ORIGINAL ARTICLE

Impact of Ventilator-Associated Pneumonia on mortality and outcome in medical ICU Patients

Atef A. Ebrahim [a], Mohamed E. Habila [a], Abdelsalam F. Abdelsalam [b], Mohamed E. A. Khodiry [a,*]

[a] Department of Internal Medicine, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt
[b] Department of Clinical Pathology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***When patients are intubated with mechanical ventilation (MV) for more than 48 hours, the most common hospital-acquired illness is ventilator-associated pneumonia (VAP).***

Aim and objectives: ***Patients in the medical ICU who need invasive MV for longer than 48 hours will be studied to determine the effect of VAP on mortality and outcomes.***

Patients and methods: ***This study was conducted as an observational investigation at the medical ICU at Al-Azhar University hospitals from October 2023 to October 2024.***

Results: ***Patients diagnosed with VAP had the highest mortality rate, and there was an extremely significant distinction among the groups. There was a statistically significant difference among the groups that were analyzed in terms of the distribution of age regarding mortality findings. The bulk of the non-surviving patients were older patients. The majority of patients who did not survive were found in patients with advanced Apache II scores, indicating a statistically significant distinction among the groups that were evaluated.***

Conclusion: ***VAP is a significant challenge in ICUs, particularly for patients requiring MV for over 48 hours. It increases mortality rates, prolongs hospital stays, and increases healthcare costs. VAP also leads to complications like respiratory failure, sepsis, and multi-organ dysfunction. Preventive strategies like bundle interventions and strict infection control measures can reduce VAP incidence.***

Keywords: Ventilator associated pneumonia; Mortality; Outcome; ICU

1. Introduction

Patients in critical care units who are on mechanical ventilation are at increased risk of developing ventilator-associated pneumonia (VAP), an infection of the lungs. With death rates between 20% and 30%, it is a major source of sickness and illness. A fresh infiltrate on chest x-ray, along with additional diagnostic criteria such as elevated white blood cell count, increased fever, purulent discharges from the airways, and problems with gas exchange, is usually necessary for a diagnosis.[1]

VAP risk may be increased by another infection in ventilated patients, ventilator-associated tracheobronchitis (VAT), which has received less research. Certain modifiable factors, such as bed position, prior aspiration incidents, and antibiotic exposure, as well as underlying heart or lung illness, neurological disorders, and trauma, are risk factors for ventilator-associated pneumonia (VAP).[2]

The body's defense against infections is compromised after intubation, making it easier for microorganisms to cause infection. The risk of acquiring ventilator-associated pneumonia (VAP) is increased in intensive care unit (ICU) patients who have suffered head trauma, severe neurological disease, or both blunt trauma and head trauma.[3]

A key worry with VAP is the presence of multidrug-resistant (MDR) bacteria, which differ from the microbiologic flora responsible for conventional community-acquired pneumonia. A major multidrug-resistant Gram-negative bacterium that causes VAP is Pseudomonas aeruginosa.[4]

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* Corresponding author at: Internal Medicine, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: mohibrahim9595@gmail.com (M. E. A. Khodiry).

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There are fewer resistant organisms and better outcomes linked with early-onset VAP. Estimates vary from 33% to 50% for VAP death rates; however, pinpointing this number is difficult owing to the preexisting respiratory insufficiency in ventilated patients. ARDS patients had a higher prevalence of ventilator-associated pneumonia (VAP).[5]

The purpose of this research is to determine whether or not VAP has a negative effect on mortality and outcomes in medical intensive care unit patients who need invasive MV for more than 48 hours.

2. Patients and methods

This study was conducted as an observational investigation on 100 patients at the medical ICU at Al-Azhar University hospitals from October 2023 to October 2024. Upon recruitment, the patients were divided into two groups: Group "A" consisting of 50 patients without ventilator-associated pneumonia (VAP) but requiring invasive mechanical ventilation, and Group "B" comprising 50 patients diagnosed with ventilator-associated pneumonia during their course of invasive mechanical ventilation.

