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Reduction and surveillance of device-associated infections in adult intensive care units at a Saudi Arabian hospital, 2004–2011

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SUMMARY

Background: Device-associated infections (DAI) are recognized as a marker of patient safety. Data regarding DAI rates in Saudi Arabia are sparse.
Methods: This was a prospective surveillance study of DAI rates conducted in the adult intensive care units of the Saudi Aramco Medical Services Organization, carried out using the DAI definition provided by the Centers for Disease Control and Prevention's National Healthcare Safety Network. DAI prevention bundles were introduced in 2006 for ventilator-associated pneumonia (VAP), in mid-2010 for catheter-associated urinary tract infections (CAUTI), and in 2008 for central line-associated blood stream infections (CLABSI).
Results: DAI rates for VAP, CLABSI, and CAUTI are reported for the study period from 2004 to 2011. CAUTI was the most common DAI (42.2%), followed by CLABSI (38.5%) and VAP (19.3%). The overall rate of each infection type per 1000 device-days was 8.18 for CAUTI, 10 for CLABSI, and 4.52 for VAP. Annual DAI rates showed a significant reduction over time from the beginning of the study to the end of the study for CLABSI (16.3 vs. 6.06), CAUTI (6.75 vs. 3.41), and VAP (9.8 vs. 1.3) ($p < 0.05$).
Conclusions: CAUTI was the most common infection, and the use of DAI prevention bundles was associated with a significant decrease in DAI rates over time.

1. Introduction

Device-associated infections (DAIs) are associated with an increased length of hospital stay, added costs, and increased morbidity and mortality.[1,2] Measurements and improvements in DAI are important quality improvements and patient safety goals as set by international organizations such as the Infectious Diseases Society of America (IDSA) and the Society for Healthcare Epidemiology of America (SHEA).[3] The most commonly used program for inter-hospital comparison is the National Healthcare Safety Network (NHSN).[4] The utilization of NHSN identifies areas to target for future improvements rather than just providing a comparison.[5] A previous study showed no significant difference in catheter-associated blood stream infection (CLABSI) rates between non-US and US hospitals.[6] Other studies have shown variations in the rates of DAI between the NHSN data and the International Nosocomial Infection Control Consortium (INICC).[7] These differences were thought to be secondary to inadequate compliance with infection control guidelines, low compliance with hand hygiene, and a lack of administrative and financial support.[7]

There are few data regarding DAI rates in Saudi Arabia. Studies have been limited to a specific unit or to a specific device.[8–11] One study included multiple DAI rates from various units.[11] Thus, we undertook this prospective study to evaluate the trends in DAI over time and to calculate the impact of the implementation of bundles for the prevention of DAI.

2. Materials and methods

The study was conducted in the adult intensive care units of the Saudi Aramco Medical Services Organization (SAMSO). SAMSO has a 10-bed medical ICU (MICU), a 10-bed surgical ICU (SICU), and an eight-bed coronary ICU (CCU). We collected data related to device

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information and the number of device-days and patient-days in each unit.

2.1. Definition of device-associated healthcare-associated infections (DA-HAI)

The diagnosis of DAI was based on the NHSN definitions.[4] The specific criteria for each diagnosis of DA-HAI are listed below.

VAP was identified using a combination of radiologic, clinical, and laboratory criteria. VAP was considered present in patients on mechanical ventilation with a chest X-ray showing a new or progressive infiltrate, consolidation, cavitation, or pleural effusion. Clinical criteria included at least one of the following: new onset of purulent sputum, a change in character of sputum, and isolation of a bacterial agent from tracheal aspirate/brushing or bronchoalveolar lavage.

CLABSI was defined as a laboratory-confirmed infection in a patient with a central line in place for ≥48 h who had a recognized pathogen isolated from one or more percutaneous blood cultures, and when the infection was not related to an infection at another site. Isolation of the same organism (i.e., identical species and antibiogram) from a semi-quantitative or quantitative culture of a catheter segment and from the blood (preferably drawn from a peripheral vein) of a patient with accompanying clinical symptoms of BSI (fever >38 °C, chills, or hypotension) and no other apparent source of infection was required. For common skin contaminants including diphtheroids (*Corynebacterium spp*), *Bacillus spp* (not *Bacillus anthracis*), *Propionibacterium spp*, coagulase-negative staphylococci (including *Staphylococcus epidermidis*), viridans group streptococci, *Aerococcus spp*, and *Micrococcus spp*, two or more blood cultures drawn on separate occasions were required to be positive.

