AMERICAN JOURNAL OF PREVENTIVE MEDICINE AND PUBLIC HEALTH, 2019
VOL 4, NO. 1, PAGE 1–7
10.5455/ajpmph.20181030050337

ORIGINAL RESEARCH

Open Access

Device-associated infection rates in different intensive care units in a tertiary care hospital in Egypt

Rania Hassan[1], Abdel-Hady El-Gilany[2], Noha El-Mashad[3], Amina M. Abd elaal[3]

[1]Ministry of Health, Mansoura New General Hospital, Cairo, Egypt

[2]Professor, Public Health & Preventive Medicine, Faculty of Medicine, Mansoura University, Mansoura, Egypt

[3]Professor, Clinical Pathology, Faculty of Medicine, Mansoura University, Mansoura, Egypt

ABSTRACT

Background: Device-associated hospital-acquired infections (DA-HAIs) are a threat to patient safety, particularly in intensive care units (ICUs).

Methods: A prospective observational study was carried out for 12 months from January 2017 to December 2017 in five ICUs, including general ICU, cardiology care unit, neonatal ICU, pediatric ICU, and neurosurgery ICU of Mansoura New General Hospital. Data were collected from patient's file and laboratory results according to definitions of CDC. DA-HAIs were calculated by dividing the total number of device associated infections by the total number of device days and multiplying the result by 1,000.

Results: In the current study, 1,666 patients hospitalized for 11.280 days in different ICUs. These patients acquired 91 DA-HAIs. The most frequent DA-HAIs (per 1,000 device-days) were ventilator-associated pneumonia (VAP) (10.9), central line-associated bloodstream infection (CLA-BSI) (5.9), and catheter-associated urinary tract infections (CA-UTI) (5.6). The urinary catheter utilization ratio was 0.54, central line utilization ratio was 0.33, and ventilator utilization ratio was 0.28. The most frequently isolated organisms were *Klebsiella* spp. (34%) and *E. coli* (20.9%). The most frequent bacteria causing VAP, CLA-BSI, and CA-UTI were *Klebsiella* spp. (60%), *Staphylococcus aureus* and *Enterococcus* spp. (27.3% for each), and *E. coli* (41.2%), respectively.

Conclusions: Surveillance of DA-HAIs is the first step to improve infection control activity and to implement preventive bundles measures in the ICU.

ARTICLE HISTORY

Received October 30, 2018
Accepted December 21, 2018
Published January 03, 2019

KEYWORDS

Ventilator-associated pneumonia; central line-associated bloodstream infection; catheter-associated urinary tract infection; causative organisms

Introduction

Hospital-acquired infections (HAIs) are infections which develop 48 hours after hospital admission or 48 hours after discharge that was not incubating at the time of admission at the hospital [1]. The intensive care units provide vital support to critically ill patients. HAIs are one of the most serious complications in ICUs patients because they lead to high morbidity, mortality, length of stay, and cost [2].

HAIs and mortality in ICUs are 5–10 times more prevalent than in other wards of the hospital [3]. Patients admitted to ICUs are at risk of acquiring DA-HAIs because of their debilitated immune systems and exposure to invasive devices, such as ventilators, urinary catheters, and central lines [4].

In Egypt, a previous study estimated that DA-HAIs were 24.5% per 1,000 ICU-days [5]. However, the International Nosocomial Infection Control Consortium (INICC) reported ventilator-associated pneumonia (VAP) rate was 15.8/1,000 ventilator days, central line-associated bloodstream infection (CLABSI) rate was 6.8/1,000 central line days, and catheter-associated urinary tract infections (CAUTI) rate was 6.3/1,000 urinary catheter days in different developing countries [6].

There are few studies of DA-HAIs in ICUs of university hospitals; however, there is a dearth of

Contact Rania Hassan Salim ✉ rania_hassan2018@students.mans.edu.eg Ministry of Health, Mansoura New General Hospital, Cairo, Egypt.

information about DA-HAIs rates in ICUs of general hospitals in Egypt. This study aimed to assess the DA-HAIs and device utilization ratios in different ICUs in Mansoura New General Hospital (MNGH) in Egypt and to assess the most common organisms causing them.

Methods

The study was conducted for 1 year from January 2017 to December 2017 with all patients admitted to the different ICUs of MNGH, including general ICU, cardiac care unit (CCU), neonatal ICU (NICU), pediatrics ICU (PICU), and neurosurgery ICU. The patients admitted to the ICUs were observed prospectively by the unit-directed active surveillance method based on patient clinical data and the laboratory results.

