World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-53 December 2025
ISSN: 2749-3644

CURRENT PERSPECTIVE IN VENTILATOR ASSOCIATED PNEUMONIA AND ITS MANAGEMENT:

Ojum S.
Department of Anaesthesia,
Rivers State University Teaching Hospital, Port Harcourt

Article history:

Received: September 11th 2025
Accepted: October 10th 2025

Abstract:

Ventilator-associated pneumonia is a very serious lung infection acquired in the hospital ICU in patient undergoing mechanical ventilation. Typically, it occurs within 48 hours after intubation. It arises from the mechanical ventilation process through endotracheal tube or tracheostomy, the lung parenchyma is inflamed due to infection often caused by colonization of the oropharynx and upper airway. Two most cost common ways of infection includes: bacteria from the stomach that are aspirated into the lungs due to impaired swallowing and cough reflexes in ventilated patients, and endotracheal intubation as a procedure that breaches airway defense, facilitating the entry of pathogens into the lungs and impairing mucociliary clearance. This is the most common infections that develops during stay in the intensive care unit. The patients whose infection is caused by gram- negative multi-resistant strains that produce several types of beta-lactamases are more severe. Therefore, empirical antibacterial therapy for ventilator-associated pneumonia needs improvement and optimization. The aim of the study was to compare the effectiveness of two empirical antibacterial therapy carbapenems, aminoglycosides and monobactamin management of ventilator-associated pneumonia. This is a retrospective study single-center study, which included 30 patients aged 18 years and 60 years above who developed ventilator-associated after a prolonged artificial ventilation, divided into two groups. In using Meropenem in combination with Aztreonam there was a significant result as it concerns clearance of microorganisms from the gut and prevention of superinfection, it was also noted that there was reduction of bacteria resistance, and these enhanced effective oxygenation of the lungs as compared to the traditional antibacterial drugs regularly used in the management of ventilator associated pneumonia. The use of Meropenem combined with Aztreonam antibacterial therapy for ventilator-associated pneumonia has a positive effect in the decrease in the duration of artificial ventilation and there was a reduction in length of stay in the intensive care unit [ICU], hence reducing cost of treatment, and with lower mortality rate as compared to the group that used traditional antibiotics. Is important to note this definitions, recurrence of VAP means: there is initial recovery after 8 days of antibiotic therapy with subsequent repeated manifestation of VAP. Superinfection: This is initial recovery after 8 days of antibiotic therapy with subsequent repeated manifestation of VAP, caused by completely different pathogens.

Keywords: lungs, combination of drugs, Aztreonam.

INTRODUCTION:

Ventilator-associated pneumonia (VAP) is a lower respiratory tract infection, which is associated with tracheal intubation or tracheostomy and causes significant number of complications, which prolongs stay in ICU and increases cost of treatment significantly increases, it also worsens mortality and morbidity amongst patients' in the intensive care unit. Several studies have shown that VAP is one of the most common infections that develops during a stay in the

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-53 December 2025
ISSN: 2749-3644

intensive care unit [1]. This complication occurs in approximately 10-50% of patients, who require mechanical ventilation (MV), and the risk of developing VAP progressively increases in parallel with the increase in the time the patient spends on mechanical ventilation, the highest peak in the development of VAP occurs on the fifth day of MV [2]. Subsequently, VAP is associated with an increased incidence of complications in patients, an increase in their duration of MV, duration of stay in both the intensive care unit and in the hospital [3]. Most bacteria and microorganisms that are implicated in the development of VAP are multi resistant. Of course before a patient comes to ICU a lot of antibiotics would have been used and this could cause the multi resistant strains of pathogens drugs. Mostly implicated are Acinetobacter, Klebsilla, Enterobacteriaceae, and Pseudomonas aeruginosa [4].