Inclusion criteria:

To be eligible for the study, patients must be between 18 and 60 years old and of any gender, and they should have been on invasive mechanical ventilation for over 48 hours. The study protocol had been ethically approved, and written informed consent was obtained from all participating patients.

Exclusion criteria:

Individuals falling within the following groups were not considered for participation: Those under 18 or over 60 years old, and those with compromised immune systems due to conditions like diabetes mellitus or malignancies. Secondly, individuals with pre-existing pulmonary conditions such as bronchial asthma, chronic obstructive pulmonary disease (COPD), and pneumonia were ineligible. Thirdly, patients undergoing immunosuppressive therapy for autoimmune disorders like systemic lupus erythematosus (SLE) or rheumatoid arthritis (RA) were also excluded. Participants with additional co-existing health issues like end-stage renal disease (ESRD) or hepatocellular carcinoma (HCC) were omitted to ensure a more precise analysis.

Operational design:

The following data was collected from every patient upon admission: Take a thorough patient history that includes the following: patient's age, gender, the reason for their admission to the intensive care unit (ICU), the presence or absence of any co-morbidities (such as hypertension or diabetes), the length of time the patient was on mechanical ventilation, the time it took to wean them off of it, the percentage of weaning failure, the fatality rate, the overall outcome, and the simplified Acute Physiology Score (SAPS II) to evaluate the severity of their illness upon admission:

Twelve physiological variables, six age-related factors, three underlying disease-related factors (acquired immunodeficiency syndrome, metastatic cancer, and hematologic malignancy), and one kind of admission (planned surgical, unscheduled surgical, or medical) make up SAPS II. In order to evaluate the physiological and pathological alterations linked to mechanical ventilation, this study's data gathering process incorporates a thorough pre- and post-ventilation workup.

Radiology study:

In order to assess the initial state of the lungs, a chest X-ray was taken. In order to have a better understanding of any possible structural changes, a computed tomography (CT) scan of the chest was also performed.

Laboratory study:

Laboratory tests for liver and kidney function, including complete blood count, C-reactive protein, erythrocyte sedimentation rate, or RFT. Analysis of the patient's arterial blood gas (ABG) revealed important information about their metabolic and respiratory health.

Following the ventilation period, a post-ventilation assessment was carried out to monitor the impact of mechanical ventilation on the patient's health. This assessment encompassed CBC, CRP, ESR, ABG analysis, and sputum culture to identify potential infections or microbial growth in the respiratory tract. Furthermore, a follow-up chest X-ray tracked lung structure and function changes. A CT scan of the chest was also conducted to better understand potential structural alterations. Also, endotracheal swabs were collected before and after ventilation for culture and sensitivity analysis to assess potential microbial changes and antibiotic susceptibility.

By systematically collecting and analyzing this array of data, we aimed to gain a comprehensive overview of the effects of mechanical ventilation on various physiological markers, respiratory function, and potential complications. This meticulous data collection approach contributed to a more comprehensive understanding of the impact of mechanical ventilation on patients' health and guided clinical decision-making. The study continued until the sample size of 100 patients was achieved, with an equal number of patients in each group. After all the necessary data were collected, it was tabulated and statistically analyzed to determine the effect of ventilator-associated pneumonia on mortality and outcomes in medical intensive care unit patients who were given invasive mechanical ventilation.

Statistical analysis:

The means and standard deviations (SD) of the continuous variables were shown. A comparison of APACHE II with and without ejection fraction was made in the main analysis. A one-month survival rate was calculated by evaluating potential risk factors using univariate Cox hazard analysis. Variables that were found to be significantly correlated with one-month survival in the univariate analysis (P<0.05) were then included in the multivariate analysis that utilized backward multiple logistic regression. The AUROC values were used to calculate discrimination, and the cutoff values, sensitivity, specificity, and overall correctness were determined by the AURO Analysis. The log-rank test was used to compare cumulative survival curves that were generated using the Kaplan-Meier technique. We considered a P-value less than 0.05.

