ORIGINAL ARTICLE

Nursing care and epidemiological profile of patients with ventilator-associated pneumonia

Cuidados de enfermagem e perfil epidemiológico de pacientes com pneumonia associada à ventilação mecânica

Cuidados de enfermería y perfil epidemiológico de pacientes con neumonía asociada a ventilador

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ABSTRACT

Background and Objectives: to assess the epidemiological profile of patients diagnosed with ventilator-associated pneumonia (VAP) in an Intensive Care Unit (ICU) and to investigate nursing care adequacy. **Methods:** a quantitative retrospective cohort study, applied in the ICU of a hospital in the countryside of Rio Grande do Sul. It involved 100% of medical records of patients over 20 years of age, in the year 2019, who developed VAP. **Results:** a total of 3,215 patients were on invasive mechanical ventilation (IMV), and of these 13 developed VAP (2.47%). Most were men (76.92%), with a mean age of 60.3 years, whose main causes of hospitalization were heart problems (30.77%), multiple trauma (30.77%) and stroke (15.39%). The main pathogens found in tracheal aspirates were *Acinetobacter sp.* (15%) and *Pseudomonas aeruginosa* (15%). The mean ICU stay was 30.61 days, and 61.53% died. For nursing care assessment, the mean checklist of the VAP bundle applied was calculated, according to the number of days in VMI. The result was 2.62 checklists per day, with the institution recommending four. **Conclusion:** the study made it possible to know the epidemiological profile of patients with VAP, in addition to observing the need for improvement in nursing care, considering that the checklist completion was below the recommended.

Keywords: Ventilator-Associated Pneumonia; Nursing Care; Epidemiological Profile.

RESUMO

Justificativa e Objetivos: avaliar o perfil epidemiológico de pacientes diagnosticados com pneumonia associada à ventilação mecânica (PAVM) em Unidade de Terapia Intensiva (UTI) e investigar a adequação dos cuidados de enfermagem. Métodos: estudo quantitativo de coorte, retrospectivo, aplicado na UTI de um hospital do interior

do Rio Grande do Sul. Envolveu 100% dos prontuários de pacientes com mais de 20 anos de idade, no ano de 2019, que desenvolveram PAVM. **Resultados:** estiveram em ventilação mecânica invasiva (VMI) 3.215 pacientes e, desses, 13 desenvolveram PAVM (2,47%). A maioria era homens (76,92%), com média de idade de 60,3 anos, cujas principais causas de internação foram problemas cardíacos (30,77%), politraumatismo (30,77%) e acidente vascular cerebral (15,39%). Os principais patógenos encontrados nos aspirados traqueais foram *Acinetobacter sp* (15%) e *Pseudomonas aeruginosa* (15%). A média de permanência na UTI foi de 30,61 dias, e foram a óbito 61,53%. Para avaliação dos cuidados de enfermagem, foi calculada a média de *checklist* do *bundle* de PAVM, aplicados, conforme a quantidade de dias em VMI. O resultado foi de 2,62 *checklists* por dia, sendo que a instituição preconiza quatro. **Conclusão:** o estudo permitiu conhecer o perfil epidemiológico dos pacientes com PAVM, além de observar a necessidade de melhora nos cuidados de enfermagem, considerando que a realização do *checklist* ficou abaixo do recomendado.

Palavras-chave: Pneumonia Associada à Ventilação Mecânica; Cuidados de Enfermagem; Perfil Epidemiológico.

RESUMEN

Justificación y Objetivos: evaluar el perfil epidemiológico de pacientes con diagnóstico de neumonía asociada a ventilación mecánica (NAVM) en una Unidad de Cuidados Intensivos (UCI) e investigar la adecuación de los cuidados de enfermería. **Métodos:** estudio de cohorte cuantitativo, retrospectivo, aplicado en el UCI de un hospital del interior de Rio Grande do Sul. Involucró el 100% de las historias clínicas de pacientes mayores de 20 años, en el año 2019, que desarrollaron NAVM**. Resultados:** un total de 3.215 pacientes estaban en ventilación mecánica invasiva (VMI), y, de estos, 13 desarrollaron NAVM (2,47%). La mayoría eran hombres (76,92%), con una edad media de 60,3 años, cuyas principales causas de hospitalización fueron problemas cardíacos (30,77%), politraumatismos (30,77%) y accidentes cerebrovasculares (15,39%). Los principales patógenos encontrados en los aspirados traqueales fueron *Acinetobacter sp* (15%) y *Pseudomonas aeruginosa* (15%). La estancia media en UCI fue de 30,61 días, y falleció el 61,53%. Para la evaluación de la atención de enfermería, se calculó el *checklist* promedio del *bundle* VAP aplicado, de acuerdo con el número de días en VMI. El resultado fue de 2,62 *checklists* por día, y la institución recomendó cuatro. **Conclusión:** el estudio posibilitó conocer el perfil epidemiológico de los pacientes con NAVM, además de observar la necesidad de mejoría en la atención de enfermería, considerando que el llenado del *checklist* estuvo por debajo de lo recomendado.