Diagnosis VAP, is based on clinical data, result of microbial studies and radiological investigation. Despite the numerous and available way of diagnosis it is still quite difficult to make the diagnosis of VAP. Hence if there is the slightest suspect of the disease suitable antibiotics must commence immediately as any delay is associated with complications and increase in mortality rate. [5] In most clinical guidelines of management of VAP, it is recommended to prescribe carbapenems/piperacillin, tazobactam, third or fourth generation of cephalosporin in combination with aminoglycosides or fluoroquinolones. [6] it is important to note that most of the organisms that are implicated in the pathogenesis of VAP the Acinetobacter, Klebsilla, Enterobacteriaceae and Pseudomonas are increasingly becoming resistant to beta-lactam, fluoroquinolones and aminoglycosides.

The gram negative multi drug resistant strains microorganisms Acinetobacter, Klebsilla, and Pseudomonas aeruginosa characteristically produces metallo-beta lactamases and extended spectrum beta-lactamases this determines their multi drug resistant features [7]. Authors has promulgated that the combination of Aztreonam and carbapenems is better as Aztreonam is the only beta lactam antibiotics resistant to the action of metallo- beta-lactamases [8]. Aztreonam as an antibiotic of has good penetration into lung tissues and non-toxic both to the kidneys, and it does not possess ototoxicity like other aminoglycosides. It is also safe as it concerns coagulation unlike the third generation cephalosporin, it is also safe as it rarely causes allergic reaction.it does not cause also diarrhea [9]. The combination of Aztreonam and carbapenems is important because Aztreonam is protected from being destroy by the its broad spectrum beta lactamases. This will enhance proper eradication of microorganisms irrespective of type of beta-lactamases resistance they possess [10].

AIM

The main aim of this study is to compare the effectives of two mostly used regimens of antibacterial therapy in management of VAP, in particular the use of carbapenems, aminoglycosides and monobactams.

MATERIAL AND METHODS:

The study is a retrospective study basically, data was collected from patient's folders, with advent of Meropenem and other newer drugs, it influenced antibiotics stewardship in the ICU. Hence 30 patients who were with the diagnosis of VAP, were careful studied and divided into two group. Group A were 18 patients who were treated with intravenous Meropenem, at the doses of 2gram daily combined with Aztreonam 3 grams per day. Group B were12 patients treated with Meropenem 2 grams daily with amikacin at 1 gram daily. The study included both sexes and age of 18 years to 60 years. The patients were admitted to the ICU of RUSTH between 2014 to 2023. The inclusion criteria were patients that underwent prolonged mechanical ventilation due traumatic brain injury. We exclude some patients from the study because there co morbidity of lung pathology of injury to the chest, fractured rib. VAP was defined in this study as the pneumonia that occurs within 48 – 72 hours post intubation, evident by radiological prove of new or increase of infiltrate in lung fields, sign of systemic inflammation, hyperthermia[fever], in blood test leukocytosis, tachycardia, in suctioning of endotracheal lavage the presence of purulent sputum. Data that was collected were clinical and laboratory parameters. The creatinine levels, oxygen parameters, duration in mechanical ventilation, length of stay in ICU, mortality rate in both groups.

Recovery from VAP was considered as those that was wean out from mechanical ventilation successfully, of course clinical parameters that show absence of pathogens in sputum, resolving of infiltrates in lung field, retrogression of clinical and laboratory evidence of VAP, and systemic inflammatory sign. In events of lack of improvement in laboratory and clinical and radiological result it means that VAP has persisted and could be fatal.

The statistical analysis was done using SPSS 15.0.1 for window. The study results are presented as mean and standard error for quantitative parametric data, median and interquartile range for quantitative nonparametric data. Frequency and percentage were used to characterize qualitative data. Student's t-test or Mann-Whitney test were used to analyze

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-53 December 2025
ISSN: 2749-3644

quantitative data, chi-square test and Fisher's test were used to analyze qualitative data. A p-value less than 0.05 was considered statistically significant.

RESULTS:

Table 1
As shown in Table 1, the groups did not differ in age, sex, and presence of concomitant pathology.

