

ORIGINAL ARTICLE

Epidemiological profile of patients with ventilation-associated pneumonia in a teaching hospital

Perfil epidemiológico de pacientes com pneumonia associada à ventilação mecânica de um hospital escola

Perfil epidemiológico de pacientes con neumonía asociada a ventilación mecánica en un hospital universitario

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ABSTRACT

Background and Objectives: Ventilator-associated pneumonia may occur within 48 to 72 hours after endotracheal intubation and mechanical ventilation, being the most frequent infection in intensive care units, linked to increased mortality. This research aims to identify the epidemiological profile of patients with ventilator-associated pneumonia in the intensive care unit of a teaching hospital. **Methods:** This is a cross-sectional, retrospective, documentary study with a quantitative approach. The data collection was carried out using a semi-structured instrument with data made available by the Hospital Infection Control Commission and in the electronic medical records of patients diagnosed with ventilator-associated pneumonia, from July to December 2022. Data were organized using the Excel software and subsequently analyzed with the program Statistical Package for Social Science for Windows, using descriptive statistics. **Results:** Most individuals were male (59.6%), aged 60 years or older (53.9%), retired (48.3%), nondrinkers (61.8%), nonsmokers (66.3%), with pre-existing comorbidities (62.9%), hospitalized due to trauma (23.6%), enteral nutrition (97.8%), *Klebsiella pneumoniae* pathogenic agent (15.7%), using endotracheal tube (91.7%), not requiring reintubation (67.4%), not presenting multidrug resistance (59.6%), and the clinical outcome was death (65.2%). **Conclusion:** There is still a need for specific interventions and measures for critically ill patients. It is expected that the variables found may contribute to promoting patient safety on mechanical ventilation and help to develop prevention strategies in order to reduce the incidence of ventilator-associated pneumonia.

Keywords: *Pneumonia, Ventilator-Associated. Intensive Care Units. Health Profile.*

RESUMO

Justificativa e Objetivos: A pneumonia associada à ventilação mecânica (PAV) ocorre

a partir de 48 a 72 horas após a intubação endotraqueal e ventilação mecânica, sendo a infecção mais frequente nas unidades de terapia intensiva, vinculada ao aumento da mortalidade. Esta pesquisa tem como objetivo identificar o perfil epidemiológico de pacientes com PAV em Unidades de Terapia Intensiva de um hospital escola. **Métodos:** Trata-se de um estudo transversal, retrospectivo, documental, com abordagem quantitativa. A coleta foi realizada através de instrumento semiestruturado, com dados disponibilizados pela Comissão de Controle de Infecção Hospitalar e nos prontuários eletrônicos dos pacientes com diagnóstico de PAV, entre julho a dezembro de 2022. Os mesmos foram organizados no software Excel e, posteriormente, analisados através do programa SPSS®, versão 22, mediante estatísticas descritivas. **Resultados:** A maioria era do sexo masculino (59,6%), faixa de etária de 60 anos ou mais (53,9%), aposentados (48,3%), não etilistas (61,8%), não tabagista (66,3%), com comorbidades preexistentes (62,9%), diagnóstico de internação por trauma (23,6%), nutrição enteral (97,8%), agente patogênico *Klebsiella pneumoniae* (15,7%), em uso de tubo endotraqueal (91,7%), não precisaram de reintubação (67,4%), não tiveram multirresistência (59,6%), e apresentaram como desfecho clínico óbito (65,2%). **Conclusão:** O perfil epidemiológico se caracteriza pelo sexo masculino, com idade igual ou superior a 60 anos, com comorbidades, vítima de trauma e com desfecho clínico desfavorável ao óbito. Espera-se que as variáveis encontradas possam contribuir para promover a segurança do paciente em ventilação mecânica e ajudar a desenvolver estratégias de prevenção, a fim de reduzir a incidência de PAV.

Descritores: *Pneumonia Associada à Ventilação Mecânica. Unidades de Terapia Intensiva. Perfil de Saúde.*

