



INCIDENCE AND MORTALITY OF VENTILATOR-ASSOCIATED PNEUMONIA: RETROSPECTIVE COHORT IN A UNIVERSITY HOSPITAL*

INCIDÊNCIA E MORTALIDADE DA PNEUMONIA ASSOCIADA À VENTILAÇÃO MECÂNICA: COORTE RETROSPECTIVA EM UM HOSPITAL UNIVERSITÁRIO

INCIDENCIA Y MORTALIDAD DE LA NEUMONÍA ASOCIADA A LA VENTILACIÓN MECÁNICA: COHORTE RETROSPECTIVA EN UN HOSPITAL UNIVERSITARIO

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RESUMO

Objetivo: analisar a magnitude da pneumonia associada à ventilação mecânica (PAV) e os desfechos associados em ambientes que adotam estratégias estruturadas de prevenção. **Método:** estudo de coorte retrospectiva realizado em hospital universitário de alta complexidade, localizado em Porto Alegre, Rio Grande do Sul, Brasil. Foram incluídos pacientes adultos, de ambos os sexos, internados no centro de terapia intensiva entre 2022 e 2024, com diagnóstico de PAV confirmado pela comissão de controle de infecção hospitalar. Os dados foram obtidos a partir de relatórios gerenciais dessa comissão. O estudo foi aprovado pelo comitê de ética em pesquisa (CAAE 82069124.0.0000.5327/2024). **Resultados:** no período analisado, 4.206 pacientes foram submetidos à ventilação mecânica, dos quais 57 (1,36%) desenvolveram PAV. A mortalidade entre esses pacientes foi de 59,6%, com maior frequência entre indivíduos com idade superior a 58 anos e naqueles com uso prolongado de drogas vasoativas. **Conclusão:** a baixa incidência observada é compatível com a adoção de estratégias institucionais de prevenção. Contudo, a elevada mortalidade diante de uma infecção potencialmente evitável evidencia a complexidade clínica dos pacientes críticos e reforça a necessidade de vigilância contínua, adesão sustentada às boas práticas assistenciais e fortalecimento da cultura de segurança no cuidado intensivo.

Descritores: Pneumonia Associada à Ventilação Mecânica; Infecções Respiratórias; Unidade de Terapia Intensiva.

ABSTRACT

Objective: to analyze the magnitude of ventilator-associated pneumonia (VAP) and the associated outcomes in settings that adopt structured prevention strategies. **Method:** retrospective cohort study conducted in a high-complexity university hospital located in Porto Alegre, Rio Grande do Sul, Brazil. Adult patients of both sexes admitted to the intensive care unit between 2022 and 2024 were included, with VAP diagnosis confirmed by the hospital infection control committee. Data were obtained from this committee's managerial reports. The study was approved by the research ethics committee (CAAE 82069124.0.0000.5327/2024). **Results:** during the analyzed period, 4,206 patients underwent mechanical ventilation, of whom 57 (1.36%) developed VAP. Mortality among these patients was 59.6%, with higher frequency among individuals older than 58 years and those with prolonged use of vasoactive drugs. **Conclusion:** the low incidence observed is compatible with the adoption of institutional prevention strategies. However, the high mortality in the context of a potentially preventable infection highlights the clinical complexity of critically ill patients and reinforces the need for continuous surveillance, sustained adherence to best care practices, and strengthening of the safety culture in intensive care.

Descriptors: Ventilator-Associated Pneumonia; Respiratory Tract Infections; Intensive Care Unit.

