

Original Research Article

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Surveillance of Device-Associated Infection and Antimicrobial Resistance Rates in the Medical/Surgical Intensive Care Unit of Emergency Hospital at Tanta University, Egypt

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ABSTRACT

To assess rates, bacteriological etiology and antimicrobial resistance patterns of the hospital acquired device-associated infection (DAI) in a medical/surgical intensive care unit (ICU). A prospective surveillance of DAI was conducted in the medical/surgical ICU, Emergency Hospital of Tanta University, Egypt, from 1st September 2015 to 1st March 2016, using the Centers for Disease Control and Prevention's National Healthcare Safety Network case criteria for the different DAIs. In this study, the overall rate of DAI was 24.17 per 1,000 device-days. Ventilator-associated pneumonia (VAP) was the most common DAI (52.17/1,000 ventilator-days), followed by catheter-associated urinary tract infection (CAUTI) (11.63 /1,000 catheter-days) and central line-associated blood stream infection (CLABSI) (6.93/1,000 central line-days). The main cause of VAP was *Klebsiella pneumoniae*, and for CAUTI, it was *Escherichia coli*. In CLABSI, methicillin-sensitive *Staphylococcus aureus* and *Staphylococcus epidermidis* were equally presented. Overall, 92.68% of the isolated organisms in our study were multi-drug resistant. Gram-negative isolates showed highest resistance against the third generation cephalosporins (68.29% for each), followed by sulphamethoxazole / trimethoprim (63.41%), and the least was against imipenem (12.2%). Oxacillin resistance was 60% among the Gram-positive isolates. Routine microbiological surveillance are urgently needed to guide optimizing control measures and providing an obligating antimicrobial policy to prevent the high spread of multi-drug resistant infections in ICUs.

Keywords

Device-associated infection;
Intensive care unit;
Antimicrobial resistance;
Multi-drug resistance.

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Introduction

Health care-associated infection (HAI) has become a major threat to the safety of intensive care unit (ICU) patients. Currently,

devices are the most important causes of HAI due to their prolonged use and lack of regular care or timely change when required

(Jana *et al.*, 2015). The most commonly reported device-associated infections (DAIs) involved central line-associated bloodstream infection (CLABSI), ventilator-associated pneumonia (VAP) and catheter-associated urinary tract infection (CAUTI) (Krein *et al.*, 2015).

HAI is increasingly being caused by multi-drug resistant (MDR) organisms, which are difficult to treat due to indiscriminate use of antimicrobials (Rosenthal, 2011). Development of antimicrobial resistance in bacteria prolongs hospitalization, increases morbidity and mortality rates, and results in excess economic cost (El-Saed *et al.*, 2016). To reduce HAI, surveillance is an essential tool as it is the important first step of identifying problems and priorities in assuring patient safety. Conducting continuous prospective nationwide surveillance has helped to decrease infection rates in western countries. However, the effectiveness of continuous nationwide surveillance on HAI should be investigated in each country (Choi *et al.*, 2015).

Most of the studies about DAI are carried out in developed countries where a systematic surveillance for HAI is routinely done, playing an important role in the infection control and quality assurance programs of hospitals (Edwards *et al.*, 2009). In developing nations, HAI prevention programs are insufficiently funded by Governments. For this, it is essential to initiate systematic surveillance, based on standard definitions (Mathur *et al.*, 2015). The Centers for Disease Control and Prevention (CDC)'s National Health Safety Network (NHSN) has established standardized criteria for ICU DA-HAI surveillance. This standardized surveillance method determines DAI rates per 1000 device-days, to be used as benchmarks among healthcare centers providing

infection control practitioners (ICPs) with a deeper look at the challenges they are dealing with, so they can implement an effective plan to solve them (Horan *et al.*, 2008).

This study was conducted in order to investigate the characteristics of DAI in reference to infection rates, pathogens most commonly associated with infection and their antibiogram pattern in one of the Egyptian ICUs.

Patients and Methods

Setting

A 6 months prospective surveillance was conducted in the medical/surgical ICU of Emergency Hospital, Tanta University during the period from 1st September 2015 to 1st March 2016. The unit provides inpatient care for critically ill adult patients. It consists of 3 wards, each contains 5 beds.

