CONCISE COMMUNICATION

Device-Associated Nosocomial Infection Rates in Intensive Care Units in Greece

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Site-specific, risk-adjusted incidence rates of intensive care unit (ICU)-acquired infections were obtained through standardized surveillance in 8 ICUs in Greece. High rates were observed for central line–associated bloodstream infection (12.1 infections per 1,000 device-days) and ventilator-associated pneumonia (12.5 infections per 1,000 device-days). Gram-negative microorganisms accounted for 60.4% of the isolates recovered, and *Acinetobacter* species were predominant. To reduce infection rates in Greek ICUs, comprehensive infection control programs are required.

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Nosocomial infections (NIs) are associated with increased morbidity and mortality, as well as increased resource expenditure throughout the hospital, constituting a major worldwide public health problem.[1] Surveillance of NI has become an integral part of infection control in US hospitals, especially in intensive care units (ICUs), where the risk of infection is high.[2] The National Nosocomial Infection Surveillance (NNIS) System[3] provides hospitals with ICU type-specific device-related infection rates and device utilization ratios, which allow for intrahospital and interhospital comparisons. The ability to make meaningful comparisons of infection rates has proven to be a key component in reducing infection risk.[4] Similar standards have been implemented in Europe, and national ICU surveillance networks have developed.[5]

In contrast, surveillance data regarding ICU-acquired infections are limited in Greece. In the absence of a national surveillance program, the most recent data come from a prevalence study in 14 hospitals, which found a rate of 29.8 ICU-acquired infections per 100 patients.[6] Such data have been useful in establishing the scope and magnitude of NI problems, but they are difficult to use for intrahospital and interhospital comparisons. We therefore implemented the NNIS System's methodology to estimate the incidence of ICU-acquired infections and establish the first risk-adjusted, site-specific benchmarks in Greek ICUs.

METHODS

This prospective surveillance study was conducted in the ICUs of 4 university-affiliated hospitals and 4 community hospitals, scattered throughout Greece. The study protocol was approved by the institutional review board at each hospital, and patient confidentiality was protected. All participating ICUs were polyvalent, caring mainly for medical and surgical patients, with a minor mix of other types of patients, such as neurosurgical and trauma patients. All patients who were admitted to these units and presented an infection at least 48 hours after admission were surveyed until discharge. NIs were defined according to the Centers for Disease Control and Prevention criteria.[7] A standardized survey record form was used, based on the ICU component of the NNIS System.[3] The monthly totals of patients admitted, patient-days of ICU stay, deaths, days of device use, and days of antibiotic use were recorded in each ICU. Surveillance lasted for a mean period of 6 consecutive months.

Device and antibiotic use ratios were calculated by dividing the number of days of use by the number of patient-days. The total infection density rate was calculated as the number of infections per 1,000 patient-days, and the device-associated infection incidence density rate was calculated as the number of infections per 1,000 device-days. Ninety-five percent confidence intervals (95% CIs) for incidence rates were calculated on the basis of the Poisson distribution for rare events. Analysis was performed using SPSS software, version 13 (SPSS).

RESULTS

During the surveillance period, a total of 1,739 patients were admitted to the participating units, resulting in 17,551 patient-days and a mean length of stay of 10.1 days (range, 6.5-23.7 days). The overall device use ratios were 0.95 (range, 0.88-1.00) for central lines, 0.81 (range, 0.71-0.89) for ventilators, and 0.98 (range, 0.95-1.00) for urinary tract catheters. The antibiotic use ratio was 0.88 (range, 0.72-0.98). The crude mortality rate was 21.3% (range, 15.5%-28.5%).

A total of 501 NIs were detected in 320 (18.4%) patients during their ICU stays, resulting in an overall infection rate of 28.5 infections per 1,000 patient-days (95% CI, 26.1-31.2). Three infection sites represented 87.6% of all infections; the greatest percentage of infections (40.3%) occurred in the bloodstream, followed by the lungs (35.3%) and the urinary tract (12.0%). All infections at these sites were associated with the use of invasive devices.

