



RISK FACTORS ASSOCIATED WITH THE INCIDENCE OF NOSOCOMIAL PNEUMONIA AMONG HOSPITALIZED PATIENTS AT MEURAXA REGIONAL HOSPITAL, BANDA ACEH

Riska Nasuha¹, Nurfitriani², and Rina Erlina³

¹ Abulyatama University, Banda Aceh

² Abulyatama University, Banda Aceh

³ Abulyatama University, Banda Aceh

Corresponding Author:

Nurfitriani,

The Undergraduate Medical Education Study Program at Abulyatama University is located at Jalan Blangbintang Lama KM 8.5, Gampong Lampoh Keude, Kuta Baro District, Aceh Besar Regency, Aceh, Indonesia.

Email: usmanfitrie@gmail.com

Article Info

Received: February 10, 2026

Revised: April 14, 2026

Accepted: June 17, 2026

Online Version: August 31, 2026

Abstract

Nosocomial pneumonia is among the most frequent healthcare-associated infections and imposes a substantial burden of morbidity, mortality, and cost on hospital systems, yet local epidemiological data from Aceh Province remain limited. This study aimed to identify the risk factors associated with the incidence of nosocomial pneumonia among patients treated at Meuraxa Regional Hospital, Banda Aceh. An analytical observational study with a retrospective approach was conducted using secondary medical-record data from patients hospitalized between January 2022 and December 2024. Of 248 eligible patients, 41 (16.5%) developed nosocomial pneumonia. Data were analyzed using descriptive statistics and the Chi-square test. Previous antibiotic use (OR = 2.97; 95% CI 1.50–5.90; $p = 0.001$), mechanical ventilator use ($p = 0.0004$), and prolonged hospitalization ($p < 0.001$) were significantly associated with nosocomial pneumonia, with prolonged hospitalization showing the strongest association; age, sex, and comorbidities were not significant. These findings highlight the importance of antimicrobial stewardship, careful ventilator management, and minimizing unnecessary length of stay to reduce nosocomial pneumonia risk in resource-limited hospital settings such as RSUD Meuraxa.

Keywords: Antibiotic Use, Hospital-Acquired Infection, Length of Hospital Stay, Mechanical Ventilation, Nosocomial Pneumonia



© 2026 by the author(s)

This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution-ShareAlike 4.0 International (CC BY SA) license (<https://creativecommons.org/licenses/by-sa/4.0/>).

Journal Homepage

<https://research.adra.ac.id/index.php/health>

ISSN: (P: 2988-7550) - (E: 2988-0459)

How to cite:

Nasuha, R., Nurfitriani, & Erlina, R. (2026). Risk Factors Associated with the Incidence of Nosocomial Pneumonia Among Hospitalized Patients at Meuraxa Regional Hospital, Banda Aceh. *Journal of World Future Medicine, Health and Nursing*, 4(5), 600–612. <https://doi.org/10.70177/health.v4i5.4106>

Published by:

Yayasan Adra Karima Hubbi

INTRODUCTION

Pneumonia remains a major global health problem and is one of the leading causes of morbidity and mortality worldwide. The World Health Organization (WHO) reported that pneumonia is an acute infection affecting the lung parenchyma, particularly the alveoli, which may become filled with fluid or pus, resulting in impaired gas exchange and respiratory distress (Narciso et al., 2025). The disease can be caused by various microorganisms (Yi et al., 2023), including bacteria, viruses, and fungi. Among bacterial pathogens, *Streptococcus pneumoniae* remains the most common cause of pneumonia, while viral pathogens such as influenza viruses and SARS-CoV-2 have also contributed significantly to the global burden of respiratory infections.

Addressing this burden is urgent: nosocomial pneumonia not only prolongs hospitalization and raises treatment costs, but can also strain the limited bed capacity, antimicrobial supply, and infection-control resources of regional hospitals, where such capacity is generally more constrained than in major tertiary or metropolitan centers (Asegu et al., 2024). Nosocomial pneumonia, also known as hospital-acquired pneumonia (HAP), is defined as pneumonia that develops 48 hours or more after hospital admission and was not present at the time of admission. It is recognized as one of the most common healthcare-associated infections and is associated with prolonged hospitalization, increased healthcare costs, and high mortality rates (Metersky & Kalil, 2024; Zolfaghari et al., 2024). Ventilator-associated pneumonia (VAP), a subtype of nosocomial pneumonia occurring in patients receiving mechanical ventilation for at least 48 hours, accounts for a substantial proportion of cases in intensive care units (Rosenthal et al., 2025).

The incidence of nosocomial pneumonia remains high in both developed and developing countries. Studies have reported an incidence ranging from 5 to 10 cases per 1,000 hospitalized patients, with significantly higher rates among critically ill patients receiving mechanical ventilation (Rosenthal et al., 2025). According to the Indonesian National Medical Service Guidelines, nosocomial pneumonia contributes substantially to hospital mortality in Southeast Asia, with reported mortality rates reaching 25.5% in Malaysia, 11.3% in Indonesia, and 9.1% in the Philippines (Ministry of Health of Indonesia, 2023). These findings indicate that nosocomial pneumonia continues to be a significant challenge for healthcare systems in the region.

