



Device-associated infection rates and extra length of stay in an intensive care unit of a university hospital in Wroclaw, Poland: International Nosocomial Infection Control Consortium's (INICC) findings

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Abstract

Purpose: The aim of this study was to determine device-associated health care–associated infections (DA-HAI) rates, microbiologic profile, bacterial resistance, and length of stay in one intensive care unit (ICU) of a hospital member of the International Nosocomial Infection Control Consortium (INICC) in Poland.

Materials and Methods: A prospective DA-HAI surveillance study was conducted on an adult ICU from January 2007 to May 2010. Data were collected by implementing the methodology developed by INICC and applying the definitions of DA-HAI provided by the National Healthcare Safety Network at the US Centers for Disease Control and Prevention.

Results: A total of 847 patients hospitalized for 9386 days acquired 206 DA-HAIs, an overall rate of 24.3% (95% confidence interval [CI], 21.5–27.4), and 21.9 (95% CI, 19.0–25.1) DA-HAIs per 1000 ICU-days. Central line–associated bloodstream infection rate was 4.01 (95% CI, 2.8–5.6) per 1000 catheter-days, ventilator-associated pneumonia rate was 18.2 (95% CI, 15.5–21.6) per 1000 ventilator-days, and catheter-associated urinary tract infection rate was 4.8 (95% CI, 3.5–6.5) per 1000 catheter-days. Length of stay was 6.9 days for those patients without DA-HAI, 10.0 days for those with central line–associated bloodstream infection, 15.5 days for those with ventilator-associated pneumonia, and 15.0 for those with catheter-associated urinary tract infection.

Conclusions: Most DA-HAI rates are lower in Poland than in INICC, but higher than in the National Healthcare Safety Network, expressing the feasibility of lowering infection rates and increasing patient safety. © 2011 Elsevier Inc. All rights reserved.

1. Introduction

In most developed countries, including the United States, as well as several other high-income countries, the device-associated health care–associated infection (DA-HAI)

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surveillance in the intensive care unit (ICU) is a major, effective tool to reduce and control the incidence of DA-HAI in the hospital setting, enabling a genuine improvement in patient safety and the reduction and/or avoidance of their adverse consequences [1]. In this respect, it was reported by the Centers for Disease Control and Prevention (CDC) Study of the Efficacy of Nosocomial Infection Control that surveillance plays an essential role in the reduction of DA-HAIs [2].

Increasingly, a large amount of scientific literature demonstrates that DA-HAIs are among the main threats to patient safety in the ICU, including patient morbidity and mortality [3-5]. The CDC's previous National Nosocomial Infection Surveillance System and current National Healthcare Safety Network (NHSN) have established the standardized criteria for DA-HAI surveillance [6,7]. Using a standardized methodology allows for the determination of DA-HAI rates per 1000 device-days that can be used as benchmarks among health care centers and provides infection control practitioners with an in-depth look at the institutional problems they are confronted with, so they can design an effective strategy to solve them.

In the context of an expanded framework for DA-HAI control, most of the relevant studies of ICU-acquired infections have been carried out in the industrialized countries [8]. In the developing countries, however, few published studies report on the data of DA-HAI rates by means of using standardized definitions [9-17].

The International Nosocomial Infection Control Consortium (INICC) was founded in 1998 when selected hospitals from Latin America were invited to participate in the project to measure DA-HAI using standardized definitions and methodology [18]. Shortly afterward, other hospitals located in different parts of the world joined the consortium. Nowadays, the INICC comprises a worldwide network of 40 countries of Latin America, Asia, Africa, and Europe [9-17]. The findings of this study on Poland form an integral part of INICC and reflect the outcome and process surveillance data that were systematically collected.

2. Methods

2.1. Setting

The study was carried out in an ICU at the University Hospital of Wrocław, a tertiary care teaching hospital in Poland, from January 2007 to May 2010. The hospital has 800 beds, and the participant ICU (medical-surgical) has 15 beds. The hospital has an infection control team composed of 5 physicians and an infection control practitioner with more than 10 years of experience in infection control. The clinical microbiology laboratory provides *in vitro* susceptibility testing of clinical isolates using standardized methods. The hospital institutional review board approved the study protocol. Patient confidentiality was protected by codifying

the recorded information, making it only identifiable to the infection control team.