Infections that developed 48 hours after admission into the ICU were considered ICU acquired. Patients who stayed in ICU less than 2 days were excluded. The presence and criteria of infection were assessed daily on the ward round. Microbiological samples of blood, urine, and bronchoalveolar lavage were obtained when a new infection was suspected. These samples were cultured on different media as blood, chocolate, MacConkey, and nutrient agar and identification of organisms was done by morphology, gram stain, and biochemical reactions. The definitions of infections were based on the definitions proposed by centers for disease control and prevention (CDC).

VAP diagnosed after 48 hours of mechanically ventilated patient with a chest radiograph that shows new or progressive infiltrates, consolidation, cavitation, or pleural effusion. The patient must also have at least one of the following symptoms and signs: fever (>38.0°C), leukopenia [≤4,000 WBC (white blood cells)/mm3] or leukocytosis (>12,000 WBC/mm3), and at least one of the following: new onset of purulent sputum, or change in character of sputum, or increased respiratory secretions, or increased suctioning requirements, new onset or worsening cough, dyspnea or tachypnea, rales or bronchial breath sounds, or worsening gas exchange. The patient must also have organism cultured from blood; a specimen obtained by tracheal aspirate, bronchoalveolar lavage, or biopsy [7].

For the diagnosis of CLABSI, a patient with a CVC has a recognized pathogen that is isolated from one or more percutaneous blood cultures after 48 hours of vascular catheterization and is not related to an infection at another site. The patient also has at least one of the following: fever (temperature > 38°C), chills, or hypotension [8].

For the diagnosis of CAUTI, a patient with a urinary catheter has one or more of the following symptoms with no other recognized cause: fever (temperature > 38°C), urgency, or suprapubic tenderness when the urine culture is positive for 105 colony-forming units per milliliter or more, with no more than two microorganisms isolated [1].

Denominator data (i.e., patient-days, central line-days, urinary catheter-days, and ventilator-days) were recorded daily by hospital staff on a denominator reporting form. Device-days are the total number of days of exposure to the device (ventilator, urinary catheter, or central line) by all of the patients in the selected population during the selected time period. Patient-days are the total number of days that patients are in an ICU during the specified time period.

Statistical analysis

Qualitative variables were presented as number and %. Device-associated infections (DAIs) rates per 1,000 device-days were calculated by dividing the total number of DAIs by the total number of device days and multiplying the result by 1,000 [9].

$$\text{VAP} = \frac{\text{Number of ventilator - associated pneumonias}}{\text{Number of ventilator - days}} \times 1{,}000$$

$$\text{CLABSI} = \frac{\text{Number of central line - associated BSIs}}{\text{Number of central line - days}} \times 1{,}000$$

$$\text{CAUTI} = \frac{\text{Number of urinary catheter - associated UTIs}}{\text{Number of urinary catheter - days}} \times 1{,}000$$

Device utilization ratios were calculated by dividing the total number of device days by the total number of patient-days [9].

$$\text{Ventilation utilization ratio} = \frac{\text{Number of ventilator - days}}{\text{Number of patient - days}}$$

$$\text{Central line utilization ratio} = \frac{\text{Number of central line - days}}{\text{Number of patient - days}}$$

$$\text{Urinary catheter utilization ratio} = \frac{\text{Number of urinary catheter - days}}{\text{Number of patient - days}}$$

Results

In the current study, 1,666 patients hospitalized for 11.280 days in different ICUs. These patients acquired 91 DA-HAIs. The most frequent DA-HAIs per 1,000 device-days were VAP (10.9), followed by CLA-BSI (5.9) and CA-UTI (5.6). CLA-BSI was present mainly in NICU (7.2), followed by neurosurgery

ICU (7.2), PICU (6.4), and general ICU (5.3). CA-UTI was present mainly in NICU (41.7), followed by general ICU (8.5), CCU (8.4), neurosurgery ICU (4.3), and PICU (1.7). VAP was present mainly in NICU (17.7), followed by neurosurgery ICU (10), general ICU (9.2), and PICU (6.2) (Table 1).