Palabras clave: Neumonía Asociada a Ventilación Mecánica; Cuidado de Enfermera; Perfil Epidemiológico.

INTRODUCTION

The Intensive Care Unit (ICU) is a place of great complexity that provides care to patients who need a greater number of invasive procedures and greater surveillance of clinical conditions and therefore has a multidisciplinary team for care.[1] Historically, the care criteria in an ICU follow Florence Nightingale's principles of care carried out in the Crimean War with the classification according to injury severity, where the most serious soldiers needed more intensive care.[2]

In this scenario, complications related to the care provided may occur, the so-called healthcare-associated infections (HAIs). HAI appearance and transmission arise due to some failure in the assistance provided by the team, whether due to inadequate planning, incorrect technique in execution or lack of compliance with standard precautionary measures. Among the most common HAIs in ICU patients is ventilator-associated pneumonia (VAP). IRAS, according to the Brazilian National Health Regulatory Agency (ANVISA - *Agência Nacional de Vigilância Sanitária*), are classified as an adverse event and are very frequent in health services.[3]

The First Patient Safety Yearbook, published in 2017, showed that in the world, in 2016, there were 421 million hospitalizations and 42.7 million adverse events occurred.[4] In the United States of America, adverse events occurring in hospitals are the third leading cause of death, second only to cardiovascular diseases and neoplasms. In Brazil, out of 19,128,382 hospitalized people, 1,377,243 were affected by at least one adverse event during their hospitalization. The conditions acquired within health services, in 2016, show an expense of more than 15 billion reais for government spheres. These numbers relate to the assistance model provided in the country, with several parameters that do not meet the minimum requirements to guarantee quality care.[4]

The numbers brought by the safety yearbook are largely due to the development of HAIs such as VAP and lead to the need to use invasive mechanical ventilation (IMV) in the presence of acute respiratory failure (ARF) and when there is difficulty in performing gas exchange.[5] Studies show that patients using IMV develop pneumonia associated with it due to aspiration of gastric contents, with an incidence of 50% in patients with brain injuries.[6] VAP are considered cases in which patients develop the infection after 48 hours of starting IMV.[7] As a way to reduce mortality, a package of measures was created to prevent VAP appearance, called a "bundle", through low-cost actions and care, which aims to prevent care-related injuries and help reduce mortality rates, especially within the ICU. These norms cover actions such as raising the head of the bed between 30 and 45º, oral hygiene with chlorhexidine, checking the possibility of extubation, reducing sedation, cleaning and changing the mechanical

respirator circuit and maintaining cuff pressure.[5-8]

The worldwide mortality rate from VAP ranges from 20% to 60% of cases. In Brazil, there are still no concrete data on prevalence and mortality rates, as many hospitals do not have specific diagnostic protocols. VAP notification became mandatory for ANVISA in the ICU as of 2017. Rates may vary depending on the available diagnostic methods and the affected population.[9,10]

Therefore, this study aimed to assess the epidemiological profile of patients diagnosed with VAP in the ICU and to investigate nursing care adequacy.

METHODS

This is a retrospective cohort study carried out in the ICU of a medium-sized hospital located in the countryside of Rio Grande do Sul, which has 20 adult ICU beds. The survey was carried out with 100% of medical records of patients aged over 20 years who were admitted to the ICU and who developed VAP in 2019. The option for that year was due to avoiding the pandemic period, in which there was a very large increase in patients admitted to the ICU and who required mechanical ventilation.

Data collection took place after approval by the local Research Ethics Committee under Opinion 5,273,427 and CAAE 54557621.0.0000.5310 of March 4, 2022. Data were collected in the first half of March 2022, directly from patients' electronic medical record made available on the Philips Tasy system. The information from the list of medical records was taken from an Excel spreadsheet made available by the Hospital Infection Control Center (HICC) of the researched institution. As a form of organization, two data collection worksheets were used, one with general variables and one specific for collecting bundles. The variables used were gender, age group, profession, underlying pathology, number of days in the ICU, time elapsed since the beginning of IMV until diagnosis of VAP, culture of pathogens, use of tobacco, alcohol or other drugs, carrying out the daily bundle/checklist and the sector of origin of patients to the ICU.

For nursing care assessment, it was considered that the institution has a checklist with care present within the protocol of VAP prevention measures, which must be applied four times a day, every six hours. Therefore, the number of days that patients spent on IMV and the number of checklists applied on each day were observed. Analysis was descriptive statistics using mean and standard deviation measures. For VAP cases, the absolute and relative frequency of patients on IMV was calculated. As a way of calculating the checklist average of the applied measures package, the number of checklists performed was used in the numerator and the sum of days on IMV for the 13 patients was used as the denominator.