Demo data.	indicator	G- A	G-B	P-V
Age		41± 13,4	42,3 ± 14,4	0,72
Sex	Male	10(55.6%)	7(58,3%)	0,27
	Female	8(44,4%)	5(41.6%)	0,27
Co-morbidity	DM	5 (27.7%	4(33..3%)	0,72
	HT	6(33,3%)	4(33.3%)	0,73

As shown in Table 2 below show the microorganisms that was isolated in both groups patients with of ventilator-associated pneumonia they were gram-negative strains: Acinetobacter, Pseudomonas and others. these microorganisms have great resistance to most antimicrobial drugs. Infection caused by the strain of microorganisms require a prolonged and combination of antibiotics. The doses may be high enough to eradication the infection, not undermining nephrotoxicity.

Table 2.

Microorganism isolated ventilator-associated pneumonia.

Micro organisms	G-A	G -B	P-Value
S. Aureus	7 (38 %)	3 (25 %)	0,28
Acinetobacter	2 (11 %)	4 (33.3 %)	0,05
Pseudomonas	8 (44.4 %)	4 (33.3 %)	0,11
Citrobacter	0 (0 %)	1 (8.3 %)	0,31
Providencia	1 (5 %)	1 (8.3%)	1,00
Proteus	1 (5 %)	1 (8.3 %)	1,00
Enterobacter	1 (5 %)	0 (0 %)	0,31

Table 3.
Indicators of oxygenation parameters before and after empirical antibacterial therapy.

Breathing coefficient	G-A	G-B	P Value
PaO2 /FiO2 before antibiotics	154,2 ±12,7	153,0 ±11,4	0,54
PaO2 /FiO2 after antibiotics	196,2 ± 13,7	179,4 ± 14,6	0,31
Observed changes positively after antibacterial therapy			

We studied the pattern of oxygenation before the commencement of treatment three days later after commencement of antibiotics in both groups. In order to do this, study all data of the ratio of partial pressure of oxygen in arterial blood to the fraction of oxygen in the respiratory mixture was collated from the data base. Oxygenation parameters in patients of both groups are presented in Table 3 above. As shown in Table 3, in patients of the group A, where a combination of Meropenem with Aztreonam was used as antibiotic therapy, a significant improvement in oxygenation parameters was noted (p=0.006), while in the group B no statistical difference was noted (p=0.21).

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-53 December 2025
ISSN: 2749-3644

In table 4 below, the creatinine levels in the blood plasma of patients in two groups were monitored, to ascertain that there were no toxic effects of the antibiotics on the kidney, after three days of antibacterial therapy and before commencement of therapy to ascertain the baseline kidney status. As the data in Table45 show, in patients in the group A and group B before the start of empirical antibacterial therapy, the level of blood plasma creatinine did not differ statistically.

At the same time, in patients where antibacterial therapy was carried out with a combined use of Meropenem and Aztreonam, creatinine level decrease after three days. In patients in the group B, where the antibacterial therapy of Meropenem combined with amikacin was used, the creatinine level increased slightly. When comparing creatinine levels in blood plasma in patients of the group A and group B after three days of antibacterial therapy, we can deduce that patients in the group A where a combined administration of Meropenem and Aztreonam had lower levels of creatinine in blood. This indicates that Aztreonam does not have a nephrotoxic effect, unlike amikacin.

Table 4.
Creatinine levels in blood plasma in patients of two groups before and after empirical antibacterial therapy.

Creatinine level in blood	Indicator	Group A	Group B	p
Creatinine level μmol/L before antibacterial therapy	Median	98,34	104,8	0,60
	Interquartile range	75,46-118,09	87,40-119,05	
	Rank	54,0-208,0	72,0-160,0	
Creatinine level μmol/L after antibacterial therapy	Median	89,49	119,04	0,004
	Interquartile range	68,60-119,27	108,19-137,74	
	Rank	17,0-176,0	70,0-221,0	

Three days after the commencement of antibacterial therapy the two groups were evaluated to ascertain the microbial load in the sputum showing sensitivity to the antimicrobial therapy. The results of these studies are presented in Table 5 below. The combination of Meropenem and Aztreonam antibacterial therapy for ventilator-associated pneumonia was accompanied by a rapid reduction in microbial load in the sputum in most patients, as well as a significantly lower development of resistance and superinfection. All this made it possible to further limit the use of antibiotics in patients in group A during treatment in the intensive care unit and in the hospital.