RESUMEN

Justificación y Objetivos: La neumonía asociada a ventilación mecánica (NAVVM) ocurre entre 48 y 72 horas después de la intubación endotraqueal y ventilación mecánica, por lo que es la infección más frecuente en las unidades de cuidados intensivos asociada al aumento de la mortalidad. Este estudio tiene como objetivo identificar el perfil epidemiológico de los pacientes con neumonía asociada a ventilación mecánica en la unidad de cuidados intensivos de un hospital universitario. **Métodos:** Se trata de un estudio transversal, retrospectivo, documental, con enfoque cuantitativo. La recogida de datos se realizó mediante un instrumento semiestruturado con datos facilitados por la Comisión de Control de Infecciones Hospitalarias y en los registros electrónicos de pacientes con diagnóstico de NAVVM, en el período de julio a diciembre de 2022. Los datos se pusieron en *software* Excel para, posteriormente, pasar por un análisis mediante el programa *Statistical Package for Social Science para Windows*, versión 22, utilizando estadística descriptiva. **Resultados:** La mayoría de los participantes fueron hombres (59,6%), mayores de 60 años (53,9%), jubilados (48,3%), no bebedores (61,8%), no fumadores (66,3%), con comorbilidades preexistentes (62,9%), diagnóstico de hospitalización por traumatismos (23,6%), nutrición enteral (97,8%), agente patógeno *Klebsiella pneumoniae* (15,7%), en uso de tubo endotraqueal (91,7%), no requirieron nueva intubación (67,4%), no presentaron multirresistencia (59,6%) y tuvieron como desenlace clínico muerte (65,2%). **Conclusión:** El perfil epidemiológico se caracterizó por sexo masculino, de 60 años o más, con comorbilidades, víctima de traumatismos y desenlace clínico desfavorable de muerte. Se espera que las variables encontradas puedan contribuir a promover la seguridad del paciente en la ventilación mecánica y ayudar a desarrollar estrategias de prevención para reducir la incidencia de NAVVM.

Palabras Clave: *Neumonía Asociada al Ventilador. Unidades de Cuidados Intensivos. Perfil de Salud.*

INTRODUCTION

Intensive care unit (ICU) is a continuous monitoring ward of hospitals that provides care to critically ill patients with hemodynamic instability and high risk of death. Due to this complexity and numerous invasive procedures performed, patients face a high risk of developing Healthcare-associated infections (HAIs).¹

HAIs are characterized as adverse events that persist in health services, and are considered a serious public health issue, as they put patient safety at risk, in addition to negatively affecting the quality of health services. It is important to emphasize that most HAIs can be avoided.²

Ventilator-associated pneumonia (VAP) is one of the most common HAIs in an ICU, which may occur within 48 to 72 hours after endotracheal intubation, with a high mortality rate. This infection prolongs the duration of hospital stay and mechanical ventilation (MV), considerably increasing treatment costs.³

To obtain the diagnosis of VAP, clinical, radiological, and laboratory criteria should be used; the most important are: the presence of hyperthermia (temperature $\geq 37.8^{\circ}\text{C}$), with no other related cause; the change in secretion characteristics; worsening gas exchange with the need to increase oxygen supply or increase ventilatory parameters; and alteration in pulmonary auscultation. After diagnosis of underlying heart or lung diseases, medical imaging tests should be performed to obtain the following measurement: infiltration, opacification, and cavitation. Laboratory tests should show changes in blood culture without other points of infection, leukopenia ($< 4,000 \text{ cel}/\text{mm}^3$) or leukocytosis ($> 12,000 \text{ cells}/\text{mm}^3$), positive result for pleural fluid culture, positive result for culture of pulmonary secretions obtained by alveolar bronchial lavage or tracheal aspirate.⁴

The literature indicates different mortality rates caused by VAP, but it is estimated that approximately 33% of patients with VAP died as a direct result of the infection, and the overall mortality associated with it varies from 20% to 60%, depending on associated risk factors.⁵

A study carried out in an ICU in Buenos Aires identified that some patients were diagnosed more than once with VAP and there was a predominance of the disease in male patients: 50% of them were aged over 70 years, and the mortality rates at 30 and 90 days after the infection diagnosis were 30% and 63.7%, respectively.⁶ Therefore, it is necessary

to identify the epidemiological profile of patients with VAP, since they involve possible risk factors.

This research is justified, for it may contribute to the hospitals awareness of these patients' profile, thus being able to develop strategies to improve the provided care, aiming at reducing VAP rates, implementing specific and intensive care, instructing the multidisciplinary team using protocols, training, continuing education, and continuous monitoring of these means. Moreover, it may also contribute to the emergence of new scientific research on VAP, which may help both professionals and lay people to better understand the disease, how it occurs, and why this infection affects more than one specific patient profile.

Thus, this study aimed to identify the epidemiological profile of patients with VAP in ICU of a teaching hospital.

METHODS

This is a cross-sectional, retrospective, documental study, with a quantitative approach, carried out in the ICU of a teaching hospital, which only hospitalizes patients via the Brazilian Unified Health System (SUS), provides 40 regular beds in the unit, and is a reference in trauma and orthopedics, serving 12 municipalities that make up the 3rd Regional Health District of Paraná.

