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ORIGINAL ARTICLE

Characterization of healthcare-related infections in an adult intensive care unit

Caracterização das infecções relacionadas a assistência à saúde em unidade de terapia intensiva adulto

Caracterización de las infecciones relacionadas con la asistencia sanitaria en una unidad de cuidados intensivos para adultos

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ABSTRACT

Background and Objectives: Infections related to health care have gradually increased in recent years and occurs more often in intensive care units than in other hospital admissions. The characteristics of the population and infections must be assessed to develop and apply preventive measures. Therefore, we aimed to characterize infections related to health care in patients in an adult intensive care unit in 2019. **Methods**: A quantitative, descriptive and retrospective study, performed in the adult intensive care unit of a reference, regional and tertiary hospital in the countryside of the state of São Paulo. We included data from patients over 18 years old who were in the adult intensive care unit of that hospital and diagnosed with infections officially related to health care in 2019. The data were analyzed by the descriptive statistics, Student's t-test for quantitative variables and Pearson's chi-square test for the categorical ones. The study was approved and excused of the written informed consent form (WICF) by the Human Research Ethics Committee. **Results:** The participants' mean age was 55.6 years old (19.7 standard deviation), affecting mostly men (64%) and with comorbidities (72%), and the systemic arterial hypertension was the most prevalent one (43%). Regarding procedures and devices, most were on mechanical ventilation (87%), sedated (77%), using an indwelling urinary catheter (96%) and with a central venous catheter (94%). The isolated microorganism with the highest incidence was *Klebsiella Pneumoniae* (9%). Vancomycin was the most used antibiotic against microorganisms (66%). As an outcome, 47% of patients were discharged and 53% died. **Conclusion:** *Klebsiella Pneumoniae* was the most prevalent microorganism as well as the respiratory tract infections. The age was the only variable related to the outcome.

Keywords: *Infection control. Nursing. Critical care.*

RESUMO

Justificativa e Objetivos: as infecções relacionadas à assistência à saúde aumentaram gradativamente nos

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últimos anos e sua ocorrência em unidades de terapia intensiva é maior que em outras internações hospitalares. Para desenvolver e aplicar medidas preventivas é necessário primeiramente conhecer as características da população atendida e das infecções; assim o objetivo foi caracterizar as infecções relacionadas à assistência à saúde nos pacientes internados em Unidade de Terapia Intensiva Adulto em 2019. **Métodos:** estudo quantitativo, descritivo, retrospectivo realizado em Unidade de Terapia Intensiva Adulto de um hospital de referência, regional e terciário no interior do estado de São Paulo. Foram incluídos dados de pacientes maiores de 18 anos que estiveram internados nas Unidades de Terapia Intensiva Adulto do referido hospital, com diagnóstico confirmado de infecções relacionadas à assistência à saúde em 2019. Os dados foram analisados por meio de estatística descritiva, teste t de *student* para as variáveis quantitativas e Qui-quadrado de Pearson para as categóricas. O trabalho foi aprovado com dispensa do Termo de Consentimento Livre e Esclarecido (Tcle) pelo Comitê de Ética em Pesquisa com Seres Humanos. **Resultados:** a média de idade dos participantes foi de 55,6 anos (desvio padrão 19,7) com acometimento maior no sexo masculino (64%) e com comorbidades (72%), sendo hipertensão arterial sistêmica a mais prevalente (%). Quanto aos procedimentos e dispositivos, a maioria estava em ventilação mecânica (87%), sedado (77%), em uso de sonda vesical de demora (96%) e com cateter venoso central (94%). O microrganismo isolado com maior incidência foi *Klebsiella Pneumoniae* (9%). O antibiótico mais utilizado para combater os microrganismos foi Vancomicina (66%). Como desfecho, 47% dos pacientes tiveram alta e 53% evoluíram para o óbito. **Conclusão:** Dentre as infecções analisadas, o microrganismo mais prevalente foi a *Klebsiella Pneumoniae* e as infecções do trato respiratório foram as mais prevalentes; a idade foi a única variável relacionada ao desfecho.

Descritores: *Controle de Infecções. Enfermagem. Cuidados Críticos.*

RESUMEN

Justificación y objetivos: las tasas de infecciones relacionadas con la asistencia sanitaria se han incrementado paulatinamente en los últimos años, y su incidencia en unidades de cuidados intensivos es mayor que en las demás unidades. Considerando que para desarrollar y aplicar medidas preventivas, es necesario conocer las características de la población atendida y las infecciones, el objetivo de este estudio fue caracterizar las infecciones relacionadas con la atención de salud en pacientes hospitalizados en una Unidad de Cuidados Intensivos de Adultos en el año 2019. **Métodos:** estudio cuantitativo, descriptivo, retrospectivo realizado en el sector de cuidados intensivos para adultos de un hospital regional de referencia terciario en el interior del estado de São Paulo. Se incluyeron datos de pacientes mayores de 18 años que fueron hospitalizados en las unidades de cuidados intensivos para adultos de ese hospital y que tenían un diagnóstico confirmado de infecciones relacionadas con la asistencia sanitaria en 2019. **Resultados:** La edad media de los pacientes fue de 55,6 años (desviación estándar 19,7) con mayor afectación en varones (64%) y con comorbilidades (72%), de las cuales la hipertensión arterial sistémica fue la más prevalente. En cuanto a los procedimientos y dispositivos, la mayoría fue con ventilación mecánica (87%), sedación (77%), con catéter urinario permanente (96%) y con catéter venoso central (94%). El microorganismo aislado con mayor incidencia fue Klebsiella Pneumoniae (9%). El antibiótico más utilizado para combatir los microorganismos fue la vancomicina (66%). Como resultado, el 47% de los pacientes fueron dados de alta, y el 53% falleció. **Conclusión:** La estadía promedio fue de 16.8 días, la tasa de mortalidad del 53% y el microorganismo más encontrado la Klebsiella Pneumoniae (9%). Las infecciones del tracto respiratorio fueron las más prevalentes, y la edad fue la única variable relacionada con el resultado.

Palabras clave: *Control de Infecciones. Enfermería. Cuidados críticos.*

INTRODUCTION

Intensive Care Units (ICUs) have high technological complexity that receive patients with severe morbidities and dysfunctions, requiring continuous monitoring and complex care. Since it is characterized as a critical area, with unstable patients, There is a high risk of developing infections related to health care (IRHC).[1,2] IRHC, classified as adverse events, are infections acquired during health care and represent one of the largest public health problems, with high morbidity and mortality.[3]

IRHC can start in many foci, such as respiratory, bloodstream, or urinary tract. Among them, the ones in the respiratory tract are the most complicated, such as pneumonia (PNM) and respiratory disorders due to orotracheal intubation, such as ventilator-associated tracheobronchitis (VAT) and ventilator-associated pneumonia (VAP). These infections are defined by their occurrence after 48 hours of intubation and have an incidence of 5 to 15% in ICUs with high mortality.[4-7]

IRHC also includes bloodstream-associated infections that usually occur in two situations, primary bloodstream infections (BSI) and vascular access infections (VAI). In the first case, the infections are associated with the catheter and develop severe consequences, such as bacteremia or sepsis. VAI, in turn, occurs at the catheter insertion place, without systemic repercussion.[8]

Health care in ICUs increases the costs of the hospital, since it uses many high-cost drugs, requires a specialized and numerous team, and uses more frequent and high-tech care tests.[9-11] Prevention is then essential,

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considering the costs of this type of hospitalization, reduced availability of beds and the increase in hospital stay caused by an infection.

The IRHC that affect ICU patients relate to the clinical severity of these patients, the use of many invasive devices and immunosuppressants, long hospital stay and reckless use of antimicrobials. Besides, the environment of these units provides a natural selection of several microorganisms, which causes microbial resistance.[2,12]

The rates of these infections have gradually increased in recent years. They are mainly responsible for the lethality from hospital infections of ICU patients and more prevalent in these sectors. The broad therapeutic care and the peculiarities of care of ICU patients associate with many conditions for the dissemination of resistant pathogens, increasing the possibility of contamination from these infectious agents.[1,2,13]

Due to the severity of IRHC and its high cost, health care providers increased their initiatives to reduce incidence, thus improving the quality of care. Permanent education and teaching strategies for the teams are part of the initiatives.[14]

Therefore, prevention measures are essential for safe and qualified care; however, the characteristics of the population and the infections must be assessed to develop and apply these preventive measures. Thus, our study aims to characterize infections related to health care in patients in an adult ICU in 2019.

METHODS

This is a quantitative, retrospective and descriptive study. The main purpose of a descriptive study is to characterize a phenomenon or population and establish a relationship between the variables. One of its characteristics is the use of the data collection technique, such as the questionnaire and systemic observation. This design portrays facts, indicates their frequency and qualifies the information.[15,16]

The study was developed in the adult ICU of a reference, regional and tertiary hospital in a city in the countryside of the state of São Paulo. The hospital has two adult ICUs, one specific for cardiovascular pathologies and one general ICU, with ten beds for each ICU. The collection was based only on the data from the general ICU. All patients from the database of the Service Control for Infections Related to Health Care (SCIRAS) over 18 years old, who were admitted to the hospital's ICU and diagnosed with IRHC in 2019, were included.

After prior training and under supervision of a researcher, SCIRAS database was explored by two other researchers to find patients who met the established criteria.

This survey was conducted for three days with the aid of an instrument to obtain the following variables: initial focus, treatment, outcome, gender, age, days of ICU stay, associated morbidities, use of mechanical ventilation, sedation, central venous catheter, indwelling urinary catheter, isolated microorganisms, other microorganisms and sensitivity profile.

The recorded data were entered in spreadsheets of the Microsoft Excel program® and then analyzed by descriptive statistics, the Student's *t*-test for quantitative variables and Pearson's chi-square test for categorical ones using IBM SPSS Statistics 22 software®. A 5% significance level (α) was considered.

This study was approved by the Human Research Ethics Committee of the Centro Universitário Central Paulista (CAAE: 32830020.5.0000.5380), according to opinion number 4,125,815, and required no written consent.

RESULTS

In 2019, we identified 47 patients with IRHC admitted to the general adult ICU of the study hospital, in which some were diagnosed with more than one infection. The mean age among patients was 55.6 years old (19.7 standard deviation), mostly men (64%), and the mean length of hospital stay was 16.8 days (13.24 standard deviation). As an outcome, 47% were discharged, and 53% died.

Table 1 shows that the age of the patients relates to the outcome (p = 0.049), based on the relationship between outcome and age, hospital stay and days of sedation. With higher mortality for patients with older age.

Table 1. Description of the relationship between the outcome and age, hospital stay and days of sedation among patients admitted to the adult ICU, São Carlos, SP. 2020.

	Discharge	Death	p value*
Age			
Mean	49.65	60.92	0.049
Standard deviation	20.511	17.715	
Hospital stay			
Mean	15.59	17.96	0.547
Standard deviation	13.968	12.762	
Days of sedation			
Mean	4.09	2.96	0.352
Standard deviation	5.145	2.937	

**Student's t-test*

The patients' main comorbidities were: Systemic arterial hypertension (SAH) (43%), stroke (26%), respiratory disorders (19%), diabetes mellitus (17%), heart diseases (13%), renal insufficiency (11%), and obesity (9%); although 13 patients (28%) did not present this data in medical records.

Most patients were on mechanical ventilation (87%), sedated (77%) — the mean days of sedation was 4.58 (4.12 standard deviation) —, using an indwelling urinary catheter (96%) and a central venous catheter (94%).

Most infections identified were VAT (38%), followed by VAP (28%), pneumonia (PNM) (21%) and bloodstream-associated infections (10%).

The main isolated microorganism was *Klebsiella Pneumoniae* (KPC) (9%), followed by *Pseudomonas Aeruginosa* (6%), *Acinetobacter Baumannii* (4%),

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Streptococcus PNM (4%), *Staphylococcus Aureus S.* (4%), *Pseudomonas Fluorescens S.* (2%), *Staphylococcus Epidermidis* (2%), *Streptococcus Aureus* (2%) and *Serratia Marcescens* (2%). Among the patients, 30 (64%) did not present growth of an isolated microorganism in culture.

Table 2 describes the analysis of the relationship between outcomes and variables of gender, infectious focus, mechanical ventilation, central venous catheter, indwelling urinary catheter and isolated microorganism, without significant association.

Table 2. Description of the relationship between the outcome and age, hospital stay and days of sedation among patients admitted to the adult ICU, São Carlos, SP. 2020.

	Discharge % (n)	Death % (n)	p value*
Gender			
Male	27.65 (13)	36 (17)	0.558
Female	19 (9)	17 (8)	
Main infectious focus			
VAP	9 (4)	19 (9)	0.505
PNM	11 (5)	11 (5)	
VAT	17 (8)	21 (10)	
BSI-C	2 (1)	0	
BSI-Lab	4 (2)	2 (1)	
VAI	2 (1)	0	
Mechanical ventilation			
Yes	40 (19)	45 (21)	0.820
No	6 (3)	9 (4)	
Central venous catheter			
Yes	43 (20)	49 (23)	0.894
No	4 (2)	4 (2)	
Indwelling urinary catheter			
Yes	45 (21)	51 (24)	0.926
No	2 (1)	2 (1)	
Isolated microorganism			
Staphylococcus Aureus S.	2 (1)	2 (1)	0.250
Pseudomonas Fluorescens S.	0	2 (1)	
Pseudomonas Aeruginosa	0	6 (3)	
Streptococcus PNM	0	4 (2)	
Staphylococcus Epidermidis	0	2 (1)	
Acineto Baumannii	0	4 (2)	
Streptococcus Aureus	2 (1)	0	
Klebsiella pneumoniae	4 (2)	4 (2)	
Serratia	2 (1)	0	
Absent	36 (17)	28 (13)	

**Pearson's Chi-square test*
VAP: Ventilator-Associated Pneumonia; PNM: Pneumonia; VAT: Ventilator-Associated Tracheobronchitis; BSI-C: Primary Bloodstream Infection - Clinical; BSI-Lab: Primary Bloodstream Infection - Laboratorial; VAI: Vascular Access Infection.

The main antibiotics were used to treat the infections. Vancomycin (66%), Clindamycin (60%), Meropenem (55%), Gentamycin (40%), Polymyxin (34%), Oxacillin (26%), Clavulin (23%), Rocefin (17%), Cefuroxime (13%) and Amikacin (13%).

DISCUSSION

The high prevalence of these infections often influences an unfavorable outcome for the patients in this unit.[17,18] In our study, the mean hospital stay was 16.8 days. The literature describes that prolonged hospital stay may contribute for the development of new infections or worsening in the clinical condition.[2]

In our study, infections were prevalent in men, contrary to other similar studies, which showed prevalence in women (60%).[18] This data may relate to a regional characteristic of the population assisted in that hospital.

The literature[19] describes that the presence of comorbidities among patients can increase by approximately twice the risk of death.

In the study by Oliveira et al.,[2] they found the microorganisms *Acinetobacter Baumannii* (36.3%), followed by *Klebsiella Pneumoniae* (11%). Compared to another study,[20] the main microorganisms associated with the etiology of hospital infections were *S. Aureus* (12.98%), *A. Baumannii* (9.61%) and *Klebsiella sp* (4.32%). The results of these other studies differ from our study regarding the predominant microorganisms, possibly because of the characteristics of each health service.