The highest device utilization ratio was urinary catheter (0.54), followed by central line (0.33) and ventilator (0.28). Central line-utilization was present mainly in general ICU (0.512), followed by PICU (0.355), NICU (0.253), neurosurgery ICU (0.233), and less present in CCU (0.066). Urinary catheter utilization was present mainly in General ICU (0.917), followed by neurosurgery ICU (0.789), PICU (0.458), CCU (0.255), and less present in NICU (0.009). Ventilator utilization was present mainly in general ICU (0.405), followed by NICU (0.29), PICU (0.245), neurosurgery ICU (0.224), and less present in CCU (0.043) (Table 2).

In this study, the most common DA-HAIs in general ICU were CA-UTI, followed by VAP. In CCU, the only infection present was CA-UTI. The most common DA-HAIs in NICU were VAP, followed by CLA-BSI. The most common DA-HAIs in PICU were CLA-BSI, followed by VAP. The most common DA-HAIs in neurosurgery ICU were CA-UTI, followed by VAP (Fig. 1).

In the current study, the most frequently isolated organisms were *Klebsiella* spp. (34%), followed by *E. coli* (20.9%), *Enterococcus* spp. (14.3%), *Pseudomonas* spp. (9.9%), *Staphylococcus aureus* (8.8%), and the least frequent were *Acinetobacter* spp. (5.5%), coagulase-negative staphylococci (CoNS) (4.4%), and *B hemolytic Streptococci* (2.2%). The most frequent bacteria causing VAP were *Klebsiella* spp. (60%). The most frequent bacteria causing CLA-BSI were *Staphylococcus aureus* and *Enterococcus* spp. (27.3% for each). The most frequent bacteria causing CA-UTI were *E. coli* (41.2%) and *Pseudomonas* spp. (17.6%) (Table 3).

Discussion

Invasive medical devices, as mechanical ventilation, intravascular catheters, and urinary catheters may increase the risk of development of DA-HAIs in ICUs patients [10].

The VAP rate in this study was 10.9/1,000 ventilator-days, which is lower than the overall rate in the three ICUs in Egypt (59.0/1,000 ventilator-days) [5], an adult ICU in Kuwait (9.1/1,000 ventilator days) [11], in Turkey (21.4/1,000 ventilator-days) [12], and in a study in five ICUs of three hospitals in Brazil (20.9/1,000 ventilator-days) [13]. This rate was higher than a previous study in Egypt (7.47/1,000 ventilator-days) [14] and study in Germany (6.53/1,000 ventilator-days) [15].

Table 1. Device-associated hospital-acquired infections rates per 1,000 device days in different ICUs.

Type of ICU	Ventilator days	No of patient with VAP	VAP rate	Central Line days	No of patient with CLA-BSI	CLA-BSI rate	Urinary Catheter days	No of patient with CA-UTI	CA-UTI RATE
General ICU	1.631	15	9.2	2.064	11	5.3	3.695	23	8.5
CCU	60	-	-	92	-	-	356	3	8.4
NICU	789	14	17.7	697	5	7.2	24	1	41.7
PICU	323	2	6.2	469	3	6.4	605	1	1.7
Neurosurgery ICU	398	4	10	415	3	7.2	1.406	6	4.3
Total	3.201	35	10.9	3.737	22	5.9	6.086	34	5.6

Table 2. Device utilization ratios in different ICUs.

Type of ICU	Patient days	Ventilator days	Ventilator utilization ratios	Central line days	Central line-utilization ratio	Urinary catheter days	Urinary catheter utilization ratios
General ICU	4.029	1.631	0.405	2,064	0.512	3.695	0.917
CCU	1.397	60	0.043	92	0.066	356	0.255
NICU	2.754	789	0.29	697	0.253	24	0.009
PICU	1.320	323	0.245	469	0.355	605	0.458
Neurosurgery ICU	1.780	398	0.224	415	0.233	1.406	0.789
Total	11.280	3.201	0.28	3.737	0.33	6.086	0.54