Several studies have identified various factors associated with the development of nosocomial pneumonia. Patient-related factors such as advanced age, impaired immune function, malnutrition, and underlying chronic diseases have been reported to increase susceptibility to infection (Zheng et al., 2025). Comorbid conditions including chronic obstructive pulmonary disease (COPD), chronic kidney disease, diabetes mellitus, and congestive heart failure may further elevate the risk of developing nosocomial pneumonia (Martin-Loeches et al., 2023). In addition, treatment-related factors such as prolonged hospitalization, invasive procedures, endotracheal intubation, and long-term mechanical ventilation have consistently been identified as important predictors of nosocomial pneumonia (Rosenthal et al., 2025).

Previous studies have highlighted the importance of identifying risk factors for nosocomial pneumonia to support early prevention and improve patient outcomes. However, the distribution and contribution of these risk factors may vary across hospitals due to differences in patient characteristics, healthcare facilities, infection control practices, and local epidemiological conditions. To date, there is limited evidence regarding the factors associated with nosocomial pneumonia among hospitalized patients in Aceh Province, particularly at Meuraxa Regional Hospital, Banda Aceh.

This local gap is not merely a matter of geography. RSUD Meuraxa is one of the main referral hospitals serving Banda Aceh City, receiving patients with complex and often prolonged admissions across internal medicine, pulmonary, and intensive-care wards, yet like

many regional hospitals in the province it has not previously had a systematic, hospital-based surveillance program specifically for nosocomial pneumonia. (Sinto et al., 2024). Antimicrobial stewardship and infection-prevention infrastructure are also unevenly implemented across regional hospitals in Aceh compared with larger metropolitan tertiary centers (Ministry of Health of Indonesia, 2023; Nawanindha et al., 2024) meaning that risk-factor patterns documented in better-resourced hospitals elsewhere in Indonesia may not directly transfer to this setting. A hospital-specific analysis is therefore needed to generate locally applicable evidence rather than relying on extrapolation.

Considering the high burden of nosocomial pneumonia and the lack of local epidemiological data, this study was conducted to identify and analyze the risk factors associated with nosocomial pneumonia among patients treated at Meuraxa Regional Hospital, Banda Aceh. Identifying which of these factors are locally modifiable is directly relevant to hospital infection-control policy: it can help RSUD Meuraxa and similar regional hospitals prioritize antimicrobial stewardship, ventilator-care bundles, and length-of-stay management within realistic resource constraints. The findings are expected to provide evidence-based information that can support infection prevention strategies, improve clinical management, and reduce the incidence of nosocomial pneumonia in hospital settings.

RESEARCH METHOD

Research Design

This study employed an analytical observational design with a retrospective approach. The retrospective design was selected because it enables researchers to examine the association between pre-existing exposure factors and the occurrence of nosocomial pneumonia using secondary data obtained from routinely collected hospital medical records. This approach provides an efficient method for analyzing clinical risk factors without requiring prospective patient follow-up, thereby reducing time, cost, and ethical constraints. The study was conducted at Meuraxa Regional Hospital, Banda Aceh City, Aceh Province, Indonesia, with data collection and analysis performed from May to June 2025. The reviewed medical records covered hospitalized pneumonia patients during the period of January 2022 to December 2024.

Research Target/Subject

The target population of this study consisted of all pneumonia patients treated at Meuraxa Regional Hospital between January 2022 and December 2024, with a total of 1,350 patients. The accessible population included 248 patients whose medical records met the availability requirements and eligibility criteria. The study sample consisted of patients diagnosed with nosocomial pneumonia during the study period. A total of 41 patients fulfilled the inclusion and exclusion criteria and were included as research subjects. The sampling technique applied was total sampling, in which all eligible patients were selected for analysis. The inclusion criteria included patients who were hospitalized for at least 48 hours, patients admitted to the Internal Medicine Ward, Pulmonary Ward, Intensive Care Unit (ICU), Intensive Cardiac Care Unit (ICCU), and Class I, II, or III wards during 2022–2024, patients who met the clinical diagnostic criteria for nosocomial pneumonia based on the Centers for Disease Control and Prevention (CDC), and patients aged 18 years or older. The exclusion criteria included patients with incomplete medical records related to hospitalization and treatment, patients diagnosed with pneumonia before hospital admission, and medical records that could not be located in the hospital archive system.

Research Procedure

The research procedure was conducted through several systematic stages. First, ethical approval and administrative permissions were obtained from the relevant authorities before

data collection. Second, medical records of pneumonia patients hospitalized during the study period were identified and screened based on the predetermined inclusion and exclusion criteria. Third, eligible medical records were reviewed to extract information related to demographic characteristics, hospitalization history, and potential risk factors associated with nosocomial pneumonia. Fourth, the collected data were compiled, coded, and organized into a research database. Finally, statistical analysis was performed to determine the association between potential risk factors and the occurrence of nosocomial pneumonia among hospitalized patients at Meuraxa Regional Hospital.

Instruments, and Data Collection Techniques

The research instrument used in this study was a medical record review form developed by the researchers for systematic data extraction. The study utilized secondary data obtained from patients' medical records maintained by Meuraxa Regional Hospital. The collected variables included demographic characteristics, length of hospitalization, mechanical ventilation use, nutritional status, comorbid diseases, and other clinical factors considered relevant to nosocomial pneumonia occurrence. Data collection was conducted through a structured review of medical records using a standardized extraction sheet to ensure consistency and completeness. The operational definitions of variables, including nosocomial pneumonia, mechanical ventilation use, and comorbidity status, were based on CDC diagnostic criteria and the terminology used in the hospital medical record system. To ensure data reliability, a second independent reviewer re-extracted data from a random subsample of 10% of the medical records ($n = 25$). The level of agreement between reviewers was assessed using Cohen's kappa coefficient, which demonstrated substantial agreement ($\kappa = 0.86$). Any discrepancies were resolved through discussion and verification of the original medical records with a third member of the research team.