Two hundred and eighty-five (16.4%) of the patients presented a device-associated infection during their ICU stay, resulting in 439 infections. These patients had a median age of 63 years (range, 15-93 years), and 67% were male. The median length of ICU stay was 24 days (range, 3-100 days), and the crude mortality rate was 33.3% (range, 25.0%-38.8%).

Device-associated infection rates varied widely among ICUs, ranging from 7.5 to 23.1 cases of central line–associated

TABLE 1. Device-Associated Infection Rates in Intensive Care Units at 8 Hospitals in Greece

Device-associated infection	No. of device-days	Device utilization ratio	No. of device-associated infections per 1,000 device-days			
			Pooled mean (95% CI)	Quartile		
				25%	50%	75%
CL-BSI	16,652	0.95	12.1 (10.5-13.9)	9.9	11.6	15.1
VAP	14,196	0.81	12.5 (10.7-14.4)	9.5	11.3	13.1
CA-UTI	17,203	0.98	3.5 (2.7-4.5)	2.0	3.2	5.5

NOTE. Data are for 1,739 patients, involving 17,551 patient-days. CA-UTI, urinary catheter–associated urinary tract infection; CI, confidence interval; CL-BSI, central line–associated bloodstream infection; VAP, ventilator-associated pneumonia.

bloodstream infection (BSI) per 1,000 central line–days (pooled mean, 12.1 [95% CI, 10.5-13.9]); from 3.0 to 36.9 cases of ventilator-associated pneumonia per 1,000 ventilation-days (pooled mean, 12.5 [95% CI, 10.7-14.4]); and from 0.5 to 7.7 cases of urinary catheter–associated urinary tract infection (UTI) per 1,000 urinary catheter–days (pooled mean, 3.5 [95% CI, 2.7-4.5]) (Table 1).

Microbiological data were provided by 7 units, and overall findings, in terms of percentages of all isolates recovered, are shown in Table 2. A greater percentage of infections were caused by gram-negative microorganisms (60.4%) than by gram-positive microorganisms (39.6%). In particular, coagulase-negative staphylococci (25.4% of infections) and *Acinetobacter* species (20.7% of infections) accounted for almost half of reported isolates in cases of central line–associated BSI. *Acinetobacter* species were the microorganisms most frequently implicated in cases of ventilator-associated pneumonia (28.0% of infections), followed by *Pseudomonas* species (23.2% of infections). Among the gram-negative microorganisms implicated in indwelling catheter–associated UTI, *Pseudomonas* species (14.9% of infections) and *Klebsiella* species (12.8% of infections) were the most frequently isolated; among the gram-positive microorganisms implicated in catheter-associated UTI, *Enterococcus* species (17.0% of infections) and *Streptococcus* species (17.0% of infections) were the most frequently isolated.

DISCUSSION

This study revealed that NI constitutes a significant problem in our ICUs, occurring in 18.4% of admitted patients, with an overall mean rate of 28.5 infections per 1,000 patient-days. Our results are comparable to those reported from local studies in neighboring countries, such as Italy and Turkey.[8,9] However, our overall rate is considerably higher than the US national mean rate (16.2 infections per 1,000 patient-days) in comparable medical-surgical ICUs.[5]

Consistent with several other studies,[2,10] we found that the bloodstream, lungs, and urinary tract were the major sites of NI that constituted the problem in our ICUs, representing 88% of all NIs. Most importantly, we found that all infections at these sites were device related. Thus, our results emphasize the impact of device use on the development of infection in our ICUs and point out that surveillance efforts should target the 3 major sites of infection and examine infection rates

TABLE 2. Distribution of Isolates Recovered From Patients With Device-Associated Infections in Intensive Care Units at 7 Hospitals in Greece