2.2. Surveillance

On a daily basis, data were collected prospectively from all the patients admitted to the ICUs by means of specifically designed forms. The data were gathered according to the DA-HAI definitions provided by the CDC-National Nosocomial Infection Surveillance System and CDC-NHSN, [6,7] and the methodology of INICC [18].

2.3. Collection of specimens

Central line [CL]-associated bloodstream infection (CLA-BSI). Central lines were removed aseptically, and the distal 5 cm of the catheter was amputated and cultured using a standardized semiquantitative method [19]. Concomitant blood cultures were drawn from the lines before the removal and percutaneously in nearly all cases.

Ventilator-associated pneumonia (VAP). In all cases, a deep tracheal aspirate or a small-volume, protective bronchoalveolar-lavage (mini bronchoalveolar-lavage) by endotracheal tube was done and cultured aerobically and anaerobically and was gram stained.

Catheter-associated urinary tract infection (CAUTI). A urine sample was aseptically aspirated from the sampling port of urinary catheter and cultured quantitatively.

In all cases, standard laboratory methods were used to identify microorganisms, and a standardized susceptibility test was performed [20].

2.4. Device-associated infections rates calculation

Outcomes measured during the surveillance period included the incidence density rate of CLA-BSI (number of cases per 1000 central venous catheter days), of CAUTI (number of cases per 1000 urinary catheter days), and of VAP (number of cases per 1000 mechanical ventilator [MV] days).

DA-HAI rates of VAP, CLA-BSI, and CAUTI per 1000 device-days were calculated by dividing the total number of DA-HAI by the total number of specific device-days and multiplying the result by 1000 [21].

Device utilization ratios were calculated by dividing the total number of device-days by the total number of patient-days. Device-days is the total number of days of exposure to the device (CL, ventilator, or urinary catheter) by all of the patients in the selected population during the selected time period. Patient-days is the total number of days that patients are in the ICU during the selected time period [21].

2.5. Length of stay calculation

The length of ICU stay (LOS) is recorded for each infected and uninfected patient, and the timing of the onset of

Table 1 Characteristics of the ICU at the University Hospital of Wrocław

Patients studied, n	847
Total ICU-days	9386
Device use ^a	
Ventilator days	7089
Ventilator use	0.76
CL-days	8725
CL use ^a	0.93
Urinary catheter-days	8720
Urinary catheter use	0.93

^a Device use ratios were calculated by dividing the total number of device-days by the total number of patient-days. Device-days is the total number of days of exposure to the device (CL, MV, or urinary catheter) by all of the patients in the selected population during the selected time period. Patient-days is the total number of days that patients are in the ICU during the selected time period.

DA-HAI is recorded. The effect of DA-HAI on LOS has been estimated by comparing patients with and without DA-HAI in the same ICU during the surveillance period. The excess LOS is the difference between the LOS of patients with a DA-HAI and the LOS of patients hospitalized in the ICU during that period who did not acquire a DA-HAI. Tables (2×2) and *t* test for continuous variables were used to analyze the differences among LOS. Relative risk (RR) ratios, 95% confidence intervals (CIs), and *P* values were determined for LOS analysis [18].

2.6. Statistical analysis

EpiInfo version 6.04b (CDC, Atlanta, Ga) and SPSS 16.0 (SPSS Inc [an IBM company], Chicago, Ill) were used to conduct data analysis.

χ^2 analyses for dichotomous variables and *t* test for continuous variables were used to analyze baseline differences among rates. Relative risk ratios, 95% CIs, and *P* values were determined for all outcomes.

3. Results

From January 2007 to May 2010, during the 3 years and 4 months of study, surveillance data were prospectively

Table 3 Excess LOS of patients with device-associated infections at the University of Wrocław Medical Center from January 2007 to May 2010

	Average LOS	Extra LOS	95% CI	RR
Patients without infection, d	6.9	–	5.8-8.5	1.0
Patients with CLA-BSI, d	10.0	3.1	3.2-87.7	1.4
Patients with VAP, d	15.5	8.6	6.4-56.9	2.2
Patients with CAUTI, d	15.0	8.1	4.5-132.6	2.2

collected on 847 patients hospitalized in medical-surgical ICUs for 9386 ICU-days. The number of ICU-days, device use days, and device use are shown in Table 1.