It should be noted that in 2019 the VAP checklist was implemented in the institution. In cases where patients are extubated, the institution does not apply bundle care.

RESULTS

From January to December 2019, 3215 patients were on IMV and of these, 13 developed VAP (2.47%). As for the sociodemographic profile of these 13 patients, ten were men (76.92%) aged between 26 and 87 years (mean age 60.3 years). Regarding occupation, eight patients were retired (61.53%), one farmer (7.69%), one pensioner (7.69%), one driver (7.69%), one unemployed (7.69%) and one performed general services (7.69%). The causes of ICU admissions are shown in table 1.

Table 1. Causes of ICU admission of patients who had VAP, RS, Brazil (2019).

Causes	n (%)
Stroke	2 (15.39)
Cardiac complications (AMI and surgery)	4 (30.77)
Polytrauma	4 (30.77)
Traumatic brain injury (TBI) and subarachnoid hemorrhage	2 (15.39)
Sudden dyspnea	1 (7.69)

The mean stay of these patients in the ICU was 30.61 days with a standard deviation of 22.44. The average time between IMV installation and VAP diagnosis was 12.47 days with a standard deviation of 6.78.

The pathogen causing VAP was not identified in only one (7.69%) patient. In the medical records of two patients, aspiration VAP diagnosis was recorded in the team's evolution. In other medical records, only tracheal aspirate culture result was recorded, not reporting the diagnosis of the reason for VAP. Aspirate culture results are described in table 2.

Table 2. Pathogens found in tracheal aspirates.

Pathogen	n (%)
Acinetobacter sp	2 (15)
Klebsiella sp	1 (7.69)
Staphylococcus aureus	1 (7.69)
Pseudomonas aeruginosa	2 (15)
Enterobacter sp	1 (7.69)
Serratia	1 (7.69)
Acinetobacter sp and Staphylococcus aureus	1 (7.69)
Klebsiella sp and Acinetobacter sp	1 (7.69)
Acinetobacter sp and *Pseudomonas aeruginosa*	1 (7.69)
Klebsiella sp and Pseudomonas aeruginosa	1 (7.69)
Not identified	1 (7.69)

Pathogen culture results took more than seven days in approximately all patients (rare exceptions), which can make the diagnosis difficult due to hemodynamic instability that patients were experiencing. The most prescribed antibiotics were Meropenem, Polymyxin B

and Cefepime. A total of 10 patients (83.33%) remained under contact precautions and 2 patients (16.67%) without contact precautions due to the presence of *Serratia sp*. and *Enterobacter sp*. Regarding the origin of patients before entering the ICU, only one (7.69%) came from the Surgical Center and the others (92.30%) were admitted through the institution's emergency department. Regarding the outcome of these patients, 5 (38.47%) were discharged from the ICU and 8 (61.53%) died, and 2 (25%) were discharged from the ICU, but later died in another sector. With regard to the presence of alcohol and tobacco use, two (15.39%) had some degree of alcoholism and five (38.47%) used tobacco, four of which died.

As a way of analyzing nursing care, the average checklist performed during hospitalization was calculated, with the care provided in the bundle. The average result of applying the measurement protocol was 2.62 checklists per day. It should be noted that it was observed that in some patients there were days when care was not recorded. For two patients (15.39%), there was no collection for two days during the period on IMV, one patient (7.69%) remained three days without collection and one (7.69%) remained four days without collection. All four patients evolved to death and 9 (69.23%) who were admitted to the ICU already had endotracheal intubation due to hemodynamic instability and did not tolerate ventilator weaning well.

DISCUSSION

The ICU is a place of extreme complexity, with a high risk of HAI, also considered as adverse events and among them VAP, with an estimated mortality rate of 13%.[11] In the USA, in 2017, 157,000 cases of pneumonia were reported and of these, 39% were VAP.[12]

The main triggering reason for VAP is due to aspiration of secretions present in the upper airways or reflux of gastric content.[13] Intubated patients have a reduced level of consciousness due to the presence of sedation, thus accumulating secretions in the oropharynx, resulting in microaspirations.[14]

The patients' profile showed that most cases of VAP were men, with a mean age of 55 years. The authors observed that the mean time from the start of IMV to VAP diagnosis was 30.14 days, with the main causes of development being the occurrence of adverse events, older patient age, presence of comorbidities, waiting to perform complementary exams and presence of infections.[15] In the research carried out, a shorter time of diagnosis can be observed, which may suggest reduced care.

The most common bacteria found in tracheal aspirates were *S. aureus*, *Haemophilus ssp* and *P. aeroginosa*.[16] In patients' tracheal aspirates, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* were observed in up to two thirds of the strains, showing resistance to carbapenems.[12] In this research, in the aspirate, *Acinetobacter baumanii* and *P. aeroginosa* were found more frequently.