The carbapenemases-producing *Klebsiella Pneumoniae* (KPC), is a bacterium restricted to the hospital environment. Its main characteristic is the production of a betalactamase enzyme called carbapenemase, which inhibits carbapenem antibiotics. This bacterium can cause IRHC in immunosuppressed patients and in the ICU patients who have multiple entry routes for contamination that facilitate infection by multidrug-resistant bacteria.[21]

Other similar studies showed data on the antibiotic resistance profile for the treatment of infections, in which the most resistant ones were Imipenem (15.59%), Amikacin (14.65%), Ceftazidime (12.35%), Vancomycin (12.35%) and Ceftriaxone (8.33%).[22]

Regarding invasive devices, only one patient did not use it, while the others used at least one device, such as an indwelling urinary catheter (96%), central venous catheter (94%) and mechanical ventilation (85%). Comparing these data with a similar study, we observed that most patients also used invasive procedures and devices, such as indwelling urinary catheters (70%), mechanical ventilation (49.9%) and central venous catheters (49.6%), which confirm their high rate of use in intensive care.[2]

Most infections in our study occurred due to ventilation-associated tracheobronchitis (VAT), based on the analysis of rates and characteristics. Another study described respiratory tract infections as the most prevalent ones (65.3%), followed by bloodstream infections (17.8%) and urinary tract infections (16.9%),[22] which is similar to our study. Respiratory tract infections are mainly caused by inoculation of the pathogen in the patient's respiratory tract. Intubated patients lose the natural anatomical barrier between the oropharynx and trachea, removing the cough reflex and accumulating secretions, which allows greater colonization and aspiration of contaminated secretions to the lower airways. The long use of mechanical ventilation in patients with orotracheal

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intubation is associated with an increase in morbidity and mortality in the ICU.[2]

The outcome of our study showed that 47% of the patients were discharged and 53% died. Age was the only variable significantly related to the outcome (p = 0.049), with higher mortality in individuals over 60 years old. A similar study found a higher incidence of infections in older adults, but without a significant relationship with the outcome.[18] Another study also showed a higher prevalence of infections in patients over 50 years old and, as in our study, and obtained a significant relationship between outcome and age, which suggests an increase in mortality associated with older adults.[19] Aging is considered a risk factor for infections related to health care, especially respiratory tract infections. The physiological changes in this process may hinder early diagnosis and worsen the infectious condition[23-24].

As a limitation of our study, we cite the absence of some data in the records of some patients, such as comorbidities and isolated microorganism in the initial focus, resulting in gaps of information.

As implications for the practice, we emphasize that this type of study allows the identification of the hospital's profile of infections and to direct prevention actions for quality care, with an efficient and effective multidisciplinary team.

We aimed to characterize infections related to health care in patients admitted to an adult ICU in 2019, which contributes to support other studies on infection control, by demonstrating the importance and value of an efficient SCIRAS in hospitals, with the participation of health care providers to avoid major care-related problems and possible infectious complications.

The mean length of hospital stay was 16.8 days for patients with hospital infections. Mortality was 53% among patients, and discharge, 47%. The most common resistant microorganisms responsible for infections were *Klebsiella Pneumoniae* (KPC) (9%), followed by *Pseudomonas Aeruginosa* (6%). VAT was the most prevalent infection, affecting 38% of patients, followed by VAP (28%) and pneumonia (21%). We concluded that the mean age was the only prevalent variable to the outcome of the patients' clinical condition. Therefore, we note the importance of preventive actions toward patients aged ≤ 60 years of age, and those intubated and tracheostomized in ICUs.

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AUTHORS' CONTRIBUTION:

Natasha Eduarda Baldavia and **Riane Baffa Da Silva** contributed to the conception, data collection, analysis and writing of the article;

Amanda de Assunção Lino contributed to the planning and design of the article, review and final approval of the article;

Danielle Cristina Garbuio contributed to the conception, planning, analysis and review of the article.

All authors approved the final version of the manuscript and declared themselves responsible for all aspects of the article, guaranteeing their accuracy and integrity.