The study population consisted of 89 patients who were hospitalized in the adult ICU of a teaching hospital and who were diagnosed with ventilator-associated pneumonia from July to December 2022. The inclusion criteria was patients aged 18 years or older, who were hospitalized and diagnosed with VAP during hospitalization. Patients aged under 18 years or those whose medical records were not fully available were excluded from the study.

Data collection was carried out using a semi-structured instrument, with information provided by the Hospital Infection Control Committee (CCIH) of the institution and consultation of the patients' electronic medical records, using the Tasy information system. Following the variables of interest: sociodemographic (sex, age group, occupation) and clinical-epidemiological (alcoholism, smoking, preexisting comorbidity, hospitalization diagnosis, enteral nutrition, pathogen, airway management, reintubation, multidrug resistance, outcome, previous and total days of hospitalization, and ventilation).

The data collected in the medical records were organized and tabulated in Excel

program and analyzed by the program Statistical Package for Social Science for Windows (SPSS®) version 22, using descriptive statistics of absolute and relative frequency.

This study was submitted to the Research Ethics Committee of Cesumar University, according to opinion No. 6,054,902 CAAE No. 69280823.9.0000.5539, respecting the recommendations contained in Resolutions No. 466/2012, No. 510/2016 and No. 580/2018 of the National Health Council (CNS), which provides for the guidelines and standards for research involving human beings.

RESULTS

Of the 89 patients hospitalized with VAP, 53 (59.6%) were male; 48 (53.9%) were aged 60 years or older, with a average age of 57.8 years; 43 (48.3%) were retired; 55 (61.8%) did not drink; 59 (66.3%) were nonsmokers; 56 (62.9%) had comorbidities such as systemic arterial hypertension (SAH), diabetes mellitus (DM), and chronic obstructive pulmonary disease (COPD) (Table 1).

Regarding hospitalization diagnoses, trauma was the most common cause, with 21 (23.6%) cases; followed by respiratory insufficiency (n = 15; 16.9%); stroke (n = 15; 16.9%); lowered level of consciousness (n = 11; 12.4%); and other causes (n = 27; 30.2%) (Table 1).

Regarding other variables, 87 (97.8%) were under enteral nutrition; pathogens were identified in 40.4% of the patients: *Klebsiella pneumoniae* in 14 (15.7%) patients; *Acinetobacter baumannii* in 9 (10.1%); *Staphylococcus aureus* in 7 (7.9%); *Pseudomonas aeruginosa* in 6 (6.7%) patients; and *Enterobacter cloacae* in 6 (6.7%) patients. Regarding the device, 81 (91.1%) used an endotracheal tube; 80 (67.4%) did not require reintubation; and 53 (59.6%) did not present multidrug resistance. Regarding clinical outcome, 58 (65.2%) of the patients died and 31 (34.8%) were discharged from the hospital (Table 1).

The average length of hospital stay was 30 days and average duration of MV was 19 days. The average length of hospital stay prior to VAP was 8.7 days and the average duration of ventilation prior to VAP was 9.1 days.

Table 1 – Epidemiological profile of patients diagnosed with ventilator-associated pneumonia (n=89). Ponta Grossa, Paraná, Brazil, 2023.

Parameter		N (%)
Sex	Male	53 (59.6)
	Female	36 (40.4)
Age group	18 to 39 years old	20 (22.5)

	40 to 59 years old	21 (23.6)
	≥ 60 years old	48 (53.9)
Occupation	Retired	43 (48.3)
	Employed/Self-employed/Student	29 (32.6)
Alcoholism	Unemployed	17 (19.1)
	Yes	34 (38.2)
Smoking	No	55 (61.8)
	Yes	30 (33.7)
Pre-existing comorbidity	No	59 (66.3)
	Yes	56 (62.9)
Hospitalization diagnosis	No	33 (37.1)
	Trauma	21 (23.6)
	Respiratory failure	15 (16.9)
	Stroke	15 (16.9)
	Lowered level of consciousness	11 (12.4)
Enteral nutrition	Others	27 (30.2)
	Yes	87 (97.8)
Pathogen	No	2 (2.2)
	<i>Klebsiella pneumoniae</i>	14 (15.7)
	<i>Acinetobacter baumannii</i>	9 (10.1)
	<i>Staphylococcus aureus</i>	7 (7.9)
	<i>Pseudomonas aeruginosa</i>	6 (6.7)
	<i>Enterobacter cloacae</i>	6 (6.7)
	Others	10 (11.2)
Airway management	Negative culture	37 (41.7)
	Endotracheal tube	81 (91.1)
	Tracheostomy	8 (8.9)
Reintubation	Yes	29 (32.6)
	No	80 (67.4)
Multi-resistance	Yes	36 (40.4)
	No	53 (59.6)
Outcome	Discharge	31 (34.8)
	Death	58 (65.2)