Data Analysis Technique

The collected data were analyzed using statistical software. Descriptive analysis was initially conducted to summarize participants' characteristics and describe the distribution of research variables. Categorical variables were presented as frequencies and percentages, while numerical variables were expressed as means and standard deviations or medians with interquartile ranges, depending on the distribution of the data. Furthermore, bivariate analysis was performed to examine the association between each potential risk factor and the incidence of nosocomial pneumonia using the Chi-square test with a significance level of $p < 0.05$. The null hypothesis (H_0) stated that there was no association between risk factors and the occurrence of nosocomial pneumonia, whereas the alternative hypothesis (H_1) stated that an association existed. The H_0 hypothesis was rejected when the p-value was less than 0.05, indicating a statistically significant relationship between the analyzed risk factors and nosocomial pneumonia incidence.

RESULTS AND DISCUSSION

The study yielded a population of 248 patients, with a sample size of 41. This study used secondary data (medical records).

Table 1. Patient Characteristics

Nosocomial Pneumonia	Yes	41	16.5%
	No	207	83.5%
Age	18–59 years	113	45.6%
	>59 years	135	54.4%
Sex	Men	102	41.1%
	Women	146	58.9%

Comorbidity	Present	143	57.7%
	Absent	105	42.3%
Previous Antibiotic Use	Yes	80	32.3%
	No	168	67.7%
Mechanical Ventilator Use	Yes	108	43.5%
	No	140	56.5%
Duration of Hospitalization	<6 days	72	29.0%
	6–10 days	135	54.4%
	>10 days	41	16.5%

This study involved 248 patients who were sampled with demographic and clinical characteristics. Forty-one patients experienced nosocomial pneumonia (16.5%); 207 patients did not (83.5%). The age distribution of patients showed almost balanced results: the age group ≥ 59 years numbered 135 patients (54.4%), while the age group 18–59 years numbered 113 patients (45.6%). Female patients outnumbered male patients, at 146 (58.9%) and 102 (41.1%) respectively.

The distribution of comorbidities showed that 143 patients (57.7%) had a history of comorbidities, while 105 patients (42.3%) did not. The distribution of antibiotic use history showed that 80 patients (32.3%) had a history of previous antibiotic use, while 168 patients (67.7%) did not. The distribution of mechanical ventilator use showed that 108 patients (43.5%) were on mechanical ventilators, while 140 patients (56.5%) were not. The distribution of hospitalization duration showed that most patients, 135 (54.4%), were treated for 6–10 days; 72 (29.0%) patients had a length of stay under six days, while 41 (16.5%) patients stayed longer than ten days.

Table 2. Relation Between Age and the Incidence of Nosocomial Pneumonia

Age	Nosocomial Pneumonia				<i>p-value</i>
	Yes		No		
	n	%	n	%	
18-59 years old	23	20,4%	90	79,6%	0,138
>60 Years old	18	13,3%	117	86,7%	
Total	41	16,5%	207	83,5%	

Table 2 shows the results of the Chi-square analysis of the relationship between age and the incidence of nosocomial pneumonia at Meuraxa Regional Hospital, which was not significant ($p = 0.138$; OR 1.66, 95% CI 0.85–3.26 for the 18–59-year group relative to ≥ 60 years). H_0 was accepted and H_1 was rejected.

Table 3. Relationship Between Gender and the Incidence of Nosocomial Pneumonia

Sex Gender	Yes	No	<i>p-value</i>
Men	22 (21.6%)	80 (78.4%)	0.074
Women	19 (13.0%)	127 (87.0%)	
Total	41 (16.5%)	207 (83.5%)	

Table 3 shows that the relationship between gender and the incidence of nosocomial pneumonia was not significant ($p = 0.074$; OR 1.84, 95% CI 0.94–3.61 for men relative to women). H_0 was accepted and H_1 was rejected.

Table 4. Relation Between Comorbidities and the Incidence of Nosocomial Pneumonia

Comorbid	Yes	No	<i>p-value</i>
Present	25 (17.5%)	118 (82.5%)	0.638
Absent	16 (15.2%)	89 (84.8%)	
Total	41 (16.5%)	207 (83.5%)	

Table 4 shows that the relationship between comorbidities and the incidence of nosocomial pneumonia was not significant ($p = 0.638$; OR 1.18, 95% CI 0.59–2.34). H_0 was accepted and H_1 was rejected.

Table 5. Relation Between Previous Antibiotic Use and the Incidence of Nosocomial Pneumonia

Previous Antibiotic Use	Yes	No	<i>p-value</i>
Exist	22 (27.5%)	58 (72.5%)	0.001
Non existent	19 (11.3%)	149 (88.7%)	
Total	41 (16.5%)	207 (83.5%)	

Table 5 shows a significant association between previous antibiotic use and the incidence of nosocomial pneumonia ($p = 0.001$; OR 2.97, 95% CI 1.50–5.90). H_1 was accepted and H_0 was rejected: patients with prior antibiotic use had almost three times the odds of developing nosocomial pneumonia compared with patients without prior antibiotic use.