Considered statistically significant.

3. Results

Table 1. Distribution of demographic information among the groups under study Significant in terms of statistics.

	GROUP "A" WITHOUT VAP N=50	GROUP "B" WITH VAP N=50	TEST	P VALUE
		AGE		
MEAN ±SD	61.72±16.9	62.22±14.3	t=0.159	0.873
		SEX		
MALE	28 (56%)	24 (48%)	X2=0.64	0.423
FEMALE	22 (44%)	26 (52%)		

P value >0.05 indicates non- significates, P value <0.05 indicates statistical significance, and p<0.001 indicates strong significance. Unpaired t test (t) and chi-squared test (X2).

The age and sex differences between the groups under study were not statistically significant, (table 1; figures 1&2).

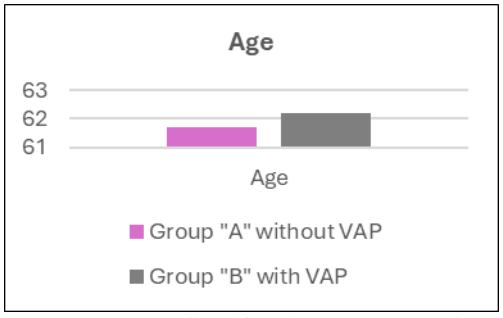

Figure 1. Age distribution among the groups under study.

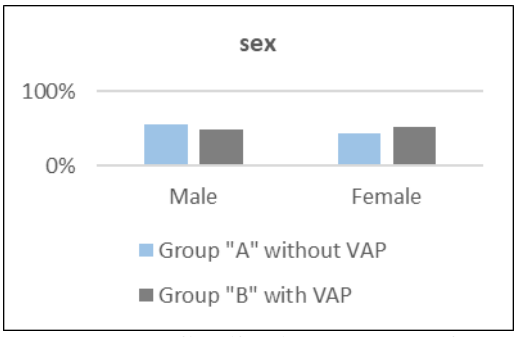

Figure 2. Sex distribution among the groups under study.

Table 2. Comorbidity distribution among the examined groups.

	GROUP "A" WITHOUT VAP N=50	GROUP "B" WITH VAP N=50	TEST (X2)	P VALUE
HYPERTENSION	28(56%)	25(50%)	0.36	0.54
DIABETES MELLITUS	12(24%)	13(26%)	0.053	0.81
HEART FAILURE	13(26%)	14(28%)	0.051	0.82
SEPTICEMIA	9(18%)	16(32%)	2.61	0.105
COPD	5(10%)	5(10%)	0	1

P value >0.05 indicates non- significates, P value <0.05 indicates statistical significance, and p<0.001 indicates strong significance.", CHIP test (X2) and COPD (chronic obstructive pulmonary disease).

Regarding heart failure, septicemia, COPD, diabetes mellitus, and hypertension, there were no statistically significant distinctions among the groups under study, (table 2; figure 3).

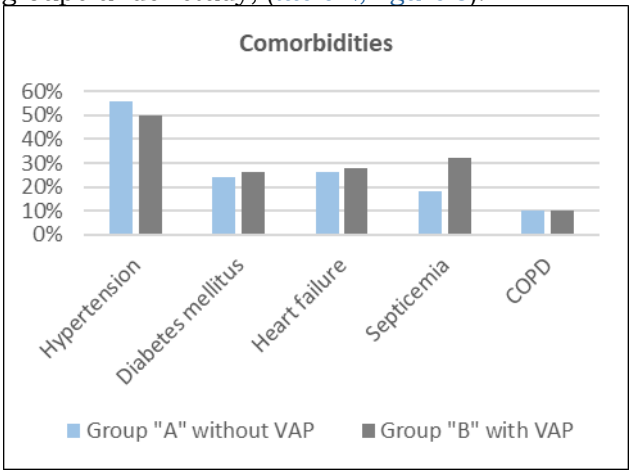

Figure 3. Comorbidity distribution among the categories under study.