Table 5. Microbiological results of the effectiveness of antibacterial therapy.

Indicator	Study group	Observation grou	Chi-square test	p level
Absence of microorganism growth	27 (84,4%)	8 (25%	20,43	<0,0(
Resistance	2 (6,3%)	9 (28,1%	4,95	0,0:
Superinfection	1 (3,1%)	7 (21,9%	3,57	0,0⁴
Resistance and superinfection	2 (6,3%)	8 (25%	3,72	0,0⁴

To ascertain how the effective of the quality of treatment, length of stay in the intensive care unit and duration of mechanical ventilation of the lungs in patients of both groups. These data are presented in Table 6, the duration of stay in the intensive care unit of patients in the group A, where a combination of Meropenem with Aztreonam was used, was significantly shorter than that of patients of group B where Meropenem and amikacin was used. Similarly, data were obtained when analyzing the duration of mechanical ventilation of the lungs in patients of both groups. The use of Meropenem in combination with Aztreonam as antibacterial therapy for ventilator-associated pneumonia reduced the duration of artificial ventilation of the lungs, as well as the duration of treatment in the intensive care unit.

Table 6. Indicators of the quality of treatment in the intensive care unit.

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-53 December 2025
ISSN: 2749-3644

Indicator	Indicator	Study group	Observation grou	P level
Duration of ALV days	Median	19,0	23,5	0,037
	Interquartile range	16,0-26	21,3-26	
	Rank	13,0-90	20,0-38	
Duration of stay in th intensive care unit day	Median	21,5	25,5	0,045
	Interquartile range	16,3-27	23,0-28	
	Rank	15,0-90	20,0-38	

Mortality rates in the intensive care unit are shown in Table 7 below.
Table 7 shows the mortality rate in the intensive care unit, in patients of the study group A was 25.0% lesser than group B.

Table 7. Mortality rates in the intensive care unit in the study and observation groups.

Indicator	Group A	Group B	P level
Mortality rate	6 (33.3%)	7 (58,3%)	0,168

DISCUSSION

The presence of an endotracheal or tracheostomy tube in the airways and mechanical ventilation increases the risk of developing ventilator-associated pneumonia by 6-20 times in compared with patients without tracheal intubation and prolonged artificial ventilation lungs. Accordingly, mortality in patients who develops ventilator-associated pneumonia is 47%, while in patients without this complication, is 22% [1]. Therefore, the choice of the optimal antibacterial therapy is extremely important for effective treatment of this category of patients.

Combination of beta-lactam drugs with amino-glycosides has long been considered a classic combination of drugs that has a bactericidal effect almost all gram-negative nosocomial antibiotic-resistant strains [2]. The fact that management of infections caused by gram-negative strains poses great challenge as they produce metal-beta-lactamases which is resistant to most antibacterial drugs. As a result, aminoglycosides to lead to effective clinical improvement of patients with ventilator-associated associated pneumonia.

In a study, of 47 patients with ventilator-associated pneumonia caused by gram-negative microorganism, where Ps. aeruginosa, Enterobacter, Klebsiella, E. Coli. were isolated. In 31 patients, antibacterial therapy was carried out with Aztreonam, and tobramycin was used in 16 patients. Eradication of the pathogen in the group where patients received Aztreonam was noted in 92% of cases, and in the group where treatment was carried out with tobramycin only in 57% of cases ($p<0.05$). Regression of ventilator-associated pneumonia in the group where Aztreonam was used was noted in 93% of patients, and in patients where tobramycin was the drug of choice only 50% of cases ($p<0.05$). They concluded that Aztreonam had clear advantages compared to tobramycin in the context of treating ventilator- associated pneumonia caused by gram-negative microorganisms [11].