Surveillance

Standardized data were collected for all ICU patients with inserted devices, including demographic criteria (name, age, sex) and clinical criteria (date and indication of admission, date and indication of device insertion, signs of DAI, and the outcome). Daily data were collected on the following: the number of patients in the ICU and the total number of patient-days (bed-days), central line-days, mechanical ventilator-days, and urinary catheter-days. Patients on one or more devices were monitored to observe any infection related to the device use.

The infection control team consisted of 2 physicians, 2 microbiologists one of them was an ICP with 2 years of experience in infection control, and 2 link nurses.

CDC/NHSN surveillance criteria were used to identify all specific types of HAI (CDC/NHSN Surveillance Definition, 2013).

Sampling and microbiological study

For VAP, a quantitative culture of aspirated endotracheal secretions was done, the growth was considered significant, if $>10^5$ colony forming units (CFU)/mL. For CAUTI, we used a quantitative culture of aseptically aspirated urine from the urinary catheter, the growth was considered significant, if $\geq 10^3$ and $<10^5$ CFU/mL. For CLABSI, the distal 4-cm tip portion of the central venous catheter was cut and cultured after removing the catheter aseptically, with a concomitant percutaneously drawn blood culture. A cut-off of ≥ 15 CFU for the tip culture is indicative of catheter colonization (CDC/NHSN Surveillance Definition, 2013). Concomitant blood samples for blood culture were per-cutaneously drawn to confirm central line-related blood stream infections.

Microbiological study was carried out in the laboratory of the Medical Microbiology and Immunology Department of Tanta Faculty of Medicine for identification of the isolated organisms by routine standard methods and the species was confirmed using the API 20E and API 20 NE systems (bioMerieux, France).

The antimicrobial susceptibility patterns were accessed by disc diffusion method and interpreted according to Clinical and Laboratory Standards Institute guidelines (Clinical and Laboratory Standards Institute, 2015). The following discs were used; amoxicillin/clavulanic acid (30 μ g), aztreonam (30 μ g), ceftriaxone (30 μ g), ceftazidime (30 μ g), ceftazidime (30 μ g), cefoxitin (30 μ g), cefepime (30 μ g), ciprofloxacin (5 μ g),

gentamicin (10 μ g), erythromycin (15 μ g), imipenem (10 μ g), linezolid (30 μ g), penicillin G (10 units), piperacillin/tazobactam (110 μ g), sulphamethoxazole/trimethoprim (25 μ g), tetracycline (30 μ g), vancomycin (30 μ g) [Oxoid, UK]. All isolates were screened for the production of extended-spectrum beta-lactamases (ESBL) and confirmed by double disc synergy test (Clinical and Laboratory Standards Institute, 2015).

Calculation of DAI rates

DAI rate was calculated by dividing the total number of DAIs (VAP, CAUTI or CLABSI) by device-days, multiplied by 1000. Device-days are the total number of days use for the relevant devices during the selected time period (Vallès *et al.*, 2012). Device utilization ratio (DUR) was calculated by dividing the total number of device-days by the total number of patient-days (Dudeck *et al.*, 2015). Patient-days are the total number of days that patients stay in the ICU during the selected time period (Apostolopoulou *et al.*, 2013).

Statistical analysis

The results for quantitative variables were expressed as the mean \pm SD and were analyzed using Student's t test. Qualitative variables were expressed as percentages and were compared using the z-test for proportions, while Fisher's exact test was used for small samples. A $P < 0.05$ was considered statistically significant. All statistics were performed using Minitab17.

Results and Discussion

As far as we know, this is the first surveillance study that uses the definitions standardized by the CDC to estimate the rates of DAI and the associated

antimicrobial resistance in Tanta University Hospitals. This surveillance was conducted in the medical/surgical ICU at Emergency Hospital of Tanta University, Egypt. Results of this study were analyzed in relation to the reports of another 2 Egyptian surveillances that followed the CDC criteria; one of them was carried out in a respiratory ICU of a member hospital of the INICC in Cairo (Raslan *et al.*, 2012) and the other was carried out in the emergency ICU of Ain Shams University Hospital in Cairo (Hamdy *et al.*, 2014). Also, our results were compared to the reports of 2 recent international studies conducted in medical/surgical ICUs of 2 developing countries, Malaysia (Rai *et al.*, 2016) and Costa Rica (Ugalde *et al.*, 2016). In addition, last international reports of INICC for the period (2007-2012) (Rosenthal *et al.*, 2014) and CDC-NHSN (2013) (Dudeck *et al.*, 2015) were used to compare our results. The lack of some data in these 6 comparable studies allowed only the comparison of the available data.

