* (MRSA) is an important cause of HAI in Turkey. Prolonged hospitalization and exposure to broad-spectrum antibiotics increases the risk of infection with MRSA. The ICUs are multi-bedded rooms with no barriers between patients, and in most of the ICUs there are no isolation rooms, and thus few of the MRSA-infected patients can be isolated in side-rooms or small wards.

Overall, resistance is higher in Turkish ICUs as compared with ICUs in the US NNIS hospitals; *S. aureus* isolates resistant to meticillin compared with NNIS reports (89.2 versus 48.1%), Enterobacteriaceae resistant to ceftriaxone (48.2 versus 17.8%) and *P. aeruginosa* resistant to fluoroquinolones (51.1 versus 29.1%). There was a high rate of resistance to all major antibiotics commonly used in ICUs. Control of antibiotic resistance will require more restrictive use of anti-infectives, isolation and more effective HAI control.[31]

These are possible explanations for the higher DAI rates and bacterial resistance in developing country ICUs, some of which have been already suggested by previous investigators: lack of administrative and financial support, shortage of trained personnel, over-crowded wards and insufficient supplies.[32] Infection control guidelines are not well followed, national infection control surveillance and hospital accreditation are not mandatory, and most centres have highly variable hand hygiene compliance.[18,19,33]

The present study has several limitations. Other severity illness scores, such as APACHE, were not used because of lack of resources to calculate this score. As in other cohort studies, some of the hospitals began participating at different times, and in some surveillance was interrupted. For this reason, simultaneous data are not available for all the participating hospitals.

The first step towards the reduction of HAI risk in hospitalized patients is the surveillance of such infections,[3] and one of the next steps is to adopt basic infection control practices that have been shown to prevent HAIs.[34,35] We believe that the problem of DAIs in the participating INICC Turkish hospitals will provide the necessary stimulus for instituting change. This has already been shown when, at several INICC-member hospitals in different countries, hand hygiene compliance was substantially increased, along with care of invasive devices, which resulted in a significant reduction in the incidence of the overall rate of DAI and the specific rates of CVC-associated BSIs, CAUTIs and VAP.[36–41]

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