



PREVALENCE AND RISK FACTORS OF VENTILATOR-ASSOCIATED PNEUMONIA IN ICU SETTINGS: A NARRATIVE REVIEW

P. Rathnayaka, T. Suwarnnasabaesan, D. C. Madhushan, M. A. N. Karunathilaka, W. U. Sanjeewani, M. K. C.P. Gunasekare and K. G. G. Samankumari

Department of Nursing, Faculty of Health Sciences, The Open University of Sri Lanka, Sri Lanka

Ventilator-associated pneumonia (VAP), a major hospital-acquired infection, affects 5% to 40% of patients on mechanical ventilators worldwide, with rates varying by region, intensive care unit (ICU) type, and diagnostic criteria. Its mortality rate can range from 10% to over 30%, particularly in cases involving multidrug-resistant organisms (MRO). Ventilator-associated pneumonia increases ICU stays and duration of mechanical ventilation (MV), driving up healthcare costs. This review aims to synthesize recent evidence on the prevalence of VAP in ICUs and reported risk factors across different settings. Articles published between January 2020 and June 2025 that included adult ICU patients were selected. The literature search was conducted following SANRA guidelines and using databases including PubMed, Scopus, Google Scholar with key words such as ‘ventilator-associated pneumonia,’ ‘prevalence,’ ‘risk factors,’ ‘ICU,’ and ‘mechanical ventilation’. Only peer-reviewed original research was included. Systematic and narrative reviews were considered only to provide contextual background but were not included as primary evidence. Results were presented in tables highlighting the author and year, title of the study, study design, and key findings of each study. Prevalence of VAP ranged from 9% to 50% depending on region, patient condition, and ICU protocols. Multicenter studies indicate a prevalence of 20-35%. Patients with traumatic brain injuries (TBI) and those with COVID-19 indicated VAP prevalence rates exceeding 45%. Risk factors included prolonged MV, reintubation, TBI, use of sedatives, biofilm formation on endotracheal tubes, and infection by MRO. COVID-19 ICU patients were found to have higher rates of VAP, often involving MRO. VAP is still a considerable healthcare concern in ICU settings, with prevalence and risk factors strongly influenced by patients’ clinical conditions, regional healthcare practices, and individual patient characteristics. This review highlights the need for risk-specific prevention strategies, particularly in high-risk populations. Continued surveillance, adherence to evidence-based protocols, and antimicrobial stewardship are critical to reducing VAP occurrence and improving patient outcomes.

Keywords: ventilator-associated pneumonia, prevalence, risk factors, ICU

**Corresponding Author: rmmpa@ou.ac.lk*



PREVALENCE AND RISK FACTORS OF VENTILATOR–ASSOCIATED PNEUMONIA IN ICU SETTINGS: A NARRATIVE REVIEW

P. Rathnayaka, T. Suwarnnasabaesan, D.C. Madhushan, M.A.N. Karunathilaka, W.U. Sanjeewani, M.K.C.P. Gunasekare and K.G.G. Samankumari

Department of Nursing, Faculty of Health Sciences, The Open University of Sri Lanka., Sri Lanka

INTRODUCTION

The rate of VAP, a dangerous infection that can happen in hospitals, varies by region, type of intensive care unit (ICU), and diagnostic criteria. It affects 5% to 40% of patients on mechanical ventilators around the world. In bacterial populations that are resistant to more than one drug, the death rate can be anywhere from 10% to more than 30%. VAP causes patients to remain in intensive care units and on mechanical ventilation (MV) longer, which can raise medical costs by 40%. There are clear differences in incidence rates across regions. The North American continent has lower rates, while low and middle-income countries have higher rates. In Asia-Pacific and Latin America, there are 13–16 cases per 1,000 ventilator days. Some common VAP agents are Gram-negative bacteria like *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Acinetobacter baumannii*. Preventive antibiotics seem to work, but some patients are more likely to get them if they smoke, are male, or have a higher APACHE II score. Because risk profiles, microbiology, and frequency vary around the world, a comprehensive evaluation is necessary.

METHODOLOGY

This narrative review was carried out using a structured and transparent approach to explore the existing literature on the prevalence and risk factors of VAP in ICU settings across diverse health care settings and populations.

Studies were included:

- Articles published between January 2020 and June 2025 that included adult ICU patients receiving mechanical ventilation and examined the prevalence and risk factors associated with VAP.
- Peer-reviewed original research articles in English Language.

Exclusion criteria included:

- Pediatric or neonatal populations
- Studies not focused on VAP

The literature search was conducted using multiple data bases including PubMed, Scopus, Google Scholar, with the keywords ‘ventilator associated pneumonia’, ‘prevalence’, ‘risk factors’, ‘ICU’, and ‘mechanical ventilation’.

Data were extracted using a standardized charting form that included author, study design, population, key findings, and citations.

Extracted data were synthesized descriptively and presented in a tabular format.