Table 3. Score distribution among the groups under study.

	GROUP "A" WITHOUT VAP N=50	GROUP "B" WITH VAP N=50	TEST (T)	P VALUE
SAPSII SCORE				
MEAN±SD	38.54±5.21	38.58±6.38	0.034	0.97
APACHE II				
MEAN±SD	23.3±7.7	25.9±11.3	1.34	0.18

P value >0.05 indicates non- significates, P value <0.05 indicates statistical significance, and p<0.001 indicates strong significance. deviation, test of t

Regarding the SAPSII and APACHE II scores, there was not a statistically significant distinction among the groups under study, (table 3; figure 4).

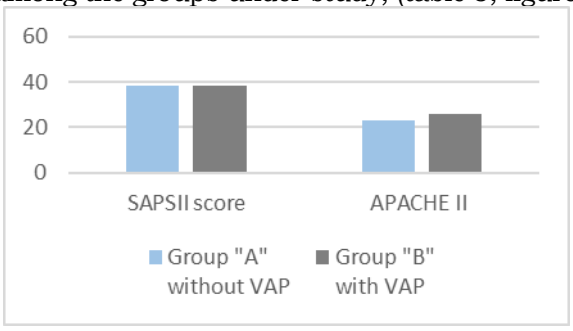

Figure 4. Score distribution among the groups under study.

Table 4. Clinical outcome distribution among the groups under study.

	GROUP "A" WITHOUT VAP N=50	GROUP "B" WITH VAP N=50	TEST (T)	P VALUE
LENGTH OF ICU STAY				
MEAN±SD	13.6±6.22	29.08±11.73	8.24	<0.001
LENGTH OF VENTILATION				
MEAN±SD	9.52±4.07	19.36±5.07	10.7	<0.001

P value >0.05 indicates non-significates, P value <0.05 indicates statistical significance, and p<0.001 indicates strong significance.t: Unpaired test of t.

There was statistically significant difference between studied groups regarding length of ICU stay, and length of ventilation, (table 4; figure 5).

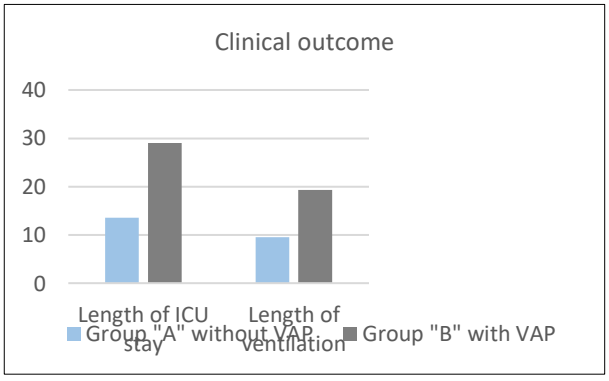

Figure 5. Clinical outcome distribution among the groups under study.

Table 5. Hospitalization reasons for each of the categories under study.

	GROUP "A" WITHOUT VAP N=50	GROUP "B" WITH VAP N=50	TEST (X2)	P VALUE
INTRACRANIAL HEMORRHAGE	8(16%)	7(14%)	0.078	0.78
ACUTE RESPIRATORY FAILURE	5(10%)	6(12%)	0.102	0.74
MALNUTRITION	4(8%)	5(10%)	0.122	0.72
MYOCARDIAL INFARCTION	5(10%)	4(8%)	0.122	0.72
SUDDEN CARDIOPULMONARY ARREST	4(8%)	3(6%)	0.154	0.69
CEREBROVASCULAR DISEASE	4(8%)	4(8%)	0	1
ABDOMINAL SURGERY	3(6%)	4(8%)	0.154	0.69
CRANIAL SURGERY	3(6%)	2(4%)	0.211	0.64
TRAUMA	2(4%)	3(6%)	0.211	0.64
PULMONARY EMBOLISM	2(4%)	2(4%)	0	1

P value >0.05 indicates non-significantness, P value <0.05 indicates statistical significance, and p<0.001 indicates strong significance.", X2: Chi-squared analysis.