RESUMEN

Objetivo: analizar la magnitud de la neumonía asociada a la ventilación mecánica (NAV) y los desenlaces asociados en entornos que adoptan estrategias estructuradas de prevención. **Método:** estudio de cohorte retrospectiva realizado en un hospital universitario de alta complejidad, ubicado en Porto Alegre, Rio Grande do Sul, Brasil. Se incluyeron pacientes adultos, de ambos sexos, internados en la unidad de cuidados intensivos entre 2022 y 2024, con diagnóstico de NAV confirmado por la comisión de control de infecciones hospitalarias. Los datos se obtuvieron a partir de informes gerenciales de dicha comisión. El estudio fue aprobado por el comité de ética en investigación (CAAE 82069124.0.0000.5327/2024). **Resultados:** en el período analizado, 4.206 pacientes fueron sometidos a ventilación mecánica, de los cuales 57 (1,36%) desarrollaron NAV. La mortalidad entre estos pacientes fue del 59,6%, con mayor frecuencia entre individuos mayores de 58 años y en aquellos con uso prolongado de fármacos vasoactivos. **Conclusión:** la baja incidencia observada es compatible con la adopción de estrategias institucionales de prevención. Sin embargo, la elevada mortalidad ante una infección potencialmente evitable evidencia la complejidad clínica de los pacientes críticos y refuerza la necesidad de vigilancia continua, adhesión sostenida a las buenas prácticas asistenciales y fortalecimiento de la cultura de seguridad en el cuidado intensivo.

Descriptores: Neumonía Asociada a la Ventilación Mecánica; Infecciones Respiratorias; Unidad de Cuidados Intensivos.

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What is already known:

- The incidence of ventilator-associated pneumonia varies widely in literature, ranging from 6% to 52% among patients admitted to intensive care units, with mortality rates of 20%-50%, depending on the care context and the profile of the population studied.
- The prevention of healthcare-associated infections is associated with reduced hospital costs, shorter length of stay, and lower risk of infectious complications, as demonstrated across different care settings.
- Understanding the clinical and epidemiological profile of patients with ventilator-associated pneumonia is essential for analyzing associated factors and planning preventive and surveillance strategies in intensive care.

What this article adds:

- Identifies a cumulative incidence of ventilator-associated pneumonia of 1.36% among 4,206 patients undergoing mechanical ventilation in a high-complexity university hospital during the analyzed period.
- Analyzes the temporal reduction in ventilator-associated pneumonia incidence after the restructuring of an institutional prevention program in a university hospital in the post-pandemic context.
- Highlights the importance of continuous surveillance, ongoing education, and strengthening the safety culture, combined with adherence to prevention bundles, to maintain low ventilator-associated pneumonia rates and mitigate the risk of operational complacency.

INTRODUCTION

Healthcare-associated infections (HAIs) represent one of the main concerns associated with prolonged hospitalization in intensive care units (ICUs). Increased length of stay is related not only to higher patient morbidity and mortality but also to increased hospital costs⁽¹⁾. Among such infections, ventilator-associated pneumonia (VAP) stands out as one of the most prevalent in ICUs, defined as a pulmonary infection acquired after 48 h of invasive mechanical ventilation⁽²⁾.

VAP results from exposure of the airways to the external environment through the orotracheal tube, which facilitates entry and colonization by microorganisms⁽³⁾. Early assessment and treatment pose important clinical challenges since premature and inappropriate antibiotic therapy may lead to adverse effects such as antimicrobial resistance and the occurrence of new infections. Conversely, delayed initiation of treatment is directly associated with increased mortality⁽⁴⁾.

VAP rates vary according to patient profile and available diagnostic methods. Evidence indicates a higher probability of infection during the first days of mechanical ventilation, with an approximate risk of 3% in the first 5 days and 2% in subsequent days⁽⁵⁾. Overall, incidence may range from 6% to 52% among ICU patients, with estimated mortality between 20% and 50%, reaching up to 70% in cases involving multidrug-resistant microorganisms^(2,6).

Factors such as impaired immune response and prior antibiotic use are important determinants of infection severity and prolonged hospitalization^(7,8). Additionally, the use of invasive devices such as nasogastric tubes, and failures in care practices, including inadequate airway suctioning and failure to maintain head-of-bed elevation, are associated with increased risk of contamination⁽⁸⁾.

Studies conducted in general ICUs describe a clinical and epidemiological profile of VAP characterized predominantly by male patients, age over 50 years, and the presence of prior comorbidities, often admitted in a post-operative context⁽⁹⁾. Procedures and invasive interventions commonly performed in ICUs also increase the risk of pulmonary infection, including orotracheal reintubation, enteral nutrition, and prior dialysis⁽¹⁰⁾.