The patients acquired 206 DA-HAIs, giving an overall rate of 24.3% (95% CI, 21.5-27.4) or 21.9 DA-HAIs per 1000 ICU-days (95% CI, 19.0-25.1). Ventilator-associated pneumonia was the most commonly encountered type of infection, accounting for 63% of all DA-HAIs, followed by CAUTI at 20% and CLA-BSI at 17% (Table 2).

The CLA-BSI rate was 4.01 per 1000 CL-days (95% CI, 2.8-5.6; Table 2). Similarly, LOS was longer in patients with CLA-BSI compared with those without DA-HAI (10.0 days; 95% CI, 3.2 vs 6.9 days; 95% CI, 5.8-8.5), yielding an extra LOS of 3.1 days (RR, 1.40; Table 3).

As for VAP, the rate was 18.2 per 1000 MV-days (95% CI, 15.5-21.6; Table 2). The LOS of patients with VAP was 15.5 days (95% CI, 6.4-56.9), yielding an extra LOS of 8.6 days (RR, 2.20; Table 3).

The CAUTI rate was 4.8 per 1000 UC-days (95% CI, 3.5-6.5; Table 2). The LOS of patients with CAUTI was 15.0 days (95% CI, 4.5-132.6), yielding an LOS of 6.9 days (RR, 2.16; Table 3).

See bacterial resistance in Table 4.

4. Discussion

In the developing world, DA-HAIs are considered a primary and serious threat to patient safety and are associated to patient morbidity and attributable mortality [9-17]. Moreover, DA-HAIs have also been reported as one considerable factor contributing to an increase in health

Table 2 Device-associated infections rates (VAP, CLA-BSI, and CAUTI) at the University Hospital of Wrocław from January 2007 to May 2010

Infection site	Device type	Device-days	DA-HAI	Distribution of DA-HAI (%)	Rate per 100 patients	Rate per 1000 device-days ^a
VAP	MV	7089	129	62.6%	15.2%	18.2 (15.5-21.6)
CLA-BSI	CL	8725	35	17.0%	4.1%	4.01 (2.8-5.6)
CAUTI	UC	8720	42	20.4%	0.5%	4.8 (3.5-6.5)

UC indicates urinary catheter.

^aRate per 1000 device-days: rates were calculated by dividing the total number of DA-HAIs by the total number of specific device-days by all of the patients in the selected population during the selected time period and multiplying the result by 1000.

Table 4 Bacterial resistance of DA-HAIs

Pathogen, antimicrobial	Resistance percentage
<i>Staphylococcus aureus</i> : methicillin	30
Coagulase-negative <i>Staphylococci</i> : methicillin	100
<i>Pseudomonas</i> spp.	
Ceftazidime	50
Ciprofloxacin	35.7
Ceftazidime	50
Imipenem	28.6
<i>Enterobacter</i> spp.	
Ceftazidime	53.8
<i>Klebsiella</i> spp: ceftazidime	13.3
<i>Acinetobacter</i> spp: piperacillin-tazobactam	44
<i>Escherichia coli</i> : ceftazidime	14.3

University of Wroclaw Medical Center, from January 2010 to May 2010.

care costs [9,10,22,23]. However, it has been shown in several research studies conducted in the United States that the incidence of DA-HAI can be reduced by as much as 30%, which would result in correlative reduced health care costs. It is noteworthy that US hospitals that were able to reduce their DA-HAI rates relied on strategies developed by their infection control programs, which included targeted device-associated surveillance [2]. In addition, compliance with hand hygiene has been found to be an effective and essential tool to any infection control intervention.

In a previous study from Poland, the HAI prevalence per 100 patients in the ICUs was as high as 23.9% (95% CI, 23.0-24.8), which is similar to our DA-HAI rate of 24.3% (95% CI, 21.6-27.4). Also, as in our present study, VAP was the most common infection [24].

The CLA-BSI rate was 4.01 (95% CI, 2.8-5.6) per 1000 CL-days in this study, which is lower than the INICC report rate (7.4 per 1000 CL-days), but higher than the NHSN rate 1.5 (95% CI, 1.4-1.6). However, VAP rate was higher in this study (18.2 per 1000 MV-days, [95% CI, 15.5-21.6]) than the one in the INICC report (14.7 per 1000 MV-days [95% CI, 14.2-15.2])[12] and higher than the NHSN rate as well (1.9 per 1000 MV-days [95% CI, 1.8-2.1]). The CAUTI rate was 4.8 (95% CI, 3.5-6.5) per 1000 catheter-days in this study, which is comparable with the 6.1 rate (95% CI, 5.9-6.4) of overall INICC ICUs, [12] and higher than the 3.1 of NHSN rate (95% CI, 3.0-3.3).

The average LOS of patients without DA-HAI, with CLA-BSI, and with VAP was similar in this study to the overall INICC ICUs [12].

Several factors have probably contributed to the observed DA-HAI rates in this study, many of which are particular to the country and to the hospital setup itself. First, in Poland, guidelines on specific infection control practices are in place, but national infection control surveillance in ICUs is not conducted. Practice bundles for the prevention of DA-HAI have now become central to the care of patients in the ICU. Other hospitals in the country are also working toward

accreditation. In addition, national accreditation by the Ministry of Health has become mandatory. Second, in Poland, as in most developing countries, administrative and financial support is limited, which almost inevitably results in limited funds and resource availability to deal with infection control [25]. Third, there are insufficient supplies, and wards are overcrowded. Fourth, there is a lower nurse-to-patient ratios compared with US hospitals, which has also been associated with increased risk of DA-HAI [26]. Finally, and unlike in US hospitals, our DA-HAI rates might be higher than NHSN rates because the ICU at our center admits many patients who are terminally ill with advanced chronic illnesses and who receive multiple courses of antibiotics and are colonized and/or infected with multidrug resistant pathogens.

The first step that would contribute to a reduction in DA-HAI risk in hospitalized patients is the institution of surveillance of DA-HAI [2]. Next, basic but effective infection control practices need to be adopted for improving the prevention of DA-HAIs [27-30]. Needless to say, shared knowledge and accurate information on this serious problem in hospital ICUs can be highly motivating for developing effective high-quality infection control strategies. In this regard, there is evidence from several centers in INICC suggesting positive modifications in hospital practices: substantial increase in hand hygiene compliance, institution of performance feedback programs for hand hygiene, and subsequent significant reduction in CLA-BSI, CAUTIs, and VAP rates [14,31-36].

However, the present study presents many limitations, the first one being the fact that these data may not be generalized to primary or other tertiary medical centers in Poland. For 3 years and 4 months, we have prospectively collected data as an integral part of the implementation of a comprehensive surveillance system in 1 ICU from a Polish hospital. There is a likelihood that the efficacy of surveillance could have affected the observed rates, which constitutes a possible bias. In addition, variations in DA-HAI rates among the INICC member hospitals and between countries might be accounted for by heterogeneity in the patient populations, the severity of illness, and the efficacy of infection control interventions. Third, processing and interpretation of culture specimens are currently being performed at individual member hospitals' laboratories rather than at a central laboratory. However, most laboratories follow the CLSI criteria and definitions so that variability is kept at a minimum.

In conclusion, DA-HAIs pose a huge and largely underrecognized threat to patient safety in the developing countries. In Poland, the rates of most DA-HAIs are lower than INICC rates but higher than NHSN rates, emphasizing that there is still room for improvement to lower infection rates and provide safer care to patients. Through continued and systematic surveillance, health care personnel at INICC member hospitals are provided with simple but effective and inexpensive preventive strategies [14,31-37]. We expect that this results in wider acceptance of infection control programs

in all hospitals members of the consortium, thereby leading to significant reductions in DA-HAI rates, particularly in the ICU setting. For that reason, as in the case of this Polish hospital, any hospital may participate in the INICC network, which was created in an understanding of the paramount need from developing countries to significantly prevent, control, and reduce DA-HAI and their adverse consequences. In INICC, not only are investigators freely provided with training and methodological tools to conduct outcome and process surveillance, but through the publication of these confidentially collected data, relevant scientific evidence-based literature is fostered as well.

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