In this study, patients with the presence of *Serratia sp* and *Enterobacter sp* in the tracheal aspirate

were not maintained under contact precautions due to multidrug-resistant negativity in the antibiogram according to medical record analysis. According to ANVISA's manual for infection prevention by multidrug-resistant microorganisms in health services, both pathogens can be multidrug-resistant, and contact precautions are indicated only in the presence of resistance to carbapenems and cephalosporins.[17] Drug resistance is caused by changes in bacteria that reduce the antibiotic's effectiveness.[18]

Acinetobacter baumannii is considered opportunistic (does not cause community infection) and is the main cause of VAP. Its emergence is associated with several factors such as hemodynamic instability and the need for more invasive measures for stabilization, long hospital stay, recent surgeries, among other situations. This same process takes place with *Pseudomonas aeruginosa*. As a way to prevent and control the spread of these two bacteria, professionals should clean their hands and equipment, use closed aspiration systems, culture the pathogen and also the surfaces, and isolate patients infected with multidrug-resistant microorganisms.[5] These bacteria easily sustain themselves in hostile environments. Its tolerance to low humidity rates and biofilm formation are the main characteristics for the high prevalence in the ICU and mainly for VAP appearance considering the use of artificial tracheal tubes and the presence of humidity inside them, when used in IMV.[14]

As VAP requires a longer hospital stay and a higher cost for government spheres, the Institute for Health Care Improvement (IHI) created the VAP bundle, also called a package of measures aimed at prevention based on mortality rates.[6] The institution where the research was carried out uses a checklist of actions that were created based on the VAP measurement package where professionals indicate the care that was carried out and which was not, and ideally it should be applied every six hours, four times a day. In the research, the daily average of application of care was 2.62 checklists performed, a little more than half a day. This deficit in care increases the chance of staying in the ICU, making it difficult for patients to improve and may lead to more severe complications such as death.[19]

The care provided in the package includes raising the head of the bed, reducing the risk of secretion bronchoaspiration, especially when exposing and manipulating the airways, and prevents bacteria present in the oral cavity from migrating to the lungs.[12] The prophylaxis of gastric ulcers due to stress is a preventive measure, since agents that raise gastric pH can promote the growth of bacteria, which can lead to the development of infection in case of bronchoaspiration.[10] Oral hygiene with chlorhexidine makes it difficult to create a biofilm, a reservoir for pathogens.[20] The cuff pressure must be checked according to institutional protocols and be between 20 and 30 cmH_2O to prevent bronchoaspiration from occurring, if the pressure is below the recommended level, or tracheal injury, when the value is above the recommended level.[12]

Another study on the epidemiological profile addresses the percentage of development of VAP in

36.6% of the 186 intubated patients. The main causes of ICU admission were diseases of the central nervous system, heart disease and trauma with a median from intubation to the beginning of VAP of 4 days. In pathogen culture, *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus aureus* were found representing only 5.9% of positive cultures, but which were treated with an association between meropenem and vancomycin and piperacillin and tazobactam empirically. There was no result indicating contact precautions, habits or percentage of death. The authors conclude that there are no specific studies investigating VAP's clinical epidemiology.[21]

The main microorganisms are resistant to carbapenem antibiotics, being indicated as the main choices in polymyxin B and tigecycline treatment in cases of infection by *Acinetobacter baumannii*. For microorganisms resistant to these mentioned antibiotics, the choices should be based on the antibiogram. More than 70% of *P. aeruginosa* are susceptible to polymyxin, amikacin, piperacillin/tazobactam, meropenem, and imipenem. *E. coli* and *K. pneumoniae* are highly susceptible to carbapenems. Vancomycin and linezolid remain highly active against MRSA strains.[22]

Within the ICU, there is a need to have a multidisciplinary team to prevent VAP and other health problems through teamwork, relying on periodic training, continuing education and permanent education. This teamwork optimizes the service in the ICU, helps prevent VAP and strengthens the care provided by the nursing team to critical patients.[23]

In the researched institution, checklists were verified by the nursing technicians, only airway aspiration was carried out by nurses. The nursing team is directly involved in carrying out this care according to institutional protocols and is responsible for performing most of the preventive care. Nurses take over a leadership role by acting as supervisors of the nursing team and are responsible for ensuring that the necessary training is carried out for HAI prevention, including VAP. Nurses should observe the difficulties and needs of their team and promote permanent education together with the multidisciplinary team. [23]

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AUTHORS' CONTRIBUTIONS

Amanda Fell Kich and **Cássia Regina Gotler Medeiros** contributed to article conception, design, data collection and analysis; **Graziella Gasparotto Baiocco** and **Camila Marchese** contributed to the review and final approval of the article.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.