Study population

During the study period, surveillance data were prospectively collected for 105 patients admitted to the medical/ surgical ICU for a total of 855 patient-days. These patients were on one or more of invasive devices. Among them, only 28 (26.67%) patients developed culture-confirmed DAIs, which were acquired during the study period.

Table 1 shows the demographic characteristics of the patients who acquired DAI (group I) compared to the patients without DAI. DAI was significantly associated with the two age extremes [below 20 years age ($P = 0.02$) and over 60 years age ($P < 0.001$)]. There was no significant difference between the 2 groups regarding the sex distribution ($P = 0.38$). There were

no significant differences between the 2 groups regarding the comorbid diseases except for polytrauma with brain edema, which was significantly lower in patients with DAI ($P = 0.03$). The average length of ICU stay for patients with DAI was significantly higher than the other non-infected patients ($P < 0.001$). These results were in accordance with other studies (Talaat *et al.*, 2010; Apostolopoulou *et al.*, 2013). Also, the mortality rate was significantly higher in patients who acquired DAI than those without DAI ($P < 0.001$). Several reports confirmed that HAI increases the risk of death in critically ill patients (Bueno-Cavanillas *et al.*, 1994; Ylipalosaari *et al.*, 2006).

DAI rates

Table 2 shows the DAI rates, DURs, and the percentages of DAI distribution compared to the other 6 surveillances.

In this study, VAP represented the most frequent DAI (73.17%), followed by CAUTI (19.51%) and lastly CLABSI (7.32%). This order was in accordance with those reported by both INICC report (2007-2012) (Dudeck *et al.*, 2015) and Raslan *et al.*, 2012 but with different percentages. Similarly, VAP was the most frequent DAI in both the Malaysian (Rai *et al.*, 2016) and the Costa Rican (Ugalde *et al.*, 2016) studies; however, CLABSI was more common than CAUTI in these studies. On the contrary, CAUTI was the main DAI detected by Hamdy *et al.*, 2014. Interestingly, CLABSI was reported as the main DAI in another Egyptian study in a medical ICU (Abdelfattah *et al.*, 2013). (Table 2)

DUR is used as an indicator for the severity of the disease because a patient with severe disease is more likely to use invasive devices for more days of his ICU stay

(Dudeck *et al.*, 2013). It can provide an evaluation of the population with intrinsic susceptibility to infection that have risk for DAI (Wright *et al.*, 2011; Fakhri *et al.*, 2012). Therefore, DUR was used in this study to evaluate our DAI rates in relation to rates in the other studies. The overall rate of DAIs in the current study was 24.17/1,000 device-days. It is higher than those reported by all our comparable studies, except that observed by Raslan *et al.*, 2012 (52.9/1,000 device-days).

Our VAP rate was 52.17/1,000 ventilator-days which is higher than those reported by all our comparable studies (16.5 - 48.12/1,000 ventilator-days), except that observed by Raslan *et al.*, 2012 (73.4/1,000 ventilator-days). This could be explained by the fact that mechanical ventilator use in our patients (0.67) was much higher than those reported by all other comparable studies (except for the Malaysian study, DUR = 0.74) (Rai *et al.*, 2016). Our CAUTI rate was 11.63/1,000 catheter-days with a DUR of 0.8. In comparison with other studies, it is close to that reported by Hamdy *et al.*, 2014 (12.74/1,000 catheter-days, DUR =0.73), but much lower than Raslan *et al.* 2012 (34.2/1,000 catheter-days, DUR =0.53); and much higher than all other comparable studies (1.27 – 5.34/1,000 catheter-days). As regards our CLABSI rate, it was 6.93/1000 central line-days. It was lower than those reported by both other Egyptian studies; (22.5/1000 central line-days) (Raslan *et al.*, 2012) and (27.21/1000 central line-days) (Hamdy *et al.*, 2014), but much higher than those reported by all other comparable studies (0.82 – 9.4/1000 central line-days). Our central line utilization ratio was 0.51 which was higher than the 2 Egyptian studies (0.35 and 0.12, respectively) (Raslan *et al.*, 2012; Hamdy *et al.*, 2014), and lower than other studies (0.54 – 1.05); except for that reported by CDC-NHSN (2013) which was 0.37 (Dudeck *et al.*, 2015).