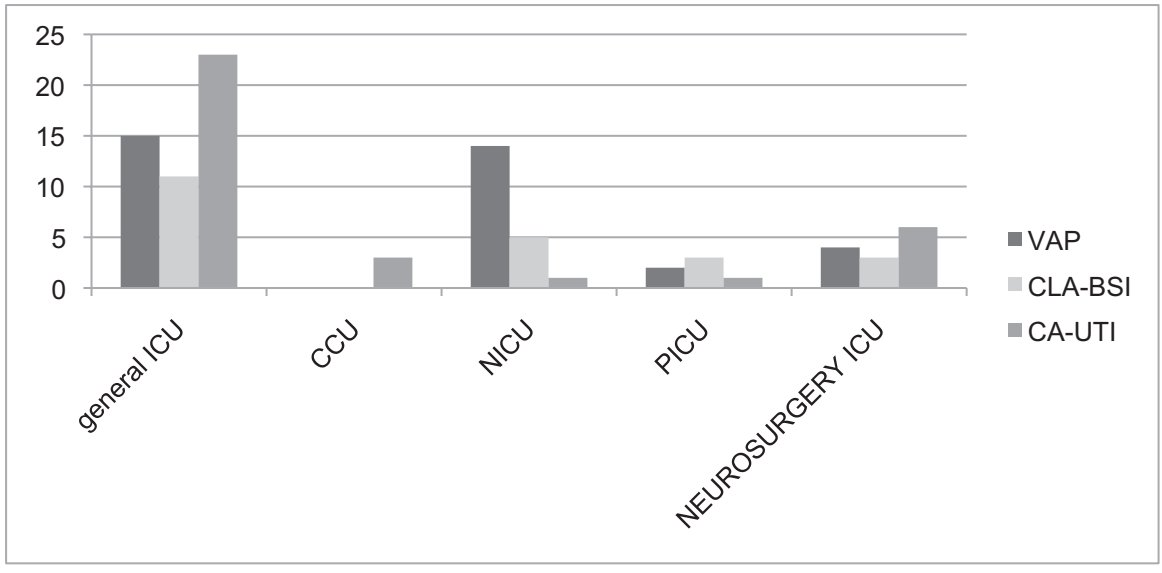

Figure 1. Distribution of device-associated hospital-acquired infections in different ICUs. VAP = ventilator-associated pneumonia; CLA-BSI = central line-associated bloodstream infection; CAUTI = catheter-associated urinary tract infections; General ICU = general intensive care unit; CCU = cardiology care unit; NICU = neonatal intensive care unit; PICU = pediatric intensive care unit; Neurosurgery ICU = neurosurgery intensive care unit.

Table 3. Distribution of causative bacteria of device-associated hospital-acquired infections by site.

	VAP	CLA-BSI	CA-UTI	Total
Staphylococcus aureus	1 (2.9%)	6 (27.3%)	1 (2.9%)	8 (8.8%)
Coagulase –ve Staphylococcus	1(2.9%)	1 (4.5%)	2 (5.9%)	4 (4.4%)
Enterococcus spp.	3 (8.5%)	6 (27.3%)	4 (11.8%)	13 (14.3%)
B hemolytic Streptococci	-	-	2 (5.9%)	2 (2.2%)
Klebsiella spp.	21 (60%)	5 (22.7%)	5 (14.7%)	31 (34%)
Pseudomonas spp.	3 (8.6%)	-	6 (17.6%)	9 (9.9%)
E. coli	2 (5.7%)	3 (13.7%)	14 (41.2%)	19 (20.9%)
Acinetobacter spp.	4 (11.4%)	1 (4.5%)	-	5 (5.5%)
Total	35	22	34	91

Percentage value denotes column percentage.

The CLABSI rate in the current study was 5.9/1,000 central line-days, which was lower than the rate identified in 11 ICUs in Columbian hospitals (11.3 per 1,000 central line-days) [16], and in a pediatric ICU in Saudi Arabia (20.06/1,000 central line-days), similar to overall rate in US hospitals (5.3 per 1,000 central line-days) [17], and higher than National Healthcare Safety Network (NHSN) rate (3.1/1,000 central line-days [18].

The CAUTI rate was 5.6/1,000 catheter days, which was lower than study performed in Egypt (15.7/1,000 catheter-days) [19] and study in Morocco (11.74/1,000 catheter days) [20]. This rate was higher than a study at Cairo University hospitals in which CAUTI rate was 2.9/1,000 catheter days [21] and in Turkey in which CAUTI rate was 5.1/1,000 catheter days [22].

The relative lower incidence of DA-HAIs, in this study, may be explained by that infection control activities enrolled in the hospital for more than 8 years and surveillance system was implemented in the hospital for more than 3 years and ever since there are efforts to decrease the infection rates by applying different preventive measures and education of hospital stuff about them, especially hand hygiene practice. However, VAP rate is higher which can be explained by inadequate nursing manpower and defect in the implantation of preventive bundles, especially for the frequency of suctions and mouth care of patients.

Device utilization ratios reflect the state of commitment of medical staff by preventive measures as insertion of the device only when indicated and removal of it as soon as the indication ended. In this study, the ventilator utilization ratio was much lower (0.28) than that reported by the NHSN (0.45) [23] and INICC (0.51) [24]. The central line utilization ratio was 0.33, which was lower than the study in Brazil (0.92) [12], and NHSN report (0.59) [25]. The urinary catheter utilization ratio was 0.56, which was in the same range in the study in Morocco (0.60) [19], and higher than study in Egypt (0.09) [20]. These relative lower utilization ratios indicate that there are efforts done by the medical staff to control the infection rates.

In this study, the most frequently isolated organisms were *Klebsiella* spp. (34%), *E. coli* (20.9%), and *Enterococcus* spp. (14.3%). Similarly to study in Egypt [26] in which *Klebsiella* spp. were the most frequently isolated organism (42%), followed by CoNS (31%), and to study in Cameroon [27] in which *Klebsiella* spp. was the most frequently isolated organism (27.6%). In contrast to study in Turkey [28] in which *Acinetobacter baumannii* (48%) and *Pseudomonas aeruginosa* (31%) were the most frequent isolated microorganisms and study in India [29] in which also *Acinetobacter baumannii* (83.2%) and *Pseudomonas aeruginosa* (73.5%) were the most frequent isolated microorganisms.

The most frequent bacteria causing VAP was *Klebsiella* spp. (60%). Similarly, to study in Egypt in which the most frequent bacteria causing VAP were *Klebsiella* spp (33.3%) [30]. In contrast to study in University Hospital in Turkey in which *Staphylococcus aureus* (33%) and *Pseudomonas aeruginosa* (23.8%) were the predominant pathogens causing VAP [2]. The most frequent bacteria causing CLA-BSI were *Staphylococcus aureus* and *Enterococcus* spp (27.3% for each). Similarly to study at Assiut University Hospital, Egypt, in which the most organisms were coagulase-negative *staphylococci* (30.3%) and *Staphylococcus aureus* (29.2%) [31]. In contrast to study in India, the predominant microorganisms in CLA-BSI were *Klebsiella* spp. (32%) and *Acinetobacter* spp (18%) [32]. The most frequent bacteria causing CA-UTI were *E. coli* (41.2%) and *Pseudomonas* spp. (17.6%). Similarly to study in a tertiary care hospital in India [33], in which the main isolated organisms from CA-UTI were *E. coli* (26%) and to study in Turkey [34], in which the main isolated organisms from CA-UTI were *E. coli* (40%) and *Pseudomonas* SPP. (28%).

This could be explained by that the spectrum of organisms causing DA-HAIs is changing from time to time, from region to region, and even from hospital to hospital according to the state of development of countries and according to infection control practice [35].

In conclusion, surveillance of DA-HAIs is the first step to improve infection control activity and to implement preventive bundles measures in the ICU.

Recommendations

Application of preventive bundles measures for controlling of DA-HAIs and continuous education and training about infection control practice help in the reduction of infection rates.

Study Limitation

Single hospital study over a single year and its results cannot be generalized to the national level. HAIs are ascertained only during the period of hospital stay as there is no system of follow-up after discharge from the hospital.

Acknowledgments

Great thanks to Dr. Tarek Arafat, manager of Mansoura New General Hospital, Dr. Reda Bedir Mahmoud, Head of infection control team in Mansoura New General Hospital, infection control team, and microbiology laboratory team for their support through this work.

Funding

None.

Conflict of Interest

None.

References

[1] NHSN. National Healthcare Safety Network (NHSN) patient safety components manual. CDC, Atlanta, GA, 2015. [Online]. Available via https://www.cdc.gov/nhsn/pdfs/validation/2015/pcsmanual_2015.pdf (Accessed January 2015).

[2] Ozer B, Akkurt C, Duran N, Onlen Y, Savas L, Turhanoglu S. Evaluation of nosocomial infections and risk factors in critically ill patients. Med Sci Monit 2011; 17(3):17–22.

[3] Sharma DK, TiwariYK, Vyas N, Maheshwari RK. An investigation of the incidence of Nosocomial infections among the patients admitted in the intensive care unit of a tertiary care hospital in Rajasthan, India. Int J Curr Microbiol App Sci 2013; 2(10):428–35.

[4] Rosenthal VD, Maki DG, Graves N. The International Nosocomial Infection Control Consortium (INICC): goals and objectives, description of surveillance methods, and operational activities. Am J Infect Control 2008; 36:1–12.

[5] Rasslana O, Seliemb Z, Ghazic I, Abd El Saboura M, El Kholy A, Sadeq F, et al. Device-associated infection rates in adult and pediatric intensive care units of hospitals in Egypt. International Nosocomial Infection Control Consortium (INICC) findings. J Infect Public Health 2012; 5:394–402.

[6] Roscnthal VD, Bijie H, Maki DG, Mehta Y, Apisarnthanarak A, Medeiros EA, et al. International Nosocomial infection Control Consortium (INICC) report, data summary of 56 countries, for 2004–2009. Am Infect Control 2012; 40(5):96–407.

[7] NHSN. National Healthcare Safety Network (NHSN) patient safety components manual. CDC, Atlanta, GA, 2017. [Online]. Available via https://www.cdc.gov/nhsn/pdfs/validation/2017/pcsmanual_2017.pdf (Accessed January 2017).

[8] NHSN. National Healthcare Safety Network (NHSN) patient safety components manual. CDC, Atlanta, GA, 2013. [Online]. Available via https://www.cdc.gov/nhsn/pdfs/validation/2013/pcsmanual_2013.pdf (Accessed January 2013).

[9] Dudeck MA, Weiner LM, Allen-Bridson K, Malpiedi PJ, Peterson KD, Pollock DA, et al. National Healthcare Safety Network (NHSN) report, data summary for 2012, Device-associated module. Am J Infect Control 2013; 41:1148–66.

[10] Breathnach AS. Nosocomial infections and infection control. Medicine 2013; 41:649–53.

[11] Aly NY, Al-Mousa HH, Al Asar el SM. Nosocomial infections in a medical-surgical intensive care unit. Med Principles Prac 2008; 17:373–7.

[12] Leblebicioglu H, Erben N, Rosenthal VD, Atasay B, Erbay A, Unal S, et al. International Nosocomial Infection Control Consortium (INICC) national report on device-associated infection rates in 19 cities of Turkey, data summary for 2003–2012. Ann Clin Microbiol Antimicrob 2014; 13:51.

[13] Salomao R, Rosenthal VD, Grimberg G, Nouer S, Blecher S, Buchner-Ferreira S, et al. Device-associated infection rates in intensive care units of Brazilian hospitals: findings of the International Nosocomial Infection Control Consortium. Rev Panam Salud Publica/Pan Am J Public Health 2008; 24(3):195–202.

[14] See I, Lessa FC, Abo ElAta O, Hafez H, Samy K, El-Kholy A, et al. Incidence and pathogen distribution of healthcare-associated infections in pilot Hospitals in Egypt. Infect Control Hosp Epidemiol 2013; 34(12):1281–8.

[15] Geffers C, Gastmeier P. Nosocomial infections and multidrug resistant organisms in Germany epidemiological data from KISS (The Hospital Infection Surveillance System). Dtsch Arztebl Int 2011; 108(6):87–93.

[16] Moreno CA, Rosenthal VD, Olarte N, Gomez WV, Sussmann O, Agudelo JG, et al. Device-associated infection rate and mortality in intensive care units of 9 Colombian hospitals: findings of the International Nosocomial Infection Control Consortium. Infect Control Hosp Epidemiol 2006; 27:349–56.

[17] Edwards JR, Peterson KD, Andrus ML, Tolson JS, Goulding JS, Dudeck MA, et al. National Healthcare Safety Network (NHSN) Report, data summary for 2006, issued June 2007. Am J Infect Control 2006; 35:290–301.

[18] Almuneef MA, Memish ZA, Balkhy HH, Hijazi O, Cunningham G, Francis C. Rate, risk factors and outcomes of catheterrelated bloodstream infection in a paediatric intensive care unit in Saudi Arabia. J Hosp Infect 2006; 62:207–13.

[19] Talaat M, Hafez S, Saied T, Elfeky R, El-Shoubary W, Pimentel G. Surveillance of catheter-associated urinary tract infection in 4 intensive care units at Alexandria university hospitals in Egypt. Am J Infect Control 2010; 38:222–8.