Regarding cerebral hemorrhage, acute respiratory failure, malnourishment, myocardial infarction, abrupt cardiac arrest, cerebrovascular illness, abdominal surgery, cranial surgery, trauma, and pulmonary embolism, there were no statistically significant differences between the groups under investigation, (table 5; figure 6).

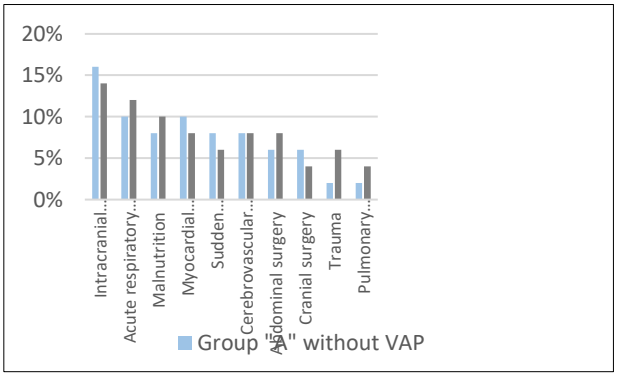

Figure 6. Hospitalization reasons for each of the categories under study.

Table 6. Causative agent distribution among the groups under study.

	GROUP "A" WITH VAP N=50	
	N	%
ACINETOBACTER SPP	16	32%
P. AERUGINOSA	12	24%
K. PNEUMONIA	4	8%
E. AEROGENES	3	6%
H. INFLUENZA	3	6%
MRSA	3	6%
POLY MICROBIAL	9	18%

Acinetobacter spp was the most common cause of VAP (32%), P. aeruginosa (24%), K. pneumonia (8%), E.aerogenes (6%), H. influenza (6%), MRSA (6%) and Poly microbial (18%), (table 6; figure 7).

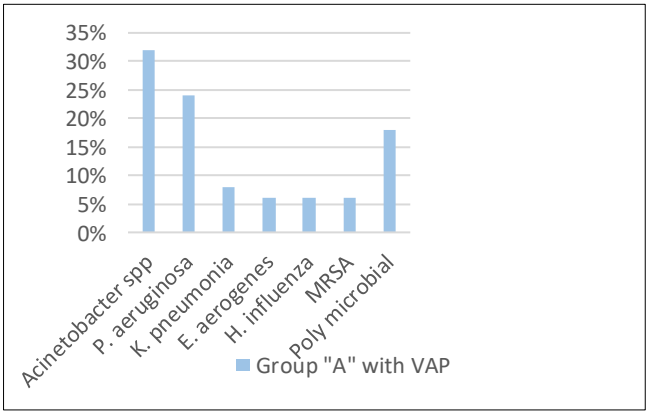

Figure 7. Distribution of Causative agents between studied groups.

4. Discussion

In terms of demographic information, such as age and sex, the present investigation found no statistically significant differences between the groups.

The findings of our study have been confirmed by Karatas et al.,[6] They sought to assess the frequency and variables associated with ventilator-associated pneumonia (VAP) in their respective intensive care units (ICUs). Patients in the hospital for longer than 48 hours who were on mechanical ventilation were included in their retrospective cohort analysis. It was determined if patients with a VAP diagnosis developed pneumonia (VAP (+)) or not (VAP (-)). The authors proved that the groups under study were statistically indistinguishable with respect to age and sex.

When looking at comorbidities such as hypertension, diabetes, heart failure, septicemia, and chronic obstructive pulmonary disease (COPD), no statistically significant difference was found across the groups that were analyzed.