The World Health Organization highlights that pre-

vention of healthcare-associated infections contributes to reduced hospital costs and patient harm, as well as shorter length of stay and lower likelihood of subsequent infections⁽¹¹⁾. Many of these measures are low cost and low complexity and are mainly performed by the nursing staff. Among the most effective interventions, professional training for practices such as oral hygiene stands out, capable of reducing VAP incidence from 8.9% to 2.8%⁽¹²⁾.

Despite the substantial volume of studies on VAP epidemiology, investigations that integrally describe infection incidence and clinical outcomes in critically ill patients treated in high-complexity university hospitals remain limited, especially in the Brazilian context. Furthermore, few national studies examine the temporal evolution of these indicators in scenarios of institutional reorganization in the post-COVID-19 period.

The present study therefore aims to analyze the magnitude of VAP and the associated outcomes in settings that adopt structured prevention strategies, contributing to monitoring care quality and strengthening patient safety.

METHOD

The study was developed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology recommendations, which guide the conduct and reporting of observational studies⁽¹³⁾.

Study design

This is a retrospective cohort study whose source population comprised all adult patients undergoing mechanical ventilation in the ICU between 2022 and 2024. The analytical cohort included patients who developed VAP, confirmed by the hospital infection control committee. For analysis of clinical outcomes, patients with VAP were internally compared according to progression to in-hospital death or discharge.

Study setting

The research was conducted in a 60-bed ICU of a high-complexity public university hospital located in southern Brazil and affiliated with Universidade Federal do Rio Grande do Sul.

Population and sample

All adult patients admitted to the ICU with a diagnosis of VAP between 2022 and 2024 were included. As this was a census survey, sample size calculation was not required.

Clinical and surgical patients of both sexes aged ≥ 18 years were included, whose VAP diagnosis was confirmed by the hospital infection control committee, according to criteria defined by the Brazilian Health Regulatory Agency (ANVISA)⁽⁵⁾. Exclusion criteria included incomplete medical records or VAP diagnosis not acquired in the ICU. No patients were excluded for these reasons during data collection.

Context

The study was developed within the Brazilian Ventilator-Associated Pneumonia Prevention Program (PAVPREV), a multidisciplinary institutional strategy created in 2006 to reduce respiratory infections among patients receiving mechanical ventilation. Until 2019, the program achieved an approximate cumulative reduction of 90% in VAP cases.

During the COVID-19 pandemic, a marked increase in VAP incidence and deterioration of care indicators were observed. In response, beginning in 2022 the institution initiated a structured process to reorganize and strengthen PAVPREV, including protocol updates, reactivation of VAP champions, theoretical and practical training in oral hygiene and ventilator management, and the resumption of joint audits between the hospital infection control committee and care leadership.

Multidisciplinary meetings began to incorporate systematic case analysis, identification of nonconformities, and direct feedback to teams. This phase consolidated integration among epidemiological surveillance, continuing education, and continuous improvement of care processes. The analyzed period (2022-2024) corresponds to consolidation of these actions, enabling evaluation of VAP incidence and clinical outcomes in a post-pandemic institutional reorganization scenario.

Data collection

Sociodemographic and clinical data were retrospectively obtained from institutional electronic medical records and stored on a secure cloud platform with restricted access to the research team.

The variables analyzed were: i) sociodemographic (sex, age, race/ethnicity, and origin); ii) clinical (reason for admission, comorbidities, Simplified Acute Physiology Score [SAPS] 3, duration of mechanical ventilation, continuous sedation, use of vasoactive drugs, ICU length of stay, and duration of mechanical ventilation until VAP diagnosis); and iii) outcomes (hospital discharge, death, and total hospital length of stay).

SAPS 3 is a prognostic score that incorporates demographic variables, comorbidities, diagnoses, use of invasive support, and physiological and laboratory parameters at ICU admission. Scores range from 0 to 217 points, with higher values indicating greater severity and higher probability of in-hospital death⁽¹⁴⁾.