Aztreonam is non nephrotoxic, unlike aminoglycosides and colistin. In a comparative study to compare the effectiveness of Aztreonam and aminoglycosides in the treatment of infections caused by gram-negative strains. It concluded that clinical improvement and microbiological clearance in the groups were identical. But kidney malfunction was noted in 9 of 54 patients receiving aminoglycosides; while in Aztreonam group only 2 of 53 patients had such complication [12]. Due the severity and intense of VAP many studies are being carried out, A Torres et al. this work compared the effectiveness of using a combination of Aztreonam + Cefotaxime and a combination of amikacin + Cefotaxime on 33 patients with ventilator-associated pneumonia caused by gram-negative microorganisms. The combination of Aztreonam + Cefotaxime was used in 16 patients; in 17 - the combination of amikacin + Cefotaxime. Clinical improvement was noted in 77% of patients where the combination of Aztreonam + Cefotaxime was used, and in 75% of patients where amikacin + Cefotaxime was used. Superinfection with microorganisms Ps. aeruginosa, Acinetobacter calcoaceticus, Streptococcus viridians was noted only in patients in the group where the combination of amikacin + Cefotaxime was used. There also impaired renal tubular function was noted only in patients where the combination of amikacin + Cefotaxime was used. The authors concluded that the combination of Aztreonam + Cefotaxime is effective in the context of empirical antibacterial therapy for ventilator-associated pneumonia. Therefore, one of the advantages of this combination is the absence of nephrotoxic which allows it to be

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-53 December 2025
ISSN: 2749-3644

used in patients with impaired renal function [13]. As shown in the study by F. Colardyn and co-authors, the use of Aztreonam in combination with another beta-lactam drug is an effective method of empirical antibacterial therapy for ventilator-associated pneumonia. A randomized study was conducted in two intensive care units. The authors compared the effectiveness of the combination of aztreonam + oxacillin with the classic combination of tobramycin + cephalosporin. The use of the combination of aztreonam + oxacillin was accompanied by clinical recovery in 80% of cases, and the mortality rate in this group was 15%. When using the classic combination of tobramycin + cephalosporin, clinical recovery was noted in 51% of cases ($p<0.05$), and the level of mortality in this group reached 23% ($p<0.05$). Superinfection in the group where the combination of aztreonam + oxacillin was used developed only in 2% of cases, while in patients with using the tobramycin + cephalosporin regimen, superinfection was recorded in 20% of cases; more moreover, 11% of patients in this group developed renal kidney dysfunction. The authors concluded that the combination of aztreonam + oxacillin is an effective and safe regimen of empirical an- antibacterial therapy for ventilator-associated pneumonia [14].
As a scheme of empirical antibacterial therapy for ventilator-associated pneumonia Herve Dupont et al. proposed to use the combination of aztreonam with cefepime, while clinical recovery was noted in 69% of patients [15]. Thomas Fekete et al. for conducting empirical antibacterial therapy for ventilator-associated pneumonia suggested to use a combination of aztreonam with cefazolin. The use of this scheme was accompanied by clinical improvement in 90% of patients and bacteriological eradication of the pathogen in 84.6% patients [16]. The results obtained in our work coincide with the data obtained during the above-mentioned randomized prospective clinical trials. Thus, clinical recovery with using the aztreonam + Meropenem regimen was noted in 75% of cases; eradication of the pathogen – in 84.4% of cases; superinfection developed in 3.1 % of cases. The use of the aztreonam + Meropenem was characterized by a significant decrease in the level of creatinine in the blood, and the level of mortality in patients of this group was 28.1%.

CONCLUSIONS:

The use of Meropenem in combination with Aztreonam as antibacterial therapy for ventilator-associated pneumonia, caused by gram negative multi resistant strains, has good results in restoring normal oxygenation indices; rapid to total reduction and total clearance of microorganisms in most patients and has lesser resistance and superinfection. This combination was safe, no nephrotoxicity, it also significantly decrease the duration of mechanical ventilation of the lungs and a reduction in the length of stay of patients in the intensive care unit.

REFERENCES

1. Vincent JL, Bihari DJ, Suter PM, Bruining HA et al. The prevalence of nosocomial infection in intensive care units in Europe. Results of the European Prevalence of Infection in Intensive Care (EPIC) study. EPIC International Advisory Committee. JAMA.1995; 274: 639-644. doi:10.1001/ jama.1995.030080055041
2. Cook JL, Walter SD, Cook RJ, Griffith LE et al. Incidence of and risk factors of ventilator-associated pneumonia in critically ill patients. Ann Intern Med.1998; 129: 433-440. doi: 10.7326/0003-4819-129-6-199809150-00002.
3. Safdar N, Dezfulian C, Collard HR, Saint S. Clinical and economic consequences of ventilator-associated pneumonia: a systematic review. Crit Care Med. 2005; 33: 2184-2193. doi: 10. 1097/01.CCM.00001811731. 53912.D9. Valles J, Pobo A, Garcia-Esquirol O, Mariscal D, Real J Et al. Excess ICU mortality attributable to ventilator-associated pneumonia: the role of early vs late onset. Intensive Care Med. 2007; 33: 1363-1369. doi: 10.1007 s00134-007-0721-0.
4. .Chastre J, Fagot JY. Ventilator-associated pneumonia. Am. J. Respir. Crit. Care Med. 2002; 165: 867-903
5. American Thoracic Society and Infection Diseases Society of America Guidelines for management of adults with hospital-aquired, ventilator- associated, and health-care-associated pneumonia. Am J Respir Crit Care Med.2005; 171:388-416. doi: 10.1164/rccm.200405-6444ST.
6. Thanyaluck Siriyong, Rachael M Murray, Lucy E. Bidgood et al. Dual
7. beta-lactam combination therapy for multi-drug resistant Pseudomonas aeruginosa infection: enhanced efficacy in vivo and comparison with monotherapies of penicillin-binding protein inhibition. Sci Rep. 2019; 9: 9098. doi: 10.1038/s41598-019-45550-z.
8. Christopher Ramsey et al. A review of pharmacokinetics and pharmaco- dynamics of Aztreonam. J Antimicrob Chemother. 2016 Oct; 71(10): 2704- 2712. doi: 10.1093/jac/dkw231.

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-53 December 2025
ISSN: 2749-3644

9. Nelson S. Brewer, Walter C. Hellinger. Mayo Clinic Proceedings. 1991; 66:1152-1157. doi: 10.1016/s0025-6196(12)65797-8.
10. Karen Bush et al. Beta-lactams and beta-lactamase inhibitors: An overview. Cold Spring Harb Perspect Med. 2016; 1; 6(8): a025247. doi: 10.1101/ cshperspect. a025247.
11. J.J. Schentang et al. treatment with Aztreonam of tobramycin in critical
12. care parients with nosocomial gram-negative pneumonia. Am J Med. 1985; 78(2A): 34-41. doi: 10.1016/0002-9343(85)90201-3.
13. A De-Maria JR et al. Randomized clinical trial of Aztreonam and aminoglycoside antibiotics in the treatment of serious infections, caused by gram-negative bacilli. Antimicrob Agents Chemother. 1989; 33(8): 1137-
14. 1143. doi: 10.1128/FFC.33.8.1137.
    A. Torres et al. Therapeutic efficacy of the combination of Aztreonam with Cefotaxime in the treatment of severe nosocomial pneumonia. Comparative study against amikacin combined with Cefotaxime. Chemotherapy. 1989; 35. Suppl 1:15-24. doi: 10.1159/000238716.
15. F. Colardyn, J.L. Gala et al. Infections in patients in intensive care units: can the combination of a monobactam and penicillin replace a classic combination of a beta-lactam agent and an aminoglycoside? Reviews of
16. Infection Diseases. 1991; Vol 13. Supplