● **Original article**

RISK FACTORS FOR HEALTHCARE-ASSOCIATED INFECTIONS IN INTENSIVE CARE UNITS*

Marcia Cardoso Teixeira Sinésio[1], Marcia Cristina da Silva Magro[2], Tatiane Aguiar Carneiro[3], Kamilla Grasielle Nunes da Silva[4]

ABSTRACT: Objective: to identify patients and risk factors related to the occurrence of healthcare-associated infections in intensive care units. **Method:** cross-sectional study with 155 hospitalized patients between 2012 and 2014 in two intensive care units of two public hospitals of the Federal District. Data were collected from the medical records and recorded in a spreadsheet using the Microsoft Excel® program. Results with p-value <0.05 were considered significant. **Results:** of the total of 155 patients, 55 (35.5%) patients were affected by healthcare-associated infections during hospitalization in the intensive care unit. Length of stay (p=0.001), hospitalization due to clinical causes (p=0.017), diabetes mellitus (p=0.002) and elective surgery (p=0.011) were independent risk factors for these infections. **Conclusion:** infectious complications affected approximately one third of the patients in the intensive care setting. Surveillance of these complications may guide actions to improve the safety of critical patients.
KEYWORDS: Cross Infection; Intensive care units; Risk factors; Hospitals, public; Patients.

FATORES DE RISCOÀS INFECÇÕES RELACIONADAS À ASSISTÊNCIA EM UNIDADES DE TERAPIA INTENSIVA

RESUMO: Objetivo: identificar os pacientes e os fatores de risco associados à ocorrência de infecções relacionadas à assistência à saúde em unidades de terapia intensiva. **Método**: estudo transversal realizado com 155 pacientes internados entre 2012 e 2014 em duas unidades de terapia intensiva de dois hospitais públicos do Distrito Federal. Os dados foram coletados em prontuário e registrados em planilha no programa *Microsoft Excel*®. Foram considerados significativos resultados com *p-value*<0,05. **Resultados**: do total de 155 pacientes, 55 (35,5%) pacientes foram acometidos por infecções relacionadas à assistência à saúde durante a internação na unidade de terapia intensiva. Tempo de internação (p=0,001), internação por causas clínicas (p=0,017), *diabetes mellitus* (p=0,002) e cirurgia eletiva (p=0,011), foram fatores de risco, independentes para essas infecções. **Conclus**ão: as complicações infecciosas acometeram cerca de um terço dos pacientes no cenário de terapia intensiva. A vigilância dessas complicações pode orientar ações para melhoria da segurança do paciente crítico.
DESCRITORES: Infecção hospitalar; Unidades de terapia intensiva; Fatores de risco; Hospitais públicos; Pacientes.

FACTORES DE RIESGO A INFECCIONES ASOCIADAS A LA ASISTENCIA EN UNIDADES DE TERAPIA INTENSIVA*

RESUMEN: Objetivo: identificar los pacientes y los factores de riesgo asociados a la ocurrencia de infecciones relacionadas a la asistencia a la salud en unidades de terapia intensiva. **Método**: estudio transversal realizado con 155 pacientes internados entre 2012 y 2014 en dos unidades de terapia intensiva de dos hospitales públicos de Distrito Federal. Se recogieron los datos por medio de prontuario y se los registraron en programa *Microsoft Excel*®. Se consideraron significativos resultados con *p-value*<0,05. **Resultados**: del total de 155 pacientes, 55 (35,5%) pacientes tuvieron infecciones relacionadas a asistencia a la salud durante la internación en la unidad de terapia intensiva. Tiempo de internación (p=0,001), internación por causas clínicas (p=0,017), *diabetes mellitus* (p=0,002) y cirugía electiva (p=0,011), fueron factores de riesgo independientes. **Conclusión**: un tercio de los pacientes en el escenario de terapia intensiva tuvieron infección. La vigilancia de esas complicaciones puede orientar acciones para mejorar la seguridad del paciente crítico.
DESCRIPTORES: Infección hospitalaria; Unidades de cuidados intensivos; Factores de riesgo; Hospitales públicos; Pacientes.

*Article derived from the dissertation entitled: "The prevalence of healthcare-associated infections in intensive care units of public hospitals in Distrito Federal, Brazil." University of Brasília, 2016.

[1]Nurse. MSc in Nursing. Professor of the School of Health Sciences. Brasília, DF, Brazil.
[2]Nurse. PhD in Nursing. Professor of the Undergraduate and Post-Graduate Nursing courses of the University of Brasília. Brasília, DF, Brazil.
[3]Nurse. Specialist in Intensive Care Nursing. Nurse at the Regional Hospital of Gama. Brasília, DF, Brazil.
[4]Nurse. Specialist in Intensive Care Nursing. Orthopedic Hospital and Specialized Medicine Nurse. Brasília, DF, Brazil.

Corresponding Author:
Marcia Cardoso Teixeira Sinésio.
Escola Superior de Ciências da Saúde
CCSW 1 lote 5 - 70.680-150. Brasília-DF-Brazil
E-mail: marcia.sinesio@gmail.com

Received: 11/07/2017
Finalized: 05/04/2018

http://dx.doi.org/10.5380/ce.v23i2.53826

INTRODUCTION

Evidence-based infection control practices are essential, however, they pose a challenge for health institutions. Their success varies according to the contextual factors of the health system. In view of the increasing dependence of unified health systems, such as ANVISA, aimed at health promotion and protection and patient safety, research on this subject is necessary and timely.

Healthcare-associated infections represent a very frequent adverse event, affecting hospitalized patients, where the outcome is characterized by increases in morbidity, mortality, length of hospital stay and sequelae[1].

The risk of acquiring healthcare-associated infections is especially significant in intensive care units. European data showed a prevalence of 19.5% for infections in patients hospitalized in this sector, compared with 5.2% for infections acquired in other hospitalization units. Consequently, the use of antimicrobials was high and necessary in 56.5% of the patients in intensive care units[2]. The World Health Organization (WHO) estimates that the outcome is unfavorable for approximately 30% of patients affected by one or more episodes of healthcare-associated infections in intensive care settings[3].

It is well known that infection control procedures should be evidence-based. Although there is a wide range in the degree of adherence to healthcare programs and bundle of prevention of healthcare-associated infections, the transformations provided by these measures can be recognized. The nuances in the success of the implementation depend not only on the quality of the programs, but may also be related to the existing differences between the organizational contexts. This fact revitalizes the need to investigate the realities in different healthcare areas, especially in the critical patient scenario[1].

As one of the most common sources of preventable damage, healthcare-associated infections represent a great threat to patient safety. Recent estimates of national morbidity and mortality related to healthcare-associated infections show evidence of a major public health problem[4-5]. There are also indications of interventions and recommendations that can substantially reduce the incidence of healthcare-associated infections. It should be mentioned that between 20% and 30% of these infectious complications are preventable[2,4-5]. Therefore, the control of healthcare-associated infections represents the key to improving the quality of care and an opportunity to save lives and reduce costs[6].

Infection surveillance analysis is a key prerequisite for quality care and prevention of healthcare-associated infections. It is recognized that routine surveillance of these infections can reduce their incidence. However, in developing countries, due to a lack of formal surveillance, the healthcare-associated infection rate is high and compliance with hand hygiene is low, which increases the relevance of the topic[7].

Patient-related factors (age, nutritional status, pre-existing infection and comorbidities), procedures, technical difficulty and prolonged duration of surgery, preoperative preparation and inadequate sterilization of surgical instruments may significantly increase the risk of infection. The virulence, the invasiveness of the organism involved, the physiological state and the immune integrity of the host also represent some of the elements that may determine the occurrence or not of infection[8].

The occurrence of healthcare-associated infections in patients hospitalized in an intensive care unit will contribute to an increase in the length of stay, higher mortality and increased spending on drugs and materials[9-11]. These infectious complications may represent a burden for the patient, expressed in the increase of disease burden and in the establishment of an associated sepsis condition[12].

This study aimed to characterize the clinical condition of the patients and the risk factors related to the occurrence of healthcare-associated infections in intensive care units.

METHOD

This cross-sectional study of the prevalence of healthcare-associated infections was developed in two general intensive care units of two large public hospitals of the Federal District.

The quantitative approach was based on hospitalization data for the years 2012, 2013 and 2014. Data collection was performed in the first half of 2015.

For the random selection of participants, probabilistic sampling was used, based on the records of the hospital infection control center in the registry of admission and discharge of patients from the intensive care unit. Patients aged ≥18 years, admitted to the intensive care unit for more than 24 hours and without a history of healthcare-associated infection prior to admission to the intensive care units, according to the medical records were included. The following were excluded: patients with incomplete medical records, patients with suspected or medical diagnosis of brain death, pregnant women and women hospitalized in the puerperium.

For the sample calculation, the significance level of 5% and the statistical power of the test of 0.84 were considered. The sample consisted of 155 patients.

The data were recorded in a spreadsheet including items related to the clinical and laboratory diagnosis of the infections, types of intervention, devices and the etiologic agent in cases of laboratory confirmation. The prognostic indices of the Simplified Acute Physiology Score (SAPS), Sequential Organ Failure Assessment (SOFA), and the Acute Physiology and Chronic Health Evaluation Score (APACHE II) were calculated from the medical records during the first week of admission to the intensive care unit.

In this study, a healthcare-associated infection was considered if it was acquired after the admission of the patient, was associated with the hospitalization or hospital procedures and fulfilled the diagnostic criteria used by the center for the control of hospital infections, according to the determination of ANVISA[13].

The coding and registration of the database were performed using the Microsoft® 2010 Excel program. Statistical analysis was performed using the IBM® Statistical Package for the Social Sciences (SPSS®), version 23.

The results were expressed as absolute and relative frequencies, as medians and as quartiles (Q1 and Q3). Statistical analysis was performed using Fisher's exact test, the Mann-Whitney test and the chi-square test with Yates correction. P-values <0.05 were considered significant. A multivariate analysis was performed by means of the logistic regression model, with odds ratio (OR) calculations. All the independent variables that showed associations with the outcome, with $p \leq 0.05$, were included in the model.

This study was approved by the Research Ethics Committee of the Federal District State Health Department, under authorization No. 983.725 of March 12, 2015, with exemption from the signing the consent form as it was a retrospective study.

RESULTS

Of the total of 155 patients, 55 (35.5%) patients were affected by healthcare-associated infections during hospitalization in the intensive care unit. There was a tendency of increasing prevalence of healthcare-associated infections, especially between 2012 and 2013. In 2014, the situation remained stable (Figure 1).

Among the patients there was a predominance of males, with 87 men (56.1%), and a mean length of stay of 26 days was observed. The mean APACHE II score was 19±8, SAPS II 50±19 and SOFA 10±5, indicating a high risk of mortality. Despite this, 90 (58.1%) patients were discharged from the intensive care unit and 65 (41.9%) died.

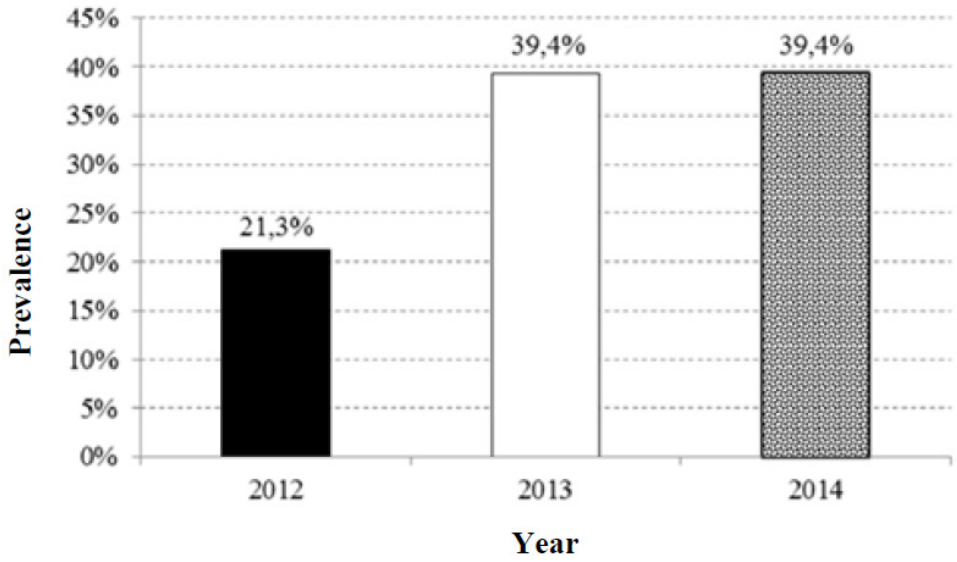

Figure 1 - Prevalence of healthcare-associated infections in patients admitted to intensive care units by year. Brasília, DF, Brazil, 2016

Source: The prevalence of healthcare-associated infections in intensive care units of public hospitals in Distrito Federal. University of Brasília, Brasília, DF, Brazil, 2016[14].

The patients predominantly came from the clinical and emergency sectors. The majority of the patients, 51 (32.9%), had systemic arterial hypertension as a previous disease. There were 17 (11%) patients with diabetes mellitus and 15 (9.7%) with chronic heart failure. Being overweight (mean body mass index of 25±6) was a characteristic of the group of patients analyzed, with 122 (76%) patients requiring invasive mechanical ventilation, the mean time of use of which was 21 days. More than half, 108 (69.7%) patients, used vasoactive drugs and 35 (23%) patients required hemodialysis.

Concerning patients with healthcare-associated infections, hospitalization for clinical reasons was a factor that showed a significant association (p=0.007). Systemic arterial hypertension, diabetes mellitus and chronic heart failure class I or II were the diseases that were significantly associated with the healthcare-associated infections, with p=0.05, p=0.001 and p=0.02, respectively. The use of vasoactive drugs and invasive mechanical ventilation also showed an association with healthcare-associated infections (p=0.001 and p=0.003, respectively) (Table 1).

Table 1 - Clinical variables related to the occurrence of healthcare-associated infections (HAIs) in the patients hospitalized in intensive care units between 2012 and 2014. Brasília, DF, Brazil, 2016. (continues)

Characteristics	With HAI (*n*=55) n (%)	Without HAI (*n*=100) n (%)	P-value
Male	32(58.2)	55(55)	0.800*
Age	59(50-73)	54(33-71)	0.060*
Body mass index.	24(20-28)	24(21-27)	0.900*
Comorbidities			
Hypertension	24(43.6)	27(27)	0.050*
Diabetes	13(23.6)	4(4)	0.001*
Chronic heart failure Functional class I or II (NYHA)	10(18.2)	5(5)	0.020*
COPD	05(9.1)	10(10)	0.900*

Stroke	06(10.9)	08(8)	0.400†
Cancer without metastasis	06(10.9)	04(4)	0.090*
Use of vasoactive drugs	48(87.3)	60(60)	0.001*
Use of mechanical ventilation	51(92.7)	71(71)	0.003*
Hemodialysis	16(29.1)	19(19)	0.200*
Clinical hospitalization	44(80)	59(59)	0.007*
Elective surgery in the ICU	09(16.4)	01(1)	0.001†
Emergency surgery in the ICU	03(5.5)	03(3)	0.400†
Glasgow	03(3-13)	10(3-15)	0.010*
APACHE II	20(17-27)	19(11-25)	0.060*
SAPS II	57(39-63)	49(29-66)	0.300*
SOFA	11(7.5-15)	09(6-14)	0.200*
Length of VAD use	09(3-19)	04(2-7)	0.001*
Length of mechanical ventilation use	22(13-42)	08(5-16)	0.001*
Length of ICU stay	40(17-67)	11(6-18)	0.001*
Discharge	29(52.7)	61(61)	0.400*
Death	26(47.3)	39(39)	

*Chi-square test with Yates correction; †Fisher's test. NYHA - New York Heart Association; COPD - chronic obstructive pulmonary disease; ICU - intensive care unit; APACHE - Acute Physiology and Chronic Health Evaluation Score; SAPS - Simplified Acute Physiology Score; SOFA - Sequential Organ Failure Assessment; VAD - vasoactive drugs.
Source: The prevalence of healthcare-associated infections in intensive care units of public hospitals in Distrito Federal. University of Brasília, Brasília, DF, Brazil, 2016[14].

Patients that developed healthcare-associated infections showed longer periods of use of vasoactive drugs, invasive mechanical ventilation and hospitalization; the degree of association in all situations was significant (p=0.001).

Patients who used orotracheal tube, tracheostomy, and long-term urinary catheter during their hospitalization in the intensive care unit were more likely to acquire a healthcare-associated infections, with this relationship being significant (p=0.005, p=0.001 and p=0.05, respectively). The duration of the devices (orotracheal tube, tracheostomy, arterial catheter, central venous catheter, hemodialysis catheter, long-term urinary catheter and nasoenteric tube) also contributed to the higher occurrence of healthcare-associated infections (p=0.001, p=0.001, p=0.007, p=0.001, p=0.040, p=0.001 and p=0.001, respectively) (Table 2).

Table 2 - Relationship between device use and occurrence of healthcare-associated infections. Brasília, DF, Brazil, 2016. (continues)

Characteristics	With HAI (n=55) n (%)	Without HAI (n=100) n (%)	P-value
Use of orotracheal tube	50(90.9)	70(70)	0.005*
Use of tracheostomy cannula	31(56.4)	21(21)	0.001*
Use of arterial catheter	26(47.3)	38(38)	0.300*
Use of central venous catheter	53(96.4)	86(86)	0.080*
Use of hemodialysis venous catheter	16(29.1)	19(19)	0.200*
Use of peripheral venous catheter	12(21.8)	32(32)	0.200*
Use of long-term urinary catheter	54(98.2)	90(90)	0.050†
Use of thoracic drain	6(10.9)	10(10)	0.900*

Use of abdominal drain	03(5.5)	10(10)	0.300†
Use of nasoenteric catheter	45(81.8)	73(73)	0.100*
No pre-ICU infection	24(43.6)	42(42)	0.400*
Length of use of orotracheal tube	14(10-16)	08(5-14)	0.001*
Length of use of tracheostomy cannula	40(27-67)	12(9-28)	0.001*
Length of use of arterial catheter	13(8-28)	7(4-13)	0.007*
Length of use of central venous catheter	39(16-54)	11(7-19)	0.001*
Length of use of hemodialysis venous catheter	14(7-32)	07(2-12)	0.040*
Length of use of peripheral venous catheter	3.5(2-8)	03(1.5-6)	0.500*
Length of use of long-term urinary catheter	37(18-56)	11(6-19)	0.001*
Length of use of thoracic drain	13(9-14)	12(6-20)	0.600*
Length of use of abdominal drain	30(20-34)	10(7-13)	0.110*
Length of use of nasoenteric catheter	27(14-68)	10(6-17)	0.001*

*Chi-square test with *Yates* correction; †Fisher's test; ICU - intensive care unit
Source: The prevalence of healthcare-associated infections in intensive care units of public hospitals in Distrito Federal. University of Brasília, Brasília, DF, Brazil, 2016[14].

The use of invasive devices, such as arterial catheter (p=0.001), central venous catheter (p=0.005) and peripheral venous catheter (p=0.003), and hemodialysis catheter (p=0.001) indicated a greater risk for non-survival of the critical patient in the intensive care setting.

The method of diagnostic confirmation of infection was predominantly clinical, however, in 25 (45.4%) patients the laboratory method was adopted.

According to the laboratory tests, in the 52 (94.5%) cases of bloodstream infection, the predominant microorganisms were multiresistant *Serratia marcescens* in 7 (13.4%) cases and oxacillin-resistant *Staphylococcus aureus* in 5 (9.6%) cases.

In 14 (25.4%) patients that acquired healthcare-associated infection at the pulmonary site, pneumonia determined by multidrug-resistant *Pseudomonas aeruginosa* were the most frequent, with 3 (21.4%) cases, followed by multiresistant, coagulase-negative *Acinetobacter baumannii* and staphylococcus strains, both with 2 (14.3%) cases each. At the urinary site, 15 (27.3%) episodes of infection occurred. Of these, the most frequent included Gram-negative bacteria in 4 (26.7%) cases and yeasts in 2 (13.3%).

The multivariate analysis showed that the length of stay in the intensive care unit (95% confidence interval - 95%CI 1.03-1.09; OR=1.06; p=.000), clinical hospitalization (95%CI, 1.30-14.67; OR=4.36; p=0.017), diabetes mellitus (95%CI, 2.32-38.04; OR=9.34; p=0.002) and elective surgery (95%CI 2.10-336.65; OR=26.61; p=0.011) were the independent risk factors for healthcare-associated infections.

● DISCUSSION

Data derived from scientific evidence presented in the last decade show that progress has been made in the prevention of specific types of healthcare-associated infections, which at one time were seen as inevitable events[7]. However, this retrospective analysis indicated that 55 (35.5%) patients hospitalized in the intensive care units of this study, in the years from 2012 to 2014, presented some type of healthcare-associated infection as complications.

It was possible to perceive the increase in the prevalence of healthcare-associated infections from the year 2012 to 2013, with the stabilization of this scenario in 2014 possibly being related to the mandatory creation of Patient Safety Centers by ANVISA. One of the responsibilities of these centers is the notification of adverse health events to the National Health Surveillance System, including healthcare-associated infections[15].

The higher rate of mortality among patients with healthcare-associated infections may be related to the fact that this group includes more severe patients, as indicated by the high values of the prognostic indices, as well as longer stays in the intensive care unit and longer use of vasoactive drugs and mechanical ventilation, findings also identified in other studies[16-18].

From this perspective, the prognostic indices, when properly applied, can quantify the severity of the disease and guide therapeutic interventions. Thus, their application becomes imperative, especially in the intensive care unit, including patients with infectious conditions so that care is provided promptly and the quality of care is guaranteed[7,19].

The frequent and often prolonged use of invasive devices and vasoactive drugs was associated, in this study, with the emergence of healthcare-associated infections, which justifies the need for adherence to infection prevention practices by the care team. Evidence shows that in European countries and the United States of America healthcare-associated infections occur in 7.1% and 4.5% of individuals, respectively. However, in developing countries this percentage is even higher, 15.5%[20]. It should be mentioned that developing countries, due to low budgets for health spending, show limitations for the organized control of different health complications, common in the hospital setting, among them healthcare-associated infections. Sometimes, the lack of standardization of different health practices demonstrates the inefficiency of the service in establishing protocols and procedures[20]. Creating awareness in managers will certainly provide guidance of actions, a fact that will favor the training of professionals for safe, quality care, in addition to reducing the burden on the health system.

Data from scientific evidence, such as this study, has shown that there are factors such as the presence of comorbidities, including systemic arterial hypertension, diabetes mellitus and chronic heart disease, which determine organ dysfunctions and influence the immunosuppression of patients. Thus, these factors may contribute to the appearance of healthcare-associated infections[6]. The conditions of the patient upon admission are expressed by the severity scores, which indicate greater vulnerability and deterioration of the bodily systems, culminating in a greater requirement for invasive interventions, which are related to the development of infections.

An increasing proportion of healthcare-associated infections are related to antimicrobial resistant pathogens, such as Staphylococcus aureus and multiresistant Gram-negative bacilli[21-23].

In this study, the prevalence of multiresistant *Serratia marcescens* and oxacillin-resistant *Staphylococcus aureus* was identified in the bloodstream. The pulmonary site was characterized by multiresistant *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. It has been shown that Gram-negative bacteria are more commonly isolated than Gram-positive bacteria in patients with healthcare-associated infections. Species such as *Pseudomonas aeruginosa* and *Acinetobacter baumannii* have been identified as the most common causes in the intensive care setting[7].

Scientific evidence, in addition to revealing healthcare-associated infections as universal, has highlighted that etiological agents vary among procedures, among health professionals, from hospital to hospital or even among different wards within the same hospital and according to the geographical location of the health units. In the last few years, the prevalence of Gram-negative microorganisms as the cause of serious infections has increased in many hospitals. The problem is more complicated in developing countries, due to the limited practices of infection control, hospital overcrowding and inappropriate use of antimicrobials[8,24].

The global burden of healthcare-associated infections is underestimated because data and resources are limited. Few low- and middle-income countries have national healthcare-associated infections surveillance programs and this culminates in poor infection prevention and control[25]. In the majority of developing countries human resources are insufficient. There is little experience in the design and implementation of surveillance programs, in addition to reduced availability of microbiology laboratories in the hospitals[26]. Critical patients are exposed to the potential risk of complications due to the complex and invasive nature of the treatments, due to the procedures required by those receiving intensive care and due to the severity of their health conditions[27].

The implementation of individual interventions can improve patient care, however, the establishment of several simple measures simultaneously, as a prevention bundle, is more likely to improve the outcomes. This is imperative to be able to control and prevent the various episodes of healthcare-associated infections, common in the care setting, and to increase the safety of critical patients[27].

The length of hospitalization and diabetes mellitus are also factors that have been related to healthcare-associated infections, as verified in the present study[7,17]. It has been reported that diabetes mellitus, due to its severity, triggers immunological alteration, causing immunosuppression, which may predispose to the occurrence of healthcare-associated infections by multidrug resistant bacteria present in the intensive care unit environment[7].

In the present study, elective surgery showed an association with the occurrence of healthcare-associated infections. In this context, scientific evidence indicates that surgery per se is an event that contributes to the occurrence of healthcare-associated infections, regardless of the type of intensive care unit, whether surgical or clinical[28].

Although a limitation of this study was the use of retrospective data from secondary sources, it was possible to verify that the risk factors associated with the occurrence of healthcare-associated infections serve as a warning of the need for an active national infection surveillance system. In turn, this highlights the reduced financial resources for the implementation of healthcare-associated infection prevention measures and the insufficient adherence of health professionals to these measures; such as hand hygiene[20,29]. However, the control and prevention as feasible strategies that must be incorporated by professionals, managers and health institutions is important in order to modify the national health landscape.

● CONCLUSION

Healthcare-associated infections affected approximately one-third of the patients admitted to the intensive care units in this study. The risk factors for healthcare-associated infections in the intensive care setting were the length of stay in the intensive care unit, clinical hospitalization, elective surgery and diabetes mellitus.

The study allowed the impact of healthcare-associated infections for hospitalized patients in an intensive care unit to be verified. The use of data from secondary sources is a limiting factor in cross-sectional studies, however, it is a relatively low cost method and is used to investigate the pattern of occurrences of an event by calculating its frequency and distribution within a population.

When verifying the prevalence of healthcare-associated infections, it is possible to estimate the impact of the event on a community or population, with the purpose of guiding human and financial resources and actions aimed at prevention or control, since the occurrence of infections is a serious and silent public health problem. When considering the impact on health expenditures, to rationalize spending and improve patient safety, broad accountability of public managers to address this problem is necessary. From the analysis of the frequency and the factors associated with the occurrence, it is possible to guide actions of surveillance, prevention and control of these infectious complications for safer care for critical patients.

● REFERENCES

1. Sax H, Clack L, Touveneau S, Jantarada Fda L, Pittet D, Zingg W.PROHIBIT study group. Implementation of infection control best practice in intensive care units throughout Europe: a mixed-method evaluation study. Implement Sci. [Internet] 2013;8(24) [accessed on 27 Mar 2017]. Available at: https://dx.doi.org/10.1186/1748-5908-8-24.

2. European Centre for Disease Prevention and Control (ECDC). Point prevalence survey of healthcare associated infections and antimicrobial use in European acute care hospitals 2011-2012. [Internet] Stockholm:ECDC; 2013[accessed on 11 Dec 2017]. Available at: https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/healthcare-associated-infections-antimicrobial-use-PPS.pdf.

3. World Health Organization(WHO). Report on the burden of endemic health care-associated infection worldwide. [Internet] Geneva: WHO; 2011 [accessed on 11 Dec 2017]. Available at: http://apps.who.int/iris/bitstream/10665/80135/1/9789241501507_eng.pdf?ua=1&ua=1.

4. Centers for Disease Control and Prevention (CDC). Making health care safer: reducing bloodstream infections. Division of Healthcare Quality Promotion. Vital signs. [Internet] 2011;60(8) [accessed on 23 Jan 2018]. Available at: https://www.cdc.gov/vitalsigns/pdf/2011-03-vitalsigns.pdf.

5. Centro Nazionale di Epidemiologia, Sorveglianza e Promozione della Salute. Infezioni correlate all'assistenza, aspetti epidemiologici. [Internet] [accessed on 11 Dec 2017]. Available at: http://www.epicentro.iss.it/problemi/infezioni_correlate/epid.asp.

6. Zimblichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, *et al*. Health care-associated infections: a meta-analysis of costs and financial impact on the US health care system. JAMAIntern Med. [Internet] 2013;173(22) [accessed on 27 Mar 2017]. Available at: http://dx.doi.org/10.1001/jamainternmed.2013.9763.

7. Datta P, Rani H, Chauhan R, Gombar S, Chander J. Health-care-associated infections: Risk factors and epidemiology from an intensive care unit in Northern India. Indian J Anaesth. [Internet] 2014;58(1) [accessed on 24 Mar 2017].Available at: http://dx.doi.org/10.4103/0019-5049.126785.

8. Negi V, Pal S, Juyal D, Sharma MK, Sharma N. Bacteriological Profile of Surgical Site Infections and Their Antibiogram: A Study From Resource Constrained Rural Setting of Uttarakhand State, India. J Clin Diagn Res. [Internet] 2015;9(10) [accessed on 24 Mar 2017].Available at: https://dx.doi.org/10.7860/JCDR/2015/15342.6698.

9. Hu B, Tao L, Rosenthal VD, Liu K, Yun Y, Suo Y, et al. Device-associated infection rates, device use, length of stay, and mortality in intensive care units of 4 Chinese hospitals: International Nosocomial Control Consortium findings. Am J Infect Control.[Internet] 2013;41(4) [accessed on 03 Jul 2017]. Available at: http://dx.doi.org/10.1016/j.ajic.2012.03.037.

10. Nangino GO, Oliveira CD, Correia PC, Machado NM, Dias AT. Financial impact of nosocomial infections in the intensive care units of a charitable hospital in Minas Gerais, Brazil. Rev bras. ter. intensiva. [Internet]2012;24(4) [accessed on 27 Mar 2017]. Available at: http://dx.doi.org/10.1590/S0103-507X2012000400011.

11. Kübler A, Duszynska W, Rosenthal VD, Fleischer M, Kaiser T, Szewczyk E, et al. 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. J Crit Care.[Internet] 2012;27(1) [accessed on 03 Jul 2017]. Available at: http://dx.doi.org/10.1016/j.jcrc.2011.05.018.

12. Rodríguez F, Barrera L, de La Rosa G, Dennis R, Dueñas C, Granados M, *et al*. The epidemiology of sepsis in Colombia: a prospective multicenter cohort study in ten university hospitals. Crit Care Med.[Internet] 2011;39(7) [accessed on 03 Jul 2017]. Available at: http://dx.doi.org/10.1097/CCM.0b013e318218a35e.

13. Agência Nacional de Vigilância Sanitária (ANVISA). Série Segurança do Paciente e Qualidade em Serviços de Saúde: Critérios diagnósticos de infecções relacionadas à assistência à saúde [Internet] Brasília: ANVISA; 2013[accessed on 27 Nov 2016].Available at:http://www20.anvisa.gov.br/segurancadopaciente/images/documentos/livros/Livro2-CriteriosDiagnosticosIRASaude.pdf.

14. Sinésio MCT, Magro MCS. Prevalência de pacientes adultos com infecção relacionada à assistência à saúde em unidades de terapia intensiva de hospitais públicos do Distrito Federal [dissertação]. Brasília (DF):Universidade de Brasília; 2016.

15. Agência Nacional de Vigilância Sanitária. Resolução RDC n. 36, de 25 de julho de 2013. Institui ações para a segurança do paciente em serviços de saúde e dá outras providências. Diário Oficial da União, Brasília: ANVISA; 2013.

16. Silva E, Dalfior JuniorL, Fernandes HS, Moreno R, Vincent JL. Prevalence and outcomes of infections in Brazilian ICUs: a subanalysis of EPIC II study. Rev bras. ter.intensiva. [Internet] 2012;24(2) [accessed on 24 Mar 2017]. Available at: http://dx.doi.org/10.1590/S0103-507X2012000200008.

17. Rodriguez-Acelas AL, de Abreu Almeida M, Engelman B, Canon-Montanez W. Risk factors for health care–associated infection in hospitalized adults: Systematic review and meta-analysis. Am J Infect Control. [Internet] 2017;45(12) [accessed on 11 Dec 2017]. Available at: https://doi.org/10.1016/j.ajic.2017.08.016.

18. Van Vught LA, Klein Klouwenberg PMC, Spitoni C, Scicluna BP, Wiewel MA, Horn J, et al.MARS Consortiumincidence, risk factors, and attributable mortality of secondary infections in the intensive care unit after admission for sepsis. JAMA. [Internet]2016;315(14) [accessed on 24 Mar 2017]. Available at: http://dx.doi.org/10.1001/jama.2016.2691.

19. Keegan MT, Soares M. What every intensivist should know about prognostic scoring systems and risk-adjusted mortality. Rev bras.ter. intensiva. [Internet] 2016;28(3) [accessed on 23 Jan 2018]. Available at: http://dx.doi.org/10.5935/0103-507X.20160052.

20. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. [Internet] 2011;377(9761) [accessed on 27 Mar 2017]. Available at: https://www.ncbi.nlm.nih.gov/pubmed/21146207.

21. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, *et al*. Multistate point-prevalence survey of health care–associated infections. N Engl J Med.[Internet] 2014;370(13) [accessed on 24 Mar 2017].Available at: http://dx.doi.org/10.1056/NEJMoa1306801.

22. Centers of Disease Control and Prevention (US). Department of Health and Human Services. Centers for Disease and Control and Prevention. Antibiotic resistance threats in the United States.[Internet]Atlanta: US; 2013[accessed on 27 Nov 2016]. Available at: https://www.cdc.gov/drugresistance/pdf/ar-threats-2013-508.pdf.

23. Roca I, Akova M, Baquero F, Carlet J, Cavaleri M, Coenen S, et al. The global threat of antimicrobial resistance: science for intervention. New Microbes New Infect [Internet]. 2015;6 [accessed on 27 Mar 2017]. Available at: https://dx.doi.org/10.1016/j.nmni.2015.02.007.

24. Ahmed MI. Prevalence of nosocomial wound infection among postoperative patients and antibiotics patterns at teaching hospital in Sudan. N Am J Med Sci. [Internet]. 2012;4(1) [accessed on 03 Jul 2017]. Available at: http://dx.doi.org/10.4103/1947-2714.92900.

25. Talaat M, El-Shokry M, El-Kholy J, Ismail G, Kotb S, Hafez S, et al. National surveillance of health care-associated infections in Egypt: Developing a sustainable program in a resource-limited country. Am J Infect Control.[Internet] 2016;44(11) [accessed on 03 Jul 2017]. Available at: http://dx.doi.org/10.1016/j.ajic.2016.04.212.

26. Dudeck MA, Weiner LM, Allen-Bridson K, Malpiedi PL, Peterson KD, Pollock DA, et al. National Healthcare Safety Network (NHSN) report, data summary for 2012, Device-associated module. Am J Infect Control.[Internet] 2013;41(12) [accessed on 03 Jul 2017]. Available at: http://dx.doi.org/10.1016/j.ajic.2013.09.002.

27. Lisboa T, Rello J. Towards zero rate in healthcare-associated infections: one size shall not fit all…Crit Care. [Internet] 2013;17(139) [accessed on 27 Mar 2017]. Available at: https://dx.doi.org/10.1186/cc12590.

28. Yue D, Song C, Zhang B, Liu Z, Chai J, Luo Y, et al. Hospital-wide comparison of health care-associated infection among 8 intensive care units: A retrospective analysis for 2010-2015. Am J Infect Control.[Internet] 2017;45(1) [accessed on 03 Jul 2017]. Available at: http://dx.doi.org/10.1016/j.ajic.2016.10.011.

29. Apostolopoulou E, Raftopoulos V, Filntisis G, Kithreotis P, Stefanidis E, Galanis P, et al. Surveillance of Device-Associated Infection Rates and Mortality in 3 Greek Intensive Care Units. Am J Crit Care [Internet] 2013;22(3) [accessed on 27 Mar 2017]. Available at: http://dx.doi.org/10.4037/ajcc2013324.