Data analysis

Data were entered into Microsoft Excel[®] spreadsheets and analyzed using IBM SPSS Statistics for Windows, version 27 (IBM Corp., Armonk, NY, USA) and WinPepi[®], version 11.65. Initially, the Shapiro-Wilk test was applied to assess normality of continuous variables.

The cumulative incidence of VAP was calculated as the ratio between the number of patients with confirmed diagnosis and the total number of patients undergoing mechanical ventilation each year, expressed as a percentage. Incidence density was not calculated due to unavailability of total mechanical ventilation days for the ventilated population in the accessed managerial database. Available mechanical ventilation time data referred exclusively to patients who developed VAP, preventing valid estimates of the time denominator for the entire population at risk.

Quantitative variables were described using mean and standard deviation or median and interquartile range, according to distribution. Group comparisons used parametric or nonparametric tests as appropriate. Proportions were analyzed using Pearson's chi-square test or Fisher's exact test, adopting a significance level of 5% ($p < 0.05$).

Comparison of annual proportions of VAP among patients undergoing mechanical ventilation was performed using Pearson's chi-square test, with Bonferroni correction.

Ethical considerations

This study constitutes a subproject linked to the research entitled "Multidisciplinary therapeutic plan: impact on clinical care quality indicators of critically ill patients", approved by the human research ethics committee under CAAE 82069124.0.0000.5327 and Opinion no. 82069124.0.0000.5327/2024. Because secondary previously anonymized data were used, informed consent was waived and replaced by institutional data use authorization.

RESULTS

Between 2022 and 2024, 4,206 adult patients underwent mechanical ventilation in the ICU, of whom 57 developed VAP, corresponding to an overall cumulative incidence of 1.36% during the period. For temporal description, cumulative incidences were also presented by year, using the number of ventilated patients in each period as the denominator (Figure 1).

The highest cumulative incidence of VAP was observed in 2022, when 1,158 patients underwent mechanical ventilation and 29 experienced the event, corresponding to 2.5%. In subsequent years, a reduction in incidence was observed, as illustrated in Figure 1.

Statistical analysis showed a significant difference among annual incidences ($p < 0.001$), with a marked reduction after 2022 and no statistically significant difference between 2023 and 2024.

The sample consisted of 29 male patients (50.9%), with a mean age of 54 ± 18 years. Most participants (82.5%) self-identified as White.

Regarding admission source, 33 patients (59.6%) were admitted through the emergency department, and 38

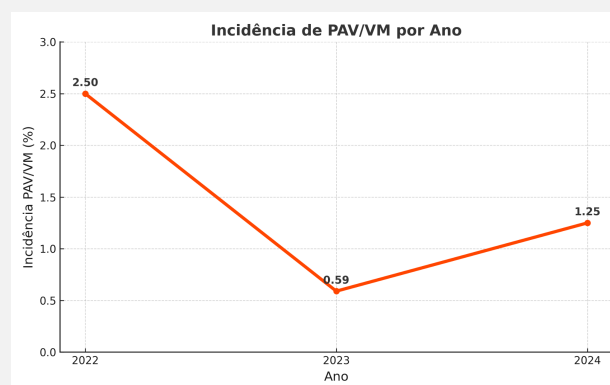
(66.7%) had hospitalization motivated by clinical treatment. Among the main reasons for orotracheal intubation, acute respiratory failure was highlighted, present in 26 cases (45.6%), and decreased level of consciousness, observed in 14 patients (24.6%) (Table 1).

For comparison of the clinical and epidemiological characteristics of individuals diagnosed with VAP, the sample was stratified into two groups: survivors and non-survivors.

The analysis showed a statistically significant association between death and older age ($p = 0.048$). Duration of vasoactive drug (VAD) use was also significantly associated with mortality, with non-survivors remaining, on average, 5 days longer on VAD ($p = 0.026$) compared with patients who were discharged from hospital.

Regarding length of stay, survivors presented longer hospital stay than non-survivors ($p = 0.002$). The remaining comparisons are presented in Table 2.

Figure 1 – Incidence of ventilator-associated pneumonia in the years 2022, 2023, and 2024. Porto Alegre, RS, Brazil, 2022 to 2024



Source: elaborated by the author (2025).

Table 1 – Sample characterization. Porto Alegre (n = 57), RS, Brazil, 2022 to 2024

Variables	n	%
Sex		
Male	29	50.9
Age (years), mean $\pm$ SD	54.3 $\pm$ 18.8	
Race/ethnicity		
White	47	82.5
Black	9	15.8
Brown	1	1.8
Source of admission		
Emergency department	34	59.6
Operating room	10	17.5
Ward	6	10.5
External ICU	7	12.3
Hospitalization		
Clinical	38	66.7
Surgical	19	33.3
Comorbidities		
Hypertension	26	45.6
DM	18	31.6
Cardiovascular diseases	17	29.8
Smoking	15	26.3
COPD	10	17.5
Cerebrovascular diseases	9	15.8
Obesity	6	10.5
Immunosuppression	13	22.8
Reason for orotracheal intubation		
Respiratory failure	26	45.6
Decreased level of consciousness	14	24.6
Intraoperative	16	28.1
Cardiorespiratory arrest	1	1.8
Duration of IMV (days), median (P25-P75)	18 (12.5-37.5)	
SAPS 3, mean $\pm$ SD	48.6 $\pm$ 19.6	
Neuromuscular blocking agents	32	56.1
Sedation duration (days), median (P25-P75)	14 (8-22.5)	
VAD duration (days), median (P25-P75)	9.5 (5-22)	
Tracheostomy	28	49.1
Hemodialysis	18	31.6
IUC	49	86
Venous/arterial catheter	56	98.2

Variables	n	%
ICU length of stay (days), median (P25-P75)	23 (14-41)	
Time to VAP (days), median (P25-P75)	7 (4.5-12.5)	
Total hospital length of stay (days), median (P25-P75)	40 (22.5-68)	
In-hospital death	34	59.6

COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; ICU: intensive care unit; IMV: invasive mechanical ventilation; IUC: indwelling urinary catheter; SAPS: simplified acute physiology score; SD: standard deviation; VAD: vasoactive drugs; VAP: ventilator-associated pneumonia.

Source: elaborated by the authors, 2025.

Table 2 – Comparison of clinical characteristics between surviving and non-surviving patients. Porto Alegre, RS, Brazil, 2022 to 2024

Variables	Survivor (n = 23)	Death (n = 34)	p-value
Sex			0.516
Female	13 (56.5)	15 (44.1)	
Male	10 (43.5)	19 (55.9)	
Age (years), mean ± SD	48.3 ± 18.2	58.3 ± 18.3	0.048
Race/ethnicity			0.436
White	19 (82.6)	28 (82.4)	
Black	3 (13.0)	6 (17.6)	
Brown	1 (4.3)	0 (0.0)	
Source of admission			0.496
Emergency department	15 (65.2)	19 (55.9)	
Operating room	5 (21.7)	5 (14.7)	
Ward	1 (4.3)	5 (14.7)	
External ICU	2 (8.7)	5 (14.7)	
Hospitalization			1.000
Clinical	15 (65.2)	23 (67.6)	
Surgical	8 (34.8)	11 (32.4)	
Comorbidities			
Hypertension	7 (30.4)	19 (55.9)	0.105
DM	4 (17.4)	14 (41.2)	0.109
Obesity	1 (4.3)	5 (14.7)	0.385
Cardiovascular diseases	8 (34.8)	9 (26.5)	0.706
Smoking	6 (26.1)	9 (26.5)	1.000
COPD	4 (17.4)	6 (17.6)	1.000
Cerebrovascular diseases	6 (26.1)	3 (8.8)	0.137
Immunosuppression	4 (17.4)	9 (26.5)	0.631
Reason for orotracheal intubation			0.640
Respiratory failure	9 (39.1)	17 (50.0)	
Decreased level of consciousness	6 (26.1)	8 (23.5)	
Intraoperative	8 (34.8)	8 (23.5)	
Cardiorespiratory arrest	0 (0.0)	1 (2.9)	
Duration of IMV (days), median (P25-P75)	18 (10-36)	17.5 (13.8-40.3)	0.643
SAPS 3, mean ± SD	44.0 ± 18.5	51.7 ± 20.0	0.149
Neuromuscular blocking agents	10 (43.5)	22 (64.7)	0.189
Sedation duration (days), median (P25-P75)	13 (7-23)	14.5 (9-23)	0.591
VAD duration (days), median (P25-P75)	6.5 (2-17)	11.5 (6-25.5)	0.026
Tracheostomy	13 (56.5)	15 (44.1)	0.516
Hemodialysis	5 (23.8)	13 (39.4)	0.374
IUC	19 (62.6)	30 (88.2)	0.702
ICU length of stay (days), median (P25-P75)	23 (19-45)	18.5 (12-40.5)	0.128
Time to VAP (days), median (P25-P75)	7 (4-13)	7.5 (5-11.5)	0.928
Total hospital length of stay (days), median (P25-P75)	51 (34-95)	25 (18-55)	0.002

COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; ICU: intensive care unit; IMV: invasive mechanical ventilation; IUC: indwelling urinary catheter; SAPS: Simplified Acute Physiology Score; SD: standard deviation; VAD: vasoactive drugs; VAP: ventilator-associated pneumonia.

Source: elaborated by the authors, 2025.

DISCUSSION

The analysis of the period from 2022 to 2024 showed an overall cumulative incidence of VAP of 1.36% among 4,206 ventilated patients in the hospital. Annual incidences were 2.5% in 2022, 0.59% in 2023, and 1.25% in 2024, remaining within the institutional infection control targets. This result was considerably lower than that described in the national and international literature, in which rates range from 1.06% to 19.70%, depending on unit profile, ventilation duration, and level of adherence to preventive protocols⁽¹⁵⁻¹⁷⁾.

A study conducted in the ICU of a general hospital in Belgium between 2007 and 2019 reported a mean VAP incidence of 2.7%⁽¹⁷⁾. In a study conducted in a large hospital in the state of Goiás, Brazil, the incidence was 1.06%, with VAP being the most prevalent infection in the unit and responsible for 43.18% of recorded HAIs⁽¹⁸⁾.

Research shows variations in VAP rates related to the implementation of patient safety strategies, although isolated preventive measures do not always result in consistent reductions in clinical outcomes. In the Belgian study, for example, a slight reduction in incidence over the years was observed, without robust evidence of sustained impact.

In the present study, a statistically significant reduction in VAP incidence was observed between 2022 and 2023 ($p < 0.001$), followed by stabilization in 2024. This trend coincides with restructuring of the institutional prevention program and adoption of a continuous improvement model based on the ANVISA prevention bundle⁽⁵⁾. The results reinforce the positive impact of the restructuring of PAVPREV, which reintroduced systematic audits, multidisciplinary training, and immediate feedback to teams, measures recognized as essential for controlling infections related to mechanical ventilation. However, although the reduction in incidence temporally coincides with program restructuring, the study design does not allow a direct causal relationship between implemented interventions and observed outcomes to be established.

The slight increase observed in 2024 reinforces the need for continuous maintenance of preventive strategies. Factors such as staff turnover, protocol fatigue, and gaps in internal audits may compromise adherence and reduce effectiveness of measures. Sustainability of results depends on permanent integration of preventive practices into routine care and systematic monitoring of indicators.

In the analysis of clinical outcomes, patients who died were significantly older than survivors (58.3 ± 18.3 vs. 48.3 ± 18.2 years; $p = 0.048$), reinforcing the association between older age and worse prognosis in intensive care. Reduced physiological reserve and greater burden of comorbidities in older individuals contribute to this result by limiting response to infectious stress and invasive procedures^(15,19).

Duration of VAD use was significantly longer among non-survivors (11.5 vs. 6.5 days; $p = 0.026$), suggesting that prolonged need for these agents reflects greater clinical instability and is associated with increased mortality risk⁽²⁰⁾. Cohort studies conducted in Argentina and South Korea identified similar findings, indicating VAD use as an independent predictor of death and a higher likelihood of

developing VAP^(21,22).