Table 6. Relation Between the Use of Mechanical Ventilators and the Incidence of Nosocomial Pneumonia

Use of Mechanical Ventilators	Yes	No	<i>p-value</i>
Yes	28 (25.9%)	80 (74.1%)	0.0004
No	13 (9.3%)	127 (90.7%)	
Total	41 (16.5%)	207 (83.5%)	

Ventilator use provides direct access for pathogenic bacteria to the lower respiratory tract, especially when not accompanied by optimal infection-prevention protocols (Bassi et al., 2024), and the bivariate analysis confirmed that mechanical ventilator use was significantly associated with nosocomial pneumonia ($p = 0.0004$).

Table 7. Relation Between Duration of Hospitalization and the Incidence of Nosocomial Pneumonia

Duration of Hospitalization	Yes	No	<i>p-value</i>
<6 days	6 (8.3%)	66 (91.7%)	0.812
6–10 days	10 (7.4%)	125 (92.6%)	
>10 days	25 (61.0%)	16 (39.0%)	

Total	41 (16.5%)	207 (83.5%)
-------	------------	-------------

Table 7 shows a significant association between duration of hospitalization and the incidence of nosocomial pneumonia ($p < 0.001$). Patients hospitalized for more than 10 days had approximately 17 times the odds of nosocomial pneumonia compared with those hospitalized for fewer than 6 days (OR 17.19, 95% CI 6.04–48.88), while the 6–10-day group did not differ significantly from the shortest-stay reference group (OR 0.89, 95% CI 0.31–2.60; $p = 0.812$). H1 was accepted and H0 was rejected for the >10-day comparison.

Figure 1 summarizes the crude odds ratios and 95% confidence intervals for all six risk factors on a single forest plot, allowing their relative magnitude to be compared directly rather than through p-values alone.

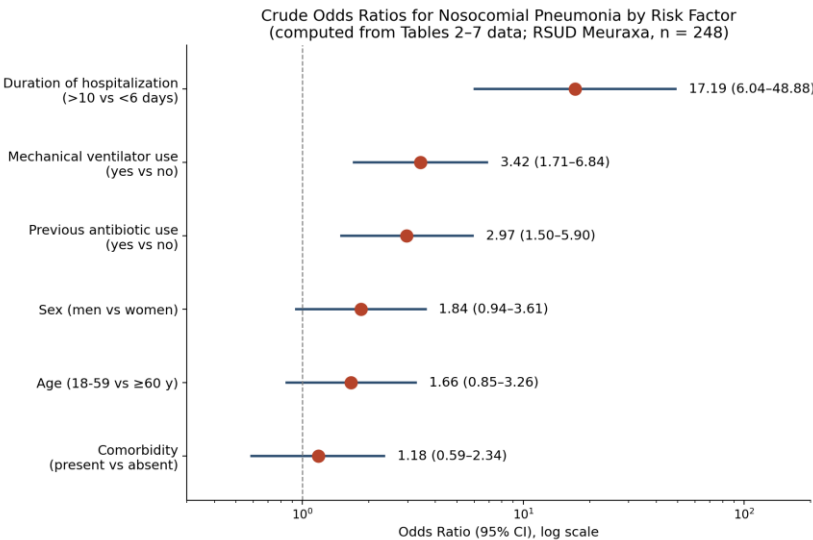


Figure 1. Crude odds Ratios (95% CI) for Nosocomial Pneumonia by Risk Factor, Computed from Tables 2–7.

Bivariate analysis results showed that age was not associated with the incidence of nosocomial pneumonia ($p = 0.138$), although the 18–59 age group showed a higher percentage (20.4%, 23 cases) than the ≥ 60 group. This finding is in line with several previous studies that stated that age is not the sole determinant of nosocomial infection incidence; the risk of nosocomial infection is more strongly determined by clinical and procedural factors such as invasive procedures, length of hospitalization, antibiotic use, and patient comorbidities, which have a greater influence than age in determining the risk of nosocomial pneumonia in hospitals (Liu et al., 2023). A 2022 study by Wang et al found different results (J. Wang et al., 2023): age significantly influenced the incidence of hospital-acquired pneumonia, with patients aged 70 and over having a substantially higher risk than younger patients, related to the degenerative decline of mucosal barrier function and impaired T-cell differentiation that facilitates pathogen entry (Victor et al., 2023).

Developmental disorders cause changes in T-cell subtypes (a $\downarrow$ CD4+/ $\uparrow$ CD8+ pattern), disrupting immune balance and reducing antibody production, which worsens the inflammatory response and lowers the effectiveness of the immune system against infection. Advanced age therefore contributes to an increased risk of infectious complications, which can worsen clinical conditions (Victor et al., 2023). This pattern of age acting mainly as a risk modifier rather than an isolated determinant is echoed by a 2025 retrospective study of elderly inpatients with community-acquired pneumonia by Li et al., which found that advancing age remained an independent predictor of in-hospital mortality only after accounting for comorbidity burden and clinical severity indices, rather than acting alone (Li et al., 2025).

Bivariate analysis results showed that gender was not associated with the incidence of nosocomial pneumonia ($p = 0.074$). Findings from several studies suggest that biological and immunological differences between men and women may influence responses to infection, but in this context these differences were not statistically strong (Sciarra et al., 2023). A 2014 study by Sciarra et al., demonstrated that estrogen increases NOS3 activity in lung macrophages, enhancing phagocytic ability and bacterial clearance; estrogen also enhances the transport of secretory IgA to the respiratory mucosa and helps prevent the infiltration of bacteria such as *Klebsiella pneumoniae*. This hormonal protective mechanism suggests variations in immune response based on specific biological characteristics (Sciarra et al., 2023). A 2023 retrospective study by Alfares et al. of hospitalized cardiac patients similarly reported that female sex was among the factors associated with a higher prevalence of hospital-acquired pneumonia, although, as in the present study, this association did not reach independent statistical significance in multivariable analysis (Alfares et al., 2023).

Bivariate analysis results showed that comorbidities were not associated with the incidence of nosocomial pneumonia ($p = 0.638$). This study found statistically insignificant differences in the results; the lack of further classification into specific comorbidity types may be a contributing factor. Wang et al (Z. Wang & Wu, 2025) study found that a high Charlson Comorbidity Index (CCI) score was a risk factor for nosocomial pneumonia in hospitalized geriatric patients, suggesting that a heavy comorbidity burden increases patient susceptibility to nosocomial pneumonia. A 2021 study by Hernández Puentes et al. found that elderly patients with comorbidities such as COPD, dementia, and cerebrovascular disease are more susceptible to nosocomial pneumonia, due to mobility difficulties that lower immunity and facilitate bacterial colonization, together with decreased mucociliary clearance and altered breathing mechanics that compromise airway defense (Hernández-Puentes et al., 2025). The difference between the present results and prior research may be due to this study's broad, undifferentiated categorization of comorbidities, which did not distinguish between specific comorbidity types. A 2024 analysis by Marushchak et al. using the Charlson Comorbidity Index (CCI) as a composite score rather than individual diagnoses found that a higher overall comorbidity burden was associated with greater pneumonia severity, suggesting that a validated composite index may capture cumulative comorbidity risk more sensitively than the broad present/absent classification used in the present study (Marushchak et al., 2024).

Bivariate analysis showed a significant association between prior antibiotic use and the incidence of nosocomial pneumonia ($p = 0.001$). These findings align with a 2024 study by Bassi et al. of critically ill trauma patients with pulmonary contusions in the intensive care unit, which showed that each additional day of antibiotic use correlated with an increased risk of isolating resistant bacteria ($p < 0.01$) (Bassi et al., 2024). Prolonged antibiotic use can increase the risk of multidrug-resistant (MDR) microorganisms (Sartika et al., 2025); these findings indicate that inappropriate or irrational antibiotic use can trigger microbial resistance and increase the risk of nosocomial infections, in line with research by Niu et al. (Niu et al., 2023), which stated that previous antibiotic use significantly contributes to the possibility of colonization with multidrug-resistant bacteria (Zhang, 2023) (Niu et al., 2023). This concern is reinforced by a 2025 microbiological surveillance study by Mgeladze et al., which documented alarmingly high rates of resistance to penicillins, macrolides, and tetracyclines among gram-positive pathogens isolated from nosocomial pneumonia cases, underscoring the broader link between antibiotic exposure and the emergence of resistant organisms in hospital settings (Mgeladze et al., 2025; Rongrungruang & others, 2025).

Bivariate analysis of mechanical ventilator use indicated a significant association with nosocomial pneumonia ($p = 0.0004$; Table 6). Ventilator use provides direct access for pathogenic bacteria to the lower respiratory tract, especially when not accompanied by optimal infection-prevention protocols (Bassi et al., 2024). Research conducted by Alnimr (Alnimr, 2023) analyzed the relationship between mechanical ventilator use and infectious

complications in ICU patients, attributing this to disruption of the airway's natural defense mechanisms and the presence of a direct pathway for pathogen entry through the endotracheal tube (Alnimr, 2023). Consistent with this, a 2025 multicenter retrospective study by Russo et al. of ICU patients found that ventilatory support, together with advanced age and chronic obstructive pulmonary disease, independently predicted the development of hospital-acquired pneumonia, supporting ventilator use as a key modifiable procedural risk factor across diverse hospital settings (Russo et al., 2025).

The bivariate analysis showed that duration of hospitalization was strongly associated with the incidence of nosocomial pneumonia ($p < 0.001$), with patients hospitalized for more than 10 days having roughly 17 times the odds of those hospitalized under 6 days. Prolonged hospital exposure has been shown to increase the incidence of nosocomial infections through mechanisms including transmission from other patients or healthcare workers, contaminated aerosols, and contaminated equipment such as ventilation and air-conditioning systems (Chea et al., 2026). Long hospital stays can also lead to oropharyngeal colonization by gram-negative bacteria, especially in patients with immobilization, impaired consciousness, medical instrumentation, and poor hygiene, further increasing the risk of exposure to nosocomial microorganisms and invasive procedures (Tong et al., 2023). This is consistent with a 2023 retrospective cohort study by Lüthi-Corridori et al., which identified a longer length of hospital stay as both a consequence of pneumonia severity and an independent contributor to subsequent complications and rehospitalization, reinforcing the bidirectional relationship between prolonged hospitalization and nosocomial infection risk observed in the present study (Amodio et al., 2024; Lüthi-Corridori et al., 2023).

Consistent with the effect-size reporting recommended above, this pattern of results is best summarized as follows: previous antibiotic use, mechanical ventilator use, and especially prolonged hospitalization were the clinically and procedurally modifiable factors most strongly associated with nosocomial pneumonia at RSUD Meuraxa, while patient-level demographic factors (age, sex) and unstratified comorbidity status were not. Reporting the magnitude of association (OR) alongside statistical significance, rather than p-values alone, is consistent with current recommendations for observational health research (Chao et al., 2023).