DISCUSSION

Most participants of this study were males. The Brazilian guidelines for treating hospital-acquired pneumonia and VAP indicate being male as an independent risk factor for the disease, i.e., it produces a change in health/disease status as a risk factor or exposure.⁷ A descriptive and quantitative study in an ICU in the city of Teresópolis presented a similar result, but with a prevalence of 73% male patients in a sample of 52 people, which was even higher.⁸

A descriptive, cross-sectional, documental study with a quantitative approach including 20 medical records of patients hospitalized in an adult ICU of a medium-sized hospital, diverged with our study regarding age, in which the highest incidence of VAP occurred in those aged under 60 years.⁹ Advanced age is a nonmodifiable risk factor for VAP diagnosis, since the body of older adults undergoes physiological changes due to aging, immunity decline, predisposition to chronic diseases, and invasive procedures, which can aggravate or increase the body response to the disease.¹⁰ Therefore, due to the

older adults' frailty and the need for an advanced airway management, the risk of complications due to this infection is increased.

An integrative literature review with articles published in the last 10 years in the Virtual Health Library and in the MEDLINE and LILACS databases, performing a descriptive analysis of 10 articles, found smoking as one of the main risk factors for acquiring PAV,¹¹ in accordance with the prevalence found in this study. Smokers face higher risks due to the harm of cigarette smoke to the functioning of immune system, degrading the lung cells, decreasing the immunoglobulins circulating in the blood, and presenting a high amount of altered leukocytes, which can cause recurrent infections.¹² We suggest a need for further anti-smoking programs to help people quit smoking, to show how harmful it is to health, and to discourage young people from starting to smoking cigarettes and/or e-cigarettes. Alcohol consumption can also interfere with the clinical recovery of hospitalized patients, by weakening the body.¹³

This study showed a predominance of patients with preexisting comorbidities, similar to a retrospective, documental study, with a quantitative approach developed in João Pessoa, Paraíba, including 59 medical records, which shows a prevalence of 74% patients with comorbidities.¹⁴ Preexisting clinical manifestations are determining factors for the need for ICU admission, in addition to the predisposition to complications and increased difficulty in recovery when affected by new diseases, such as VAP. The increase of aging-related diseases and the difficult access to quality healthcare greatly impact the health of the population and place these diseases among the main causes of death worldwide.¹⁵ Programs are needed to improve adherence to treatments related to comorbidities (SAH, DM, COPD), maintaining these morbidities under control and reducing damage to the patient's body.

Regarding the diagnosis for hospitalization, trauma was the most prevalent in patients with VAP. In a retrospective study, carried out at the Hamad General Hospital in Qatar, the highest rate of VAP was identified in patients who suffered severe injuries caused by trauma.¹⁶ In this study, the main diagnosis for hospitalization is associated with the profile of the institution, which is a regional reference center in major trauma. It is understood that trauma patients are more susceptible to developing VAP due to the need for ventilatory support, severely injured patients may require an early advanced airway management and MV for longer than other patients.¹⁷

Most patients in this study were under enteral nutrition. A descriptive, documentary, retrospective study, with a quantitative approach, carried out in a public

teaching hospital in the city of Cascavel, demonstrated that, of the 146 patients diagnosed with VAP, 54.1% of the patients used a nasogastric tube (NET).¹⁸ Malnourished and patients with obesity may develop greater vulnerability to infection and death.¹⁴ The association of nutritional status with the clinical outcome of patients in a hospital environment still needs to be continuously monitored, since malnutrition considerably increases hospital mortality, both in critical and non-critical patients.¹⁹

Regarding pathogens, in this study, there was a prevalence of Gram-negative *K. pneumoniae Carbapenemase* KPC, responsible for several infections, especially nosocomial infections. Similar data were found in a descriptive, cross-sectional, retrospective, and quantitative study, carried out in an adult ICU of a medium-sized hospital, in which the predominant microorganism was *K. pneumoniae Carbapenemase* (45% of cases).⁹ It can be observed that multidrug-resistant Gram-negative bacteria are present in most studies, corroborating our results. According to the Brazilian National Health Surveillance Agency (ANVISA), the dissemination of KPC-producing enterobacteriaceae is a serious clinical and epidemiological problem in several Brazilian health institutions. Moreover, the antimicrobial therapy applied in the treatment is based on the use of Polymyxin B or Polymyxin E, together with one or more antibiotics, such as aminoglycosides (gentamicin or amikacin), Carbapenems (meropenem or doripenem), and tigecycline.²⁰