This discrepancy in DAI rates could be explained according to 2 main factors; first one is the selection bias which includes the difference in the disease severity, type of the ICU, the duration and the time of the surveillance. The second factor is the availability of a well-established national infection surveillance system, which involves performance feedback programs, infection control fund, number of experienced ICPs, ratio of nurses to patients, and compliance with the guidelines of antimicrobial use.

Bacterial profile of the detected DAIs

The distribution of the isolated organisms from different DAIs through the study period is shown in table 3.

In the current study, *K. pneumoniae* was the leading cause of DAI (43.9%), followed by *P. aeruginosa* (17.07%), and *E. coli* (12.2%) (Table 3). This differed from that reported by Hamdy *et al.* 2014, where in their study; *S. aureus* was the predominant organism, followed by *E. coli* and *P. aeruginosa* ranked third. Also, the main isolated organisms from DAIs of the CDC-NHSN Report (2009-2010) were *S. aureus*, followed by *E.coli* and coagulase-negative *S. aureus* (CoNS) (Sievert *et al.*, 2013). Unlike other studies (Aly *et al.*, 2008; Apostolopoulou *et al.*, 2013; Erdem *et al.*, 2014), *Acinetobacterbaumannii* had low presentation in our ICU (4.88%). This could be explained by the presumption that acquiring infection with *A.baumannii* depends on many risk factors; including the type of the underlying illness, its severity, the length of hospital stay, and the previous infection (Tilley and Roberts, 1994; Lortholary *et al.*, 1995).

Notably, Gram-positive organisms accounted only for (14.63%) in our study

(Table 3). The high prevalence of Gram-negative organisms among ICU patients has been featured by several epidemiologic studies (Wisplinghoff *et al.*, 2004; Vincent *et al.*, 2009; Erdem *et al.*, 2014). This finding could be explained by the presumption that oropharyngeal flora change into Gram-negative organisms after hospitalization (Johanson *et al.*, 1969) and remain so for 3 months after discharge (Filius *et al.*, 2005).

Considering the isolated organism according to the type of DAI, *K. pneumoniae* was the most frequent organism isolated from our VAP cases, followed by *P. aeruginosa*. While, *E.coli*, followed by *Proteus mirabilis* were the causative organisms of CAUTI in the present study. In our CLABSI, the causative organisms were methicillin-sensitive *S. aureus* and *S. epidermidis*; they were equally presented. These results regarding the leading organism in each type of DAI agreed with those of Hamdy *et al.* 2014. On the contrary, our results differed from those presented by the CDC-NHSN Report (2009-2010) (Sievert *et al.*, 2013); it denoted that *S. aureus* was the main organism causing VAP, and CoNS was the main in CLABSI. While, *E. Coli* was the leading cause of their CAUTI, which agreed with our results.

Antimicrobial resistant pattern

Overall in our Gram-negative isolates, the highest resistance was against the third generation cephalosporins (68.29%), followed by sulphamethoxazole/trimethoprim (63.41%), and the least was against imipenem (12.2%). While, oxacillin resistance was 60% among the Gram-positive isolates and no resistance was detected against neither vancomycin nor linezolid (0%). In this study, Gram-negative organisms were defined as MDR, if resistant to 3 or more of the antimicrobial agents

belonging to differed structural classes (Magiorakos *et al.*, 2012). Also, MRSA is considered MDR (Garnacho-Montero *et al.*, 2014). Accordingly, 92.68% (38/41) of the isolated organisms in our study were MDR. This percentage is higher than that reported in a previous Egyptian study (55.36%) (See *et al.*, 2013), an Indian study (71.43%) (Patel *et al.*, 2016), and a Pakistani study (79.12%) (Rizwan *et al.*, 2016). ESBL were produced by 34.29% of our Gram-negative isolates (55.56% of *K. pneumoniae* and 40% of *E. coli*), which is higher than that reported by Hamdy *et al.*, 2014 (23.47%), but little lower than that reported by Saied *et al.*, 2011 (37.3%). There are several factors that can explain these higher resistance rates in our ICU, which include the strong association between colonization of MDR organisms and the length of patient hospitalization (Zhou *et al.*, 2016). Also, the misuse of antimicrobials in our ICU in the form of unnecessary use of antimicrobials or their prescription without referring to the sensitivity report.

We preferred to compare our resistant rates with only the INICC report (2007-2012) (Rosenthal *et al.*, 2014) and the CDC/NHSN report (2009-2010) (Sievert *et al.*, 2013) to be more concise, since antimicrobial resistance data are lacking in the 2 comparable Egyptian studies (Table 4).

Our *P. aeruginosa* and *E. coli* isolates had the lowest resistant rates against quinolones (28.57% and 20%, respectively), versus (41.9% and 70%, respectively) reported by INICC (2007-2012) (Rosenthal *et al.*, 2014) and (32.7% and 29.1%, respectively) reported by NHSN (2009-2010) (Sievert *et al.*, 2013). Also, both isolates had the lowest resistance rates against carbapenems (0% for each); versus (42.8% and 5.1%, respectively) reported by INICC (2007-2012)(Rosenthal *et al.*,

2014) and (30.2% and 1.7%, respectively) reported by NHSN (2009-2010) (Sievert *et al.*, 2013).

On the contrary, our *P. aeruginosa* isolates had the highest resistant rates against aminoglycosides and piperacillin/tazobactam (71.42 and 57.14%, respectively); versus (36.2% and 35.8%,

respectively) reported by INICC (2007-2012)(Rosenthal *et al.*, 2014) and (11.3% and 19.1%, respectively) reported by NHSN (2009-2010) (Sievert *et al.*, 2013). Also, We had the highest carbapenem-resistance rates in *A. baumannii* (100%) versus 77.1% reported by INICC and 61.2% reported by NHSN.

Table.1 Demographic characteristics of the medical/surgical ICU patients during the study period

Variant	Patients with DAI (n =28)	Patients without DAI (n=77)	P value
Age (y)			
<20	6(21.43)*	4(5.19)	0.02
20-40	4(14.29)	32 (41.56)*	0.01
40-60	6(21.43)	37(48.06)*	0.01
>60	12(42.85)*	4(5.19)	<0.001
Sex			
Male	19(67.86)	59(76.62)	0.38
Female	9(32.14)	18(23.38)	
Cause of admission			
Polytrauma with brain edema	9(32.15)	42(54.54)*	0.03
Polytrauma with extra-dural hemorrhage	5(17.86)	15(19.48)	0.85
Ventricular aneurism	3(10.72)	3(3.89)	0.34
Uncontrolled diabetic ketoacidosis	2(7.14)	2(2.6)	0.29
Intra-cerebral hemorrhage	2(7.14)	1(1.3)	0.17
Degenerative brain diseases	2(7.14)	1(1.3)	0.17
Pneumothorax	1(3.57)	4(5.19)	1
Gastro-intestinal cancers	1(3.57)	7(9.1)	0.68
Bladder cancer	1(3.57)	0	0.27
Hydrocephalus	1(3.57)	1(1.3)	0.46
Thalamic contusion	1(3.57)	0	0.27
Status epilepticus	0	1(1.3)	1
Outcome			
Died	15(53.57)*	8(10.39)	< 0.001
Average length of ICU stay	13.5±1.7*	6.2±2.5	< 0.001

DAI; device-associated infection, ICU; intensive care unit. Data presented as n (%)

* Statistically significant

Table.2 Data and rates of DAI in this study in comparison with other reports

DAI	This study	Egypt ¹	Egypt ²	Malaysia ³	Costa Rica ⁴	INICC (2007-2012) ⁵	CDC-NHSN (2013) ⁶
VAP							
DAI rate*	52.17	73.4	48.12	21.2	30.7	16.5	NA
DUR	0.67	0.37	0.16	0.74	0.29	0.36	NA
% of DAI	73.17	50.97	37.5	52.83	78.26	49.77	-
CAUTI							
DAI rate*	11.63	34.2	12.74	5	1.5	5.34	1.27
DUR	0.8	0.53	0.73	0.82	0.5	0.62	0.54
% of DAI	19.51	34.19	45.83	13.84	6.52	27.69	-
CLABSI							
DAI rate*	6.93	22.5	27.21	9.4	2.9	4.93	0.82
DUR	0.51	0.35	0.12	1.05	0.6	0.54	0.37
% of DAI	7.32	14.84	16.67	33.33	15.22	22.54	-
Overall							
DAI rate*	24.17	52.9	20.05	11.38	8.19	7.83	-
DUR	1.98	1.25	1.01	2.61	1.39	1.52	-
% of DAI	100	100	100	100	100	100	-
No of DAI	41	155	24	159	46	17736	-
Type of ICU	adult m/s	adult respiratory	adult emergency	adult m/s	adult m/s	adult m/s	adult m/s

1; Rasslan *et al.*, 2012. 2; Hamdy *et al.*, 2014. 3; Rai *et al.*, 2016. 4; Ugalde *et al.*, 2016. 5; Rosenthal *et al.*, 2014. 6; Dudeck *et al.*, 2015.

VAP; ventilator-associated pneumonia, CAUTI; catheter-associated urinary tract infection, CLABSI; central line-associated blood stream infection, DAI; device-associated infection, DUR; device utilization ratio, INICC; International Nosocomial Infection Control Consortium, CDC-NHSN; Centers for Disease Control and National Healthcare Safety Network Data, NA; not available for adult rates, m/s; medical/surgical

Data presented as %.*DAI rate was calculated per 1,000 device-days

Table.3 Distribution of the isolated bacteria according to the type of DAI in this study

Isolated organisms	VAP	CAUTI	CLABSI	Total
<i>Klebsiella pneumoniae</i>	18	-	-	18
<i>Pseudomonas aeruginosa</i>	7	-	-	7
MRSA	3	-	1	4
<i>Acinetobacter baumannii</i>	2	-	-	2
<i>Escherichia coli</i>	-	5	-	5
<i>Proteus mirabilis</i>	-	3	-	3
MSSA	-	-	1	1
CoNS	-	-	1	1

VAP; ventilator-associated pneumonia, CAUTI; catheter-associated urinary tract infection, CLABSI; central line-associated blood stream infection, MRSA; methicillin-resistant *Staphylococcus aureus*, MSSA; methicillin-sensitive *Staphylococcus aureus*. CoNS; coagulase-negative *Staphylococcus aureus*. Data presented as no.

Table.4 Antimicrobial resistance rates in this study in comparison with the INICC report (2007-2012) and the CDC-NHSN report (2009-2010)

DAI	Isolated organism	Drug	This study	INICC (2007-2012) ¹	CDC-NHSN (2009-2010) ²
VAP	<i>Staphylococcus aureus</i>	Oxacillin	100	62	48.8
		<i>Pseudomonas aeruginosa</i>	Carbapenems	0	42.8
	Aminoglycosides		71.42	36.2	11.3
	Fluoroquinolones		28.57	41.9	32.7
	Piperacillin/tazobactam		57.14	35.8	19.1
	<i>Klebsiella pneumoniae</i>	Carbapenems	16.66	17.2	11.2
		3 rd generation cephalosporins	88.88	62.6	23.8
<i>Acinetobacter baumannii</i>	Carbapenems	100	77.1	61.2	
CAUTI	<i>Escherichia coli</i>	Carbapenems	0	5.1	1.7
		3 rd generation cephalosporins	60	63	11.5
		Fluoroquinolones	20	70	29.1
CLABSI	<i>Staphylococcus aureus</i>	Oxacillin	50	61.2	51.5

1; Rosenthal *et al.*, 2014. 2; Sievert *et al.*, 2013.

VAP; ventilator-associated pneumonia, CAUTI; catheter-associated urinary tract infection, CLABSI; central line-associated blood stream infection, DAI; device-associated infection, INICC; International Nosocomial Infection Control Consortium, CDC-NHSN; Centers for Disease Control and National Healthcare Safety Network Data, NA; not available for adult rates. Data presented as %.

As regards oxacillin, *S. aureus* isolated from our VAP cases had the highest resistance rate (100%), compared to INICC (2007-2012) and NHSN (2009-2010) reports (62% and 48.8%, respectively) (Rosenthal *et al.*, 2014; Sievert *et al.*, 2013). While *S. aureus* isolated from our CLABSI cases had the lowest resistance rate (50%) compared to INICC and NHSN reports (61.2% and 51.5%, respectively).

In conclusion, our surveillance revealed higher rates of DAI in our medical/surgical ICU in comparison with international reports, particularly VAP and CAUTI, but not CLABSI. These higher rates are quite similar to the other national surveillances. MDR rate in our ICU is higher than that reported by other developing countries. However, we still have lower resistance rates against both quinolones and carbapenems compared to INICC and NHSN reports. Actually, the small size of the samples in this study may affect the reliability of the results. Consequently, further studies including larger sample size for longer periods are necessary to clarify the magnitude of the DAI problem and developing more effective preventive measures.

Competing interests

Authors have declared that no competing interests exist.

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