[20] Madani N, Rosenthal VD, Dendane T, Abidi K, Zeggwagh A, Abouqal R. Health-care associated infections rates, length of stay, and bacterial resistance in an intensive care unit of Morocco: findings of the International Nosocomial Infection Control Consortium (INICC .(Int Arch Med 2009; 2:29.

[21] El-Kholy A, Saied T, Gaber M, Younan M, Haleim M, El-Sayed H, et al. Device-associated nosocomial infection rates in intensive care units at Cairo University hospitals: first step toward initiating surveillance programs in a resource-limited country. Am J Infect Control 2012; 40:216–20.

[22] Inan A, Ozgultekin A, Akcay S, Engin D, Turan G, Ceran N, et al. Alterations in bacterial spectrum and increasing resistance rates in isolated microorganisms from device-associated infections in an intensive care unit of a teaching hospital in Istanbul (2004–2010). Jpn J Infect Dis 2012; 65:146–51.

[23] Edwards JR, Peterson KD, Mu Y, Banerjee S, Allen-Bridson K, Morrell G, et al. National Healthcare Safety Network (NHSN) report: data summary for 2006 through 2008, issued December 2009. Am J Infect Control 2009; 37:783–805.

[24] Rosenthal VD, Udwadia FE, Munoz HJ, Erben N, Higuera F, Abidi K, et al. Time-dependent analysis of extra length of stay and mortality due to ventilator-associated pneumonia in intensive-care units of ten limited-resources countries: findings of the International Nosocomial Infection Control Consortium (INICC). Epidemiol Infect 2011; 139:1757–63.

[25] Edwards JR, Peterson KD, Andrus ML, Tolson JS, Goulding JS, Dudeck MA, et al. NHSN facilities: National Healthcare Safety Network (NHSN)

Report, data summary for 2006, issued June 2007. Am J Infect Control 2007; 35:290–301.

[26] El-Feky E, Saleh D, El-Kholy J, Sayed A, Mansi Y, Hashem MJ. Use of personal digital assistants to detect healthcare-associated infections in a neonatal intensive care unit in Egypt. Infect Dev Ctries 2016; 10(11):1250–7.

[27] Nouetchognou JS, Ateudjieu J, Jemea B, Mesumbe EN, Mbanya D. Surveillance of nosocomial infections in the Yaounde University Teaching Hospital, Cameroon. BMC Res Notes 2016; 9:505.

[28] Tekin R, Dal T, Pirinccioglu H, Oygucu SE. A 4-year surveillance of device-associated nosocomial infections in a Neonatal Intensive Care Unit. Pediatrics and Neonatology 2013; 54: 303-308.

[29] Sharma DK, TiwariYK, Vyas N, Maheshwari RK. An investigation of the incidence of Nosocomial infections among the patients admitted in the intensive care unit of a tertiary care hospital in Rajasthan, India. Int J Curr Microbiol App Sci 2013; 2(10):428–35.

[30] Abdel-Wahab F, Ghoneim M, Khashaba M, El-Gilany AH, Abdel-Hady D. Nosocomial infection surveillance in an Egyptian neonatal intensive care unit. J Hosp Infect 2013; 83:196–99.

[31] Ahmed S, Daef E, Badary M. Nosocomial blood stream infection in intensive care units at Assiut University Hospitals (Upper Egypt) with special reference to extended spectrum b-lactamase producing organisms. BMC Res Notes 2009; 2:76.

[32] Jaggi N, Rodrigues C, Rosenthal VD, Todi S, Shah S, Saini N, et al. Impact of an International Nosocomial Infection Control Consortium multidimensional approach on central line-associated bloodstream infection rates in adult intensive care units in eight cities in India. Int J Infect Dis 2013; 17:1218–24.

[33] Saravu K, Prasad M, Eshwara V, Mukhopadhyay C. Clinico-microbiological profile and outcomes of nosocomial sepsis in an Indian tertiary care hospital—a prospective cohort study. Pathogens Global Health 2015; 109(5):228–235.

[34] Ak O, Batirel A, Ozer S, Çolakoğlu S. Nosocomial infections and risk factors in the intensive care unit of a teaching and research hospital: a prospective cohort study. Med Sci Monit 2011; 17(5):29–3.

[35] Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. JAMA 2009; 302:2323–9.