Endotracheal intubation is characterized as a medical emergency, since the patient requires invasive ventilation immediately. Regarding the device used in this study, endotracheal intubation was predominant, corroborating an analytical, cross-sectional, and retrospective study conducted in Piauí, which recorded 58.3% of use in a sample of 36 patients with VAP.²¹ According to ANVISA, endotracheal intubation facilitates bacterial colonization of the tracheobronchial tree and aspiration of contaminated secretion from the upper airways, due to the decrease in the cough reflex, the accumulation of secretion above the cuff, and the contamination of the tube itself.⁵

In our study, there were few cases of reintubation, which corroborates a retrospective, documental study with a quantitative approach, developed in a teaching hospital, in which 34% of the patients required reintubation.¹⁴ Early extubation is one of the predisposing factors to reintubation. This procedure favors reintubation in the first 24 hours after MV removal, causing an increased incidence of secondary VAP due to the risk of aspirating secretion from the upper airways.⁵

For microbial resistance, patients with VAP of our sample developed some type

of microbial multidrug resistance. A retrospective cohort study conducted in the ICU of a medium-sized hospital located in the inland Rio Grande do Sul, Brazil, also demonstrated evidence of pathogenic microorganisms resisting to antibiotics.²² The antibiotic resistance is a serious public health concern, as it interferes with infection control, increases the risk of morbidity and mortality, reduces therapeutic efficacy, poses a risk to patient safety, and causes high costs for health care.²³ Thus, to reduce resistant microorganisms in health services, it is necessary to implement strategies for the rational use of antimicrobials, to evaluate appropriate administration, and correct duration of antibiotic therapy.

In this study, the clinical outcome of 65.2% of the cases was death. In a descriptive study with a prospective approach, developed in the adult ICU of the Dr. Heitor Vieira Dourado Tropical Medicine Foundation, similar results were obtained in a sample of 30 patients, from which 63.3% died due to VAP.²⁴ Notably, some studies cited indicate the high mortality rate associated with VAP, reaffirming that this infection is a risk factor for death in ICUs. To reduce death figures associated with VAP, it is necessary to implement prevention actions in intensive care units, such as the use of a VAP prevention bundle, periodic training, as well as continuing and permanent training.¹⁷

The average length of hospitalization of patients diagnosed with VAP was 30 days in an observational, cross-sectional, and retrospective study conducted in a teaching hospital in the south of Minas Gerais. It corroborates our outcomes, which showed an average length of stay of 27 days.²⁵ This is an alarming data, because staying in the hospital environment increases the risk of infections and, as a consequence, hospital costs and the chances of an unfavorable outcome, such as death. The duration of MV in this study was longer than in a study conducted in an adult ICU with a MV time <10 days.²⁴ The increase in MV time is an important risk factor for acquiring VAP, since it compromises the body defense, favors the installation and multiplication of more resistant, aggressive, pathogenic microorganisms, and contributes to high mortality rates.⁵

The retrospective and documental design holds some limitations, as there is no direct contact with the patient, making it impossible to collect data in full and with real infection potentials. Some information about the living conditions of the people studied was unavailable. It is known that, the closer the disease occurs to the individual, the closer it is to biological explanations, in which professionals and managers have proportionally reduced success over the collective impact.

Despite the research limitations, numerous benefits may be provided not only to

the studied institution, but also to other institutions, in addition to contributing to the emergence of new research on the subject, to improve the quality of care provided to patients. Based on the knowledge of the epidemiological profile that is most susceptible to the development of VAP and the variables with the highest prevalence of infection, the institution can elaborate management and care protocols along with patient safety and the Hospital Infection Control Committee, as well as promote continuing training with professionals who work directly in the care of patients on MV, to avoid and minimize the VAP incidence.

According to the outcomes, it was found that the epidemiological profile of patients with VAP were male, aged 60 years or older, with preexisting comorbidities, mostly victims of trauma, with prolonged hospitalization and ventilation, and with a prevalent clinical outcome of death.

This study concludes that there is still a need for interventions, continuing education, and the development of specific measures for critically ill patients. Therefore, we hope that these variables can contribute to promoting patient safety in MV and improving the quality of care provided to them. Furthermore, it is expected to help in developing prevention strategies to reduce VAP incidence.

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Iris Broggian Correa Nascimento, Luciane Terezinha Ienke and Taís Ivastcheschen Taques contributed to project administration, bibliographic research, writing of the abstract, introduction, methodology, discussion, interpretation, and description of results, conclusions, review, and statistics.

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