Author and year	Title of the study	Study Design and Study setting	Key finding
Belay et al., 2022	Incidence and Predictors of Ventilator-Associated Pneumonia Among Adult Intubated Patients in Bahir Dar Specialized Hospitals, 2021: A Retrospective Follow-Up Study	A Retrospective follow-up study in Bahir Dar specialized hospitals, Ethiopia	Identified the incidence and predictors of VAP among adult intubated patients, highlighting the risk factors of prolonged mechanical ventilation and length of ICU stay.
Li et al., 2024	Incidence and risk factors of ventilator-associated pneumonia in the intensive care unit: a systematic review and meta-analysis	Systematic review and meta-analysis	Quantified the global incidence of VAP and identified risk factors like mechanical ventilation duration and underlying co-morbidities.
Tegegne et al., 2025	Prevalence of ventilator-associated pneumonia and associated factors among intubated adult patients admitted in public hospitals in Addis Ababa, Ethiopia: a facility-based retrospective study design.	Retrospective study Public hospitals in Addis Ababa, Ethiopia	Reported the prevalence of VAP among intubated patients and associated factors including sedation use and supine positions.
Y. Li et al. (2023)	The global epidemiology of ventilator-associated pneumonia caused by multi-drug resistant <i>Pseudomonas aeruginosa</i> : A systematic review and meta-analysis.	Systematic review and meta-analysis	Focused on VAP caused by multidrug resistant <i>Pseudomonas aeruginosa</i> , finding a high burden and emphasizing infection control strategies.
Montruccio et al. (2024)	Multidrug-resistant pathogens and ventilator-associated	Prospective observational	Compared VAP rates of COVID-19 vs non-COVID -19 patients ,



	pneumonia in critically ill COVID-19 and non-COVID-19 patients: a prospective observational monocentric comparative study.	comparative study Monocentric study in Italy	showed higher prevalence of multidrug resistant pathogens in COVID - 19 cases.
Frondelius et al. (2021)	Diagnostic and prognostic prediction models in ventilator-associated pneumonia: Systematic review and meta-analysis of prediction modelling studies	Systematic review and meta-analysis Multiple settings	Evaluated predictive models for VAP diagnosis and prognosis: suggested promising models but highlighted the need for external validation.
Battaglini et al. (2023)	Ventilator-associated pneumonia in neuro critically ill patients: insights from the ENIO international prospective observational study	prospective observational study International multicentre	Investigated VAP in neuro critically ill patients: found high incidence linked to poor neurological outcomes and increased ICU stay.
Pawlik et al. (2022)	Risk Factors and Protective Factors against Ventilator-Associated Pneumonia—A Single-Centre Mixed Prospective and Retrospective Cohort Study	Mixed Prospective and Retrospective Cohort Study Single centre in Poland	Identified risk factors like reintubation, prolonged ventilation as protective factors. Suggested oral hygiene protocols for VAP.
Teng et al. (2022)	Analysis of risk factors for early-onset ventilator-associated pneumonia in a neurosurgical intensive care unit	Retrospective study Neurosurgical ICU in China	Analysed early onset VAP risk factors such as age, invasive procedures, and type of brain surgery.



RESULTS AND DISCUSSION

According to the reviewed articles, VAP prevalence varies widely. Studies conducted in Ethiopia and India show a 20-35% prevalence rate, while patients with COVID-19 and traumatic brain injuries show rates nearing 45%. Evidence from recent studies shows three main risk factors: clinical, microbiological, and environmental/system factors. Clinical factors include prolonged MV (>7 days), reintubation or unplanned extubation, neurological injuries (e.g., TBI), and the use of paralytics and sedatives. Microbiological factors include Colonization by MRO (notably *P. aeruginosa* and *Acinetobacter baumannii*), Biofilm formation on endotracheal tubes. Environmental or system Factors include inadequate nurse-to-patient ratios, absence of standardized oral care or suction protocols, and limited adherence to VAP prevention bundles. These studies report outcomes associated with VAP, such as increased ICU stays (by 5–13 days on average), increased ICU mortality (from 15% to 45%), greater need for broad-spectrum antibiotics, higher healthcare costs, and longer MV days. This study highlights the challenges VAP poses to ICU settings worldwide. VAP prevalence varies widely, ranging from nearly 10% in well-resourced ICUs to nearly 45% in conditions involving traumatic brain injury and patients with COVID-19. Therefore, clinical practices, institutional capacity, and patient factors mainly influence VAP development in ICU patients. Despite the high prevalence of VAP, most cases are preventable through standardized care. Study findings confirm that prevention strategies such as elevation of the head of the bed, oral care, regular assessment for readiness to extubate help reduce VAP rates in ICU setting.