The findings of our study have been confirmed by Turkistani et al.,[7] who demonstrated that there was no significant difference between the studied groups regarding hypertension, diabetes mellitus, heart failure, septicemia and COPD.

The current study showed that there was no statistically significant difference between the studied groups regarding INR, while there was statistically significant difference regarding WBCS and there was highly statistically significant difference regarding serum lactate.

According to the scores data, there was no statistically significant difference between the studied groups regarding the SAPSII score and the APACHE II.

The findings of our study have been confirmed by Karatas et al.,[6] who found a statistically significant difference in APACHE II scores amongst the groups that were investigated.

In terms of clinical outcomes, such as duration of intensive care unit stay and duration of mechanical ventilation, the present study found statistically significant differences between the groups.

Intracranial hemorrhage, acute respiratory failure, malnutrition, myocardial infarction, sudden cardiopulmonary arrest, cerebrovascular disease, pulmonary embolism, cranial surgery, trauma, and abdominal surgery were not significantly different among the groups analyzed based on the reason for hospitalization.

The findings of our study have been confirmed by Turkistani et al.,[7] found that patients with ventilator-associated pneumonia (VAP) had a noticeably longer duration before extubation compared to those without VAP (13.5 vs. 6 days, $p<0.0001$). In a similar vein, patients with ventilator-associated pneumonia (VAP) had a much longer duration of stay in the intensive care unit (19.5 vs. 13 days, $p<0.002$). Patients in the VAP group were more likely to experience extubation failure than those in the non-VAP group (24.24% vs. 14.48%, $p=0.062$), although this difference was not statistically significant. Similarly, the death rate at 28 days from intubation time was 36.36% in the VAP group and 27.54% in the non-VAP group ($p=0.283$).

Based on the agents measured, Acinetobacter spp. Accounted for 32% of VAP cases, Pseudomonas aeruginosa for 24%, Klebsiella pneumoniae for 8%, Escherichia coli for 6%, Haemophilus influenzae for 6%, methicillin-resistant Staphylococcus aureus for 6%, and polymicrobials for 18%.

The findings of our study have been confirmed by Turkistani et al.,[7] the majority of VAP-associated infections were Gram-negative germs, particularly Klebsiella pneumoniae.

Patients with VAP had the highest mortality rate, and there was an extremely significant distinction among the groups that were evaluated.

The findings of our study have been confirmed by Karatas et al.,6 who documented a mortality

rate of 116 (65.2%) among patients identified with VAP. Among the 42 cases of mortality, 23.6% were ascribed to VAP. The mortality rate for VAP(-) patients was 52.6%. There was a statistically significant relationship between the death rate of patients with VAP (+) and VAP (-) (p=0.002). When it came to the majority of death rates in VAP patients, they found a statistically significant distinction among the groups that were analyzed.

According to the results of this study, there was a statistically significant difference in the percentage of patients who did not survive depending on their age. This disparity was most pronounced among the elderly.

The majority of patients who did not survive were found in patients with advanced Apache II scores, indicating a statistically significant distinction among the groups that were evaluated.

The findings of our study have been confirmed by Meric et al.,[8] They found that an elevated APACHE II score increases the likelihood of death but not of hospital-acquired infections.[9]

While the study did find a negative association between COPD and mortality and a positive correlation between age and death, no significant correlation was identified between hypertension, DM, heart failure, or septicemia and mortality. The death rate and clinical outcome were positively correlated.

4. Conclusion

VAP is a significant challenge in ICUs, particularly for patients requiring MV for over 48 hours. It increases mortality rates, prolongs hospital stays, and increases healthcare costs. VAP also leads to complications like respiratory failure, sepsis, and multi-organ dysfunction. Preventive strategies like bundle interventions and strict infection control measures can reduce VAP incidence.

Disclosure

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All authors have a substantial contribution to the article

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