CAUTI was defined in a patient with a urinary catheter in place exhibiting either one of the following two criteria: (1) one or more of the following signs and symptoms with no other recognized cause: fever (temperature >38 °C), urgency, supra-pubic tenderness, and urine culture $\geq 10^5$ CFU/ml, with no more than two species of microorganism isolated; or (2) positive dipstick analysis for leukocyte esterase or nitrate and pyuria (urine specimen with ≥10 white blood cells/mm^3 or ≥3 white blood cells/high-power field of unspun urine), microorganisms seen on Gram stain of unspun urine, and a positive urine culture of $\geq 10^3$ and $<10^5$ CFU/ml with no more than two species of microorganism isolated

2.2. Device utilization ratio (DUR) and DA-HAI rates

The device utilization ratio (DUR) for each device (central line, ventilator, and urinary catheter) was calculated as the number of device-days divided by the total number of patient-days in each ICU. DAI rates per 1000 device-days were calculated as the number of infections for each device divided by the total number of device-days in each ICU. Thus, risk adjustment was done by type of ICU, type of invasive device, and by adjusting the rate per 1000 device-days.[3,10] Data were collected from January 2004 to December 2011. Annual trends were presented for each type of DAI. A *p*-value of ≤0.05 was considered significant.

The bundle for CAUTI was implemented in mid-2010 and that for CLABSI was started in 2008. The bundles were those of the Institute for Healthcare Improvement.[12–14] In addition, the interventions included a multifaceted approach to the prevention of HAI and included education of healthcare workers about HAI and the bundle, implementation of the bundle, surveillance and feedback of HAI on a monthly basis through direct communication as well as dissemination of information through the hospital intranet, and feedback on compliance with the bundles.

2.3. Statistical analysis

Data analyses were done using PASW Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, USA). To compare the trends in the infection rates over the years, we used the comparison of more than two samples proportion test. To compare the means of two different times, we used the comparison of two samples means using the *t*-test.

3. Results

During the study period of 2004–2011, CAUTI was the most common DAI (42.2%), followed by CLABSI (38.5%) and VAP (19.3%). The overall rate of each infection type per 1000 device-days was 8.18 for CAUTI, 10 for CLABSI, and 4.52 for VAP. The CLABSI rate was

Table 1
Central line-associated blood stream infections (CLABSI) and device utilization ratios in three adult intensive care units, and a comparison with National Healthcare Safety Network (NHSN) data (from reference 15)

Variable	Study data					NHSN data			
	Total	95% CI	10th	50th	90th	Total	10th	50th	90th
Cardiac care unit									
No. of device-days	4133					436 409			
No. of patient-days	15 733					1 096 749			
No. of infections	37					876			
Device utilization ratio	0.26	0.18–0.33	0.18	0.24	0.36	0.4	0.18	0.39	0.61
CLABSI rate/1000 catheter-days	8.95	3.07–15.77	3.93	7.54	17.38	2.01	0	1.3	4.6
Surgical ICU									
No. of device-days	8833					729 989			
No. of patient-days	14 299					1 230 430			
No. of infections	48					1683			
Device utilization ratio	0.62	0.5–0.73	0.46	0.63	0.77	0.59	0.35	0.62	0.77
CLABSI rate/1000 catheter-days	5.43	2.47–8.88	2.25	5.75	9.03	2.31	0	1.7	5
Medical ICU									
No. of device-days	8528					362 388			
No. of patient-days	18 129					801 740			
No. of infections	130					687			
Device utilization ratio	0.47	0.41–0.54	0.39	0.5	0.55	0.45	0.14	0.44	0.69
CLABSI rate/1000 catheter-days	15.24	11.93–18.32	11.52	14.98	18.66	1.9	0	1	4.3

ICU, intensive care unit.