Recent studies show an increased incidence of VAP in COVID-19 cases. Factors such as extended mechanical ventilation, high corticosteroid use, altered immune responses, and overwhelmed ICU infrastructure during surges are the main contributors. Therefore, these findings highlight the importance of adapting VAP prevention protocols for pandemic and post-pandemic ICU care. Studies conducted in Ethiopia, India, and Latin America cite under-resourced ICUs, insufficient nurse ratios, and lack of basic preventive tools as contributors to high VAP prevalence. This indicates the need for immediate attention to introduce low-cost interventions tailored to these resource-constrained countries. MDR pathogens have become a growing concern in healthcare settings. Biofilm-related colonization of endotracheal tubes increases the risk of VAP and complicates treatment due to antibiotic resistance. Therefore, early detection and correct use of antimicrobials are essential to prevent MDR related complications. A challenge noted in the literature is the inconsistency in VAP diagnostic methods and criteria. These range from clinical signs to radiographic changes to microbiological confirmation. This variability complicates comparison across studies and underscores the need for a global consensus on diagnostic standards.



CONCLUSIONS/RECOMMENDATIONS

Ventilator-associated pneumonia is still a considerable healthcare concern in ICU settings, with prevalence and risk factors influenced considerably by patient's clinical conditions, regional healthcare practices and individual patient factors. This review draws attention to the need for risk specific prevention measures, particularly in population with elevated risk such as those with traumatic brain injury and COVID-19. Continued surveillance, adherence to evidence-based protocols, and antimicrobial stewardship are critical to reducing VAP occurrence and advancing patient care results.

REFERENCES

- Battaglini, D., Parodi, L., Cinotti, R., Asehnoune, K., Taccone, F. S., Orengo, G., Zona, G., Uccelli, A., Ferro, G., Robba, M., Pelosi, P., & Robba, C. (2023). Ventilator-associated pneumonia in neurocritically ill patients: Insights from the ENIO international prospective observational study. *Respiratory Research*, 24(1). <https://doi.org/10.1186/s12931-023-02456-9>
- Belay, C. M., Zewale, T. A., Amlak, B. T., Abebe, T. G., & Hailu, G. (2022). Incidence and predictors of ventilator-associated pneumonia among adult intubated patients in Bahir Dar specialized hospitals, 2021: A retrospective follow-up study. *International Journal of General Medicine*, 15, 8173–8182. <https://doi.org/10.2147/IJGM.S380301>
- Frondelius, T., Atkova, I., Miettunen, J., Rello, J., & Jansson, M. M. (2022). Diagnostic and prognostic prediction models in ventilator-associated pneumonia: Systematic review and meta-analysis of prediction modelling studies. *Journal of Critical Care*, 67, 44–56. <https://doi.org/10.1016/j.jcrc.2021.10.001>
- Montrucchio, G., Balzani, E., Sales, G., Vaninetti, A., Grillo, F., Trompeo, A. C., Zanierato, M., Fanelli, V., Corcione, S., Giuseppe, F., Curtoni, A., Costa, C., & Brazzi, L. (2024). Multidrug-resistant pathogens and ventilator-associated pneumonia in critically ill COVID-19 and non-COVID-19 patients: A prospective observational monocentric comparative study. *Respiratory Research*, 25(1). <https://doi.org/10.1186/s12931-024-02779-1>
- Li, W., Cai, J., Ding, L., Chen, Y., Wang, X., & Xu, H. (2024). Incidence and risk factors of ventilator-associated pneumonia in the intensive care unit: A systematic review and meta-analysis. *Journal of Thoracic Disease*, 16(9), 5518–5528. <https://doi.org/10.21037/jtd-24-150>
- Li, Y., Roberts, J. A., Walker, M. M., Aslan, A. T., Harris, P. N. A., & Sime, F. B. (2024). The global epidemiology of ventilator-associated pneumonia caused by multi-drug resistant *Pseudomonas aeruginosa*: A systematic review and meta-



analysis. *International Journal of Infectious Diseases*, 139, 78–85.
<https://doi.org/10.1016/j.ijid.2023.11.023>

Pawlik, J., Tomaszek, L., Mazurek, H., & Mędrzycka-Dąbrowska, W. (2022). Risk factors and protective factors against ventilator-associated pneumonia—A single-center mixed prospective and retrospective cohort study. *Journal of Personalized Medicine*, 12(4), 597. <https://doi.org/10.3390/jpm12040597>

Tegegne, E. M., Chekol Gete, B., & Demissie, D. B. (2025). Prevalence of ventilator-associated pneumonia and associated factors among intubated adult patients admitted in public hospitals in Addis Ababa, Ethiopia: A facility-based retrospective study. *Frontiers in Medicine*, 12, 1500901.
<https://doi.org/10.3389/fmed.2025.1500901>

Teng, G., Wang, N., Nie, X., Zhang, L., & Liu, H. (2022). Analysis of risk factors for early-onset ventilator-associated pneumonia in a neurosurgical intensive care unit. *BMC Infectious Diseases*, 22(1).