Pathogen, by class	Percentage of isolates, by type of infection		
	CL-BSI (n = 193)	VAP (n = 125)	CA-UTI (n = 47)
Gram-negative			
Pseudomonas species	8.3	23.2	14.9
Acinetobacter species	20.7	28.0	6.4
Klebsiella species	14.5	1.6	12.8
Escherichia coli	1.0	3.2	6.4
Stenotrophomonas maltophilia	0.0	2.4	0.0
Enterobacter species	2.6	3.2	8.5
Serratia marcescens	1.0	4.0	0.0
Other	3.1	6.4	10.6
Gram-positive			
Coagulase-negative *Staphylococcus* species	25.4	1.6	6.4
Staphylococcus aureus	2.6	13.6	0.0
Enterococcus species	13.0	4.8	17.0
Streptococcus species	4.1	5.6	17.0
Other	1.6	0.8	0.0
Candida species	2.1	1.6	0.0

NOTE. CA-UTI, urinary catheter–associated urinary tract infection; CL-BSI, central line–associated bloodstream infection; VAP, ventilator-associated pneumonia.

after controlling for a main extrinsic risk factor (ie, exposure to invasive devices).

The use ratios for central lines, mechanical ventilators, and urinary catheters in the ICUs we studied were all greater than the 90th percentiles reported by all types of ICUs participating in the NNIS System.[11] These discrepancies are large enough to warn that device use in our ICUs deserves further investigation. Invasive procedures have been reported as the most important factors for infection and mortality.[12] Prevention strategies, such as the more common use of noninvasive ventilation methods and earlier removal of central venous catheters, may help to decrease NI rates in our ICUs.

Moreover, the overall device-associated infection rates in the ICUs we studied were much higher, compared with rates in comparable medical-surgical ICUs participating in the NNIS System, for both ventilator-associated pneumonia (12.5 vs 5.4 infections per 1,000 patient-days) and central line–associated BSI (12.1 vs 4.0 infections per 1,000 patient-days).[11] For central line–associated BSI, our overall rate was even higher than the 90th percentile rates for all types of ICUs participating in the NNIS System.

A particularly low rate of urinary catheter–associated UTI was observed in this study, despite a high ratio of urinary catheter use. The mean rate of UTI (3.5 cases per 1,000 urinary catheter–days) was less than the average rates reported for most ICU subspecialties participating in the NNIS System.[11] Low UTI rates have been consistently reported in previous studies from several hospitals in Greece.[6,13] The high antibiotic use ratio (0.88) could be a factor contributing to the low UTI rates observed in this study.

More than half of infections in ICUs are caused by gram-negative bacteria,[10] and our data are consistent with these findings. However, the distribution of pathogenic microorganisms tends to vary between different ICU studies carried out in different countries. In contrast to the medical-surgical ICUs participating in the NNIS System,[2] *Pseudomonas, Acinetobacter,* and *Klebsiella* species constitute the major pathogens in our ICUs, whereas coagulase-negative staphylococci and *Staphylococcus aureus* are isolated less frequently. Similar departures from the NNIS data have been reported in Turkey.[9] The most interesting microbiological finding of this study was that *Acinetobacter* species are endemic in our ICUs. The presence of this pathogen in significant numbers is caused mainly by infection control shortcomings that require appropriate surveillance and control policies.[14]

Several differences between US and Greek hospital infection control policies may help to explain the marked disparities in infection rates. Although there is a central infection control committee at the Greek ministry of health responsible for issuing global guidelines and coordinating the activities of the local hospital infection control teams, there is no requirement that each hospital have its own infection control program. This has resulted in the absence of written and approved individual infection control programs from almost all Greek hospitals. Moreover, the lack of ongoing surveillance programs and the subsequently limited knowledge regarding NI rates in Greek institutions reduce the possibility of implementing targeted infection control measures and changing current hospital practices or improving compliance with published guidelines.

Another critical factor for the development of NI in our ICUs is understaffing. The nurse-to-patient ratio in our units (0.59) is relatively low, compared with that seen in most US ICUs. Studies of catheter-associated BSI have consistently demonstrated a higher infection risk associated with lower nurse-to-patient ratios and with inexperienced nursing practitioners.[15,16]

In conclusion, this study found high incidence rates of device-related infection, particularly for central line–associated BSI and ventilator-associated pneumonia, and high ratios of invasive device use in participating ICUs. To reduce infection rates and improve quality of care in Greek ICUs, comprehensive infection control programs are required.

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