A shorter median hospital length of stay was also observed among non-survivors (25 vs. 51 days), indicating that more severe conditions tend to progress early to fatal outcomes. Conversely, patients who survive remain hospitalized for longer periods, possibly related to recovery and rehabilitation following the critical episode.

Brazilian studies corroborate this pattern. In a cohort of 573 patients, 148 deaths occurred within 7 days of hospitalization⁽²³⁾. Similarly, 53.2% of deaths occurred between the 1st and 3rd days⁽²⁴⁾. Another prospective study identified length of hospital stay as a predictor of mortality, reinforcing that fatal outcomes are associated with shorter hospital stays⁽²⁵⁾.

International evidence confirms this behavior. A retrospective study reported that approximately one-third of ICU deaths occurred within the first 24 h of admission, regardless of initial severity or admission type⁽²⁶⁾. A multicenter registry involving 53,305 hospitalizations in Nordic countries showed a median length of stay among non-survivors of 1.5 days (interquartile range: 0.5-4.2)⁽²⁷⁾.

Overall, the observed mortality of 59.6% is consistent with prior research, which describes rates above 50% among patients who develop VAP during ICU hospitalization⁽²⁵⁾. This finding reinforces the importance of permanent surveillance strategies, early diagnosis, and qualified management of complications, with special attention to monitoring VAD use and adopting individualized care, particularly in older patients.

Maintaining low VAP rates depends on strict adherence to prevention protocols and continuous investment in training care teams. In this process, the role of the multidisciplinary team, especially nursing, is highlighted in implementing preventive measures and mitigating the impact of this condition on clinical outcomes.

The findings also highlight the strategic role of nursing leadership and care management in sustaining preventive practices. Consolidation of a safety culture depends on active professional participation in bedside surveillance, critical analysis of indicators, and strengthening institutional quality improvement programs.

This study has limitations that must be considered. The retrospective design and use of secondary data may introduce information bias, underdiagnosis, and variations in the quality of clinical and epidemiological records over the analyzed period. In addition, changes in surveillance processes and care organization after the pandemic may have influenced case identification, and results should be interpreted in light of these limitations.

Although literature often uses multivariate models to investigate factors associated with mortality, adjusted regression was not considered appropriate in this study due to the small number of events (34 deaths) and the risk of unstable estimates and overfitting. Therefore, analyses should be interpreted as exploratory, with hypothesis-generating potential, without the intention of identifying independent predictors or establishing causal relationships.

Prospective studies with larger samples and more robust methodological designs are needed to deepen understanding of factors associated with mortality and improve intensive care strategies.

In this context, the findings reinforce the importance of interpreting VAP indicators not only as measures of care performance but also as indirect markers of clinical complexity and vulnerability of critically ill patients, contributing to a more qualified analysis of quality and safety of care in intensive care.

CONCLUSION

The study analyzed the magnitude of VAP and its outcomes in a high-complexity university hospital in the post-pandemic period, demonstrating cumulative incidence lower than values described in the national and international literature. These findings suggest favorable performance in a setting that adopts structured prevention strategies. Implementation of a continuous improvement model based on the ANVISA prevention bundle was associated with a significant reduction in incidence, reinforcing the importance of surveillance programs and continuing education in controlling infections related to mechanical ventilation.

Despite the low incidence, high mortality was observed among patients with VAP, particularly associated with vul-

nerability conditions commonly present in critically ill patients. Older age and prolonged use of vasoactive drugs indicated greater clinical severity when associated with VAP, relating to shorter length of stay and unfavorable outcomes.

These results highlight the importance of qualified interpretation of these indicators, as they allow not only evaluation of care performance but also identification of indirect markers of clinical complexity and vulnerability of critically ill patients.

*Article derived from the undergraduate nursing thesis titled "Incidence of ventilator-associated pneumonia in a public university hospital in southern Brazil," presented to the Nursing program at the Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, in 2025.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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All authors are responsible for the textual writing and critical review of the intellectual content, the final version published, and all ethical, legal, and scientific aspects related to the accuracy and integrity of the study.



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