Limitations. This study has several limitations that should be considered when interpreting the findings. First, it relied on secondary data from medical records, which may be subject to incomplete or inconsistent documentation. Second, the retrospective, single-center design at one regional hospital limits the ability to establish temporal causality and constrains generalizability to other hospital settings. Third, comorbidities were analyzed as a single undifferentiated category, which may have obscured associations specific to individual comorbid conditions. Fourth, because only bivariate analysis was performed, the independent contribution of each risk factor could not be estimated after adjusting for the others; a multivariate logistic regression model was not performed, and is recommended for future analyses of this dataset or in a prospective follow-up study.

CONCLUSION

This study identified previous antibiotic use, mechanical ventilator use, and prolonged hospitalization as factors significantly associated with the occurrence of nosocomial pneumonia among patients treated at Meuraxa Regional Hospital, Banda Aceh, while age, sex, and unstratified comorbidity status were not significantly associated in this population. Among the significant factors, prolonged hospitalization showed by far the strongest association (OR 17.19, 95% CI 6.04–48.88 for stays exceeding 10 days), indicating that extended exposure to the hospital environment substantially increases infection risk in this setting.

These findings carry practical, longer-term implications for RSUD Meuraxa and similarly resourced regional hospitals: strengthening antimicrobial stewardship to reduce

unnecessary or prolonged antibiotic exposure, tightening ventilator-care bundles, and actively working to shorten avoidable length of stay could plausibly reduce the hospital's nosocomial pneumonia burden over time, with downstream benefits for bed availability, treatment cost, and patient safety. Because this study used a retrospective, single-hospital design, these findings should be interpreted as evidence specific to RSUD Meuraxa's patient population and case-mix rather than as a generalizable estimate for all hospitals in Indonesia; replication in other regional hospitals, ideally with prospective data collection and multivariate adjustment, is needed before the findings are extended more broadly. Further studies involving larger, multicenter samples are recommended to provide a more comprehensive understanding of risk factors for nosocomial pneumonia in similar healthcare settings.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used Google to assist with language editing, grammar improvement, manuscript organization, and formatting adjustments. During this revision, Claude (Anthropic) was used to check the manuscript against the journal's author guidelines and template, to consolidate and respond to reviewer comments, to compute odds ratios and confidence intervals from the data already reported in the manuscript's own tables, and to identify reference-list gaps and citation–source mismatches. After using these tools, the authors carefully reviewed, revised, and validated all content to ensure its accuracy, originality, and compliance with scientific standards. The authors take full responsibility for the content of this publication.

ACKNOWLEDGMENTS

Future researchers are expected to conduct research in various wards or treatment units to obtain broader population coverage and more representative results. Hospitals are advised to store patient medical records for at least five years in an orderly, systematic, and integrated manner to facilitate research. Hospitals are expected to clearly, completely, and consistently standardize the diagnosis of nosocomial pneumonia in the medical record. The completeness of medical records needs to be improved so that patient data is fully and validly documented for evaluation, reporting, and future research.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; Investigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

- Alfares, M., Almrzouqi, A., Alghamdi, R., Alsharif, R., Kurdi, L., Kamfar, S., Alzahrani, F., & Maimani, L. (2023). Risk factors of hospital-acquired pneumonia among hospitalized patients with cardiac diseases. *Cureus*, 15(1), e34253. <https://doi.org/10.7759/cureus.34253>

- Alnimr, A. (2023). Antimicrobial resistance in ventilator-associated pneumonia: Predictive microbiology and evidence-based therapy. *Infectious Diseases and Therapy*, 12(6), 1527–1552. <https://doi.org/10.1007/s40121-023-00820-2>
- Amodio, E., Schreiber, P. W., Faes Hesse, M., & Wolfensberger, A. (2024). Adverse outcomes of patients with non-ventilator-associated hospital-acquired pneumonia (nvHAP)—A single centre cohort study. *Infectious Disease Reports*, 16(2), 228–238. <https://doi.org/10.3390/idr16020018>
- Asegu, L. M., Kitschen, A., Neuwirth, M. M., & Sauerland, D. (2024). The economic burden of nosocomial infections for hospitals: Evidence from Germany. *BMC Infectious Diseases*, 24, 1291. <https://doi.org/10.1186/s12879-024-10176-8>
- Bassi, E., Merighi, C. T., Tomizuka, C. I., Ferreira, C., Henrique, S., & Damous, B. (2024). Association of antimicrobial use and incidence of hospital-acquired pneumonia in critically ill trauma patients with pulmonary contusion: An observational study. *Brazilian Journal of Anesthesiology*, 74(3), 1–8.
- Chao, Y.-S., Wu, C.-J., Po, J. Y., Huang, S.-Y., Wu, H.-C., Hsu, H.-T., Cheng, Y.-P., Lai, Y.-C., & Chen, W.-C. (2023). The upper limits of risk ratios and recommendations for reporting risk ratios, odds ratios, and rate ratios. *Cureus*, 15(4), e37799. <https://doi.org/10.7759/cureus.37799>
- Chea, N., Li, R., Eure, T., Alkis Ramirez, R., Nadle, J., Lee, J. E., Lehmann, M., Sardenga, L., Czaja, C. A., Johnston, H., Kellogg, M., Emanuel, C., Cilwick, A., Correa, M. A., Maloney, M., Ray, S. M., Howard-Anderson, J., Carswell, S., Wilson, L. E., & Grigg, C. T. (2026). Health care-associated infections in U.S. hospitals, 2023 versus 2015. *New England Journal of Medicine*, 395(3), 255–266. <https://doi.org/10.1056/NEJMoa2510881>
- Hernández-Puentes, J. S., Bastidas-Goyes, A. R., Tuta-Quintero, E., Díaz-Quijano, D., Méndez Peñalosa, N., Zuleta Sanchez, N., Herran Perez, M., Rodríguez Sánchez, J., Ortiz Marquez, V., Colmenares Leal, A., Zuleta Montañez, J., Riveros Pedraza, L., Sarmiento Cardozo, L., Piñeros Clavijo, M., Vasquez Bazurto, M., & Lenhardt Guaqueta, I. (2025). Dementia as a risk factor for 30-day mortality in community-acquired pneumonia in Colombia (CAP): A survival study. *PLOS ONE*, 20(10), e0332713. <https://doi.org/10.1371/journal.pone.0332713>
- Li, S., Li, L., Wang, S., & Wu, H. (2025). Clinical characteristics and risk factors of hospital mortality in elderly patients with community-acquired pneumonia. *Frontiers in Medicine*, 12, 1512288. <https://doi.org/10.3389/fmed.2025.1512288>
- Liu, Y., Xu, Y., Wang, S., Zeng, Z., Li, Z., & Din, Y. (2023). Antibiotic susceptibility pattern, risk factors and prediction of carbapenem-resistant *Pseudomonas aeruginosa* in patients with nosocomial pneumonia. *Heliyon*, 9(5), 1–10.
- Lüthi-Corridori, G., Boesing, M., Roth, A., Giezendanner, S., Leuppi-Taegtmeyer, A. B., Schuetz, P., & Leuppi, J. D. (2023). Predictors of length of stay, rehospitalization and mortality in community-acquired pneumonia patients: A retrospective cohort study. *Journal of Clinical Medicine*, 12(17), 5601. <https://doi.org/10.3390/jcm12175601>
- Maisyarah, S., & Sufa, R. A. (2026). Riset ilmiah modern: Teori dan praktik metodologi penelitian. Ruang Karya Bersama.
- Martin-Loeches, I., Reyes, L. F., Nseir, S., Ranzani, O. T., Povoas, P., Diaz, E., Schultz, M. J., Rodríguez, A. H., Serrano-Mayorga, C., De Pascale, G., Navalesi, P., Panigada, M., Coelho, L. M., Skoczynski, S., Esperatti, M., Cortegiani, A., Aliberti, S., Caricato, A., Salzer, H. J. F., & Fuentes, Y. V. (2023). European Network for ICU-Related Respiratory Infections (ENIRRI): A multinational, prospective, cohort study of nosocomial LRTI. *Intensive Care Medicine*, 49(10), 1212–1222. <https://doi.org/10.1007/s00134-023-07210-9>
- Marushchak, M., Krynytska, I., Homeliuk, T., Vayda, A., Kostiv, S., & Blikhar, V. (2024). Charlson comorbidity index and the severity of community-acquired pneumonia caused

- by SARS-CoV-2: A retrospective analysis. *Dental and Medical Problems*, 61(2), 173–179. <https://doi.org/10.17219/dmp/166666>
- Metersky, M. L., & Kalil, A. C. (2024). Management of ventilator-associated pneumonia: Guidelines. *Infectious Disease Clinics of North America*, 38(1), 87–101. <https://doi.org/10.1016/j.idc.2023.12.004>
- Mgeladze, G., Akhvlediani, G., Khetsuriani, S., Maisuradze, G., Robakidze, V., Mrelashvili, S., & Papiashvili, A. (2025). Nosocomial pneumonia in Georgia: A focus on gram-positive bacteria and antimicrobial resistance. *Cureus*, 17(1), e77710. <https://doi.org/10.7759/cureus.77710>
- Ministry of Health of Indonesia. (2023). National guidelines for medical services: Hospital-acquired pneumonia and ventilator-associated pneumonia. Ministry of Health of the Republic of Indonesia.
- Narciso, A. R., Dookie, R., Nannapaneni, P., Normark, S., & Henriques-Normark, B. (2025). *Streptococcus pneumoniae* epidemiology, pathogenesis and control. *Nature Reviews Microbiology*, 23, 256–271. <https://doi.org/10.1038/s41579-024-01116-z>
- Nawanindha, N., Saptawati, L., & Widyaningsih, V. (2024). Factors associated with the outcomes of patients with hospital-acquired pneumonia (HAP) at Dr. Moewardi General Hospital, Surakarta. *Jurnal Respirasi*, 10(3), 186–194.
- Niu, H., Shen, X., Liang, H., Wu, G., Cai, S., & Shen, Q. (2023). Risk factors for progression to bacteremia among patients with nosocomial carbapenem-resistant *Acinetobacter baumannii* pneumonia in the intensive care unit. *European Journal of Clinical Microbiology and Infectious Diseases*, 42(11), 1–10.
- Rongrungruang, Y. & others. (2025). Etiology of hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP) in tertiary-care hospitals in Thailand: A multicenter, retrospective cohort study. *Infection and Drug Resistance*, 18, 351–361. <https://doi.org/10.2147/IDR.S492299>
- Rosenthal, V. D., Memish, Z. A., & Bearman, G. (2025). Preventing ventilator-associated pneumonia: A position paper of the International Society for Infectious Diseases, 2024 update. *International Journal of Infectious Diseases*, 151, 107305. <https://doi.org/10.1016/j.ijid.2024.107305>
- Russo, A., Serapide, F., Alessandri, F., Gulli, S. P., Bruni, A., Longhini, F., Quirino, A., Morena, R., Marascio, N., Matera, G., d'Ettorre, G., Zullino, V., Mastroianni, C. M., Treccarichi, E. M., Garofalo, E., & Ceccarelli, G. (2025). Risk factors for the development of hospital-acquired pneumonia in patients with carbapenem-resistant *Acinetobacter baumannii* respiratory colonization and the role of multisite colonization: A multicenter retrospective study. *European Journal of Clinical Microbiology & Infectious Diseases*. <https://doi.org/10.1007/s10096-025-05137-1>
- Sartika, S. D., Katu, S., & Halim, R. (2025). Risk factors of multi-drug resistant organism in patients hospitalized with community-acquired pneumonia at Wahidin Sudirohusodo Hospital. *Antimicrobial Stewardship & Healthcare Epidemiology*. <https://doi.org/10.1017/ash.2025.141>
- Sciarra, F., Campolo, F., Franceschini, E., Carlomagno, F., & Venneri, M. A. (2023). Gender-specific impact of sex hormones on the immune system. *International Journal of Molecular Sciences*, 24(7), 6302. <https://doi.org/10.3390/ijms24076302>
- Sinto, R., Limato, R., Radiani, S. P., Huda, M. N., Surendra, H., Praptiwi, A. W., Herman, Y., Musaffa, B. A., Lazarus, G., Day, N. P. J., Limmathurotsakul, D., Karuniawati, A., & Hamers, R. L. (2024). A nationwide mixed-methods study of gaps and barriers to implementation of antimicrobial stewardship programmes in hospitals in Indonesia. *Journal of Hospital Infection*, 154, 77–87. <https://doi.org/10.1016/j.jhin.2024.10.001>
- Sophonsri, A., Lou, M., Ny, P., Minejima, E., Nieberg, P., & Wong-Beringer, A. (2023). Machine learning to identify risk factors associated with the development of ventilated

- hospital-acquired pneumonia and mortality: Implications for antibiotic therapy selection. *Frontiers in Medicine*, 10, 1268488. <https://doi.org/10.3389/fmed.2023.1268488>
- Tong, X., Ci, C., Chen, J., Sun, M., Zhao, H., & Wei, H. (2023). Incidence and risk factors for postoperative nosocomial pneumonia in elderly patients with hip fractures: A single-center study. *Frontiers in Surgery*, 10, 1–8.
- Victor, H. H., Wahyudi, E. R., Rumende, C. M., Soejono, C. H., Rooshoeroe, A. G., & Shatri, H. (2023). Penilaian domain pengkajian paripurna pasien geriatri (P3G) sebagai faktor yang berpengaruh terhadap kejadian pneumonia nosokomial pada pasien usia lanjut yang dirawat di Rumah Sakit Umum Pusat Nasional Dr. Cipto Mangunkusumo. *Jurnal Penyakit Dalam Indonesia*, 10(1), 14–24.
- Wang, J., Pei, L., & Zhao, T. (2023). CD4+ T cells related to disease severity in elderly and frailty community-acquired pneumonia patients: A retrospective cohort study. *Immunity, Inflammation and Disease*, 11, e1009. <https://doi.org/10.1002/iid3.1009>
- Wang, Z., & Wu, D. (2025). Long-term bedridden status as a predictor of in-hospital mortality in older adults with community-acquired pneumonia: A retrospective cohort study. *Clinical Interventions in Aging*, 20, 2145–2151. <https://doi.org/10.2147/CIA.S554154>
- Yi, G., de Kraker, M. E. A., Buetti, N., Zhong, X., Li, J., Yuan, Z., Zhu, W., Zhou, J., & Zhou, H. (2023). Risk factors for in-hospital mortality and secondary bacterial pneumonia among hospitalized adult patients with community-acquired influenza: A large retrospective cohort study. *Antimicrobial Resistance & Infection Control*, 12, 24. <https://doi.org/10.1186/s13756-023-01234-y>
- Zhang, Z. (2023). Collaborative learning in social constructivism: Promoting English learning in a secondary classroom in China. *Journal of Education and Educational Research*, 3(3), 1–5. <https://doi.org/10.54097/jeer.v3i3.9509>
- Zheng, X.-L., Zhang, X., Yuan, J.-H., & Yi, L.-T. (2025). Prevalence, risk factors, and outcomes of malnutrition in older adults hospitalized with community-acquired pneumonia: A retrospective study. *Frontiers in Medicine*, 12, 1522261.
- Zolfaghari, M., Seifi, A., Jaafaripooyan, E., Jahangard-Rafsanjani, Z., Afhami, S., Mohammadi, M., Emami Meybodi, M. M., Salehi, M., & Mohammadnejad, E. (2024). Burden of nosocomial infections in intensive care units: Cost of antibiotics, the extra length of stay and mortality rate. *Caspian Journal of Internal Medicine*, 15(3), 478–483. <https://doi.org/10.22088/cjim.15.3.478>

Copyright Holder :

© Riska Nasuha et al. (2026).

First Publication Right :

© Journal of World Future Medicine, Health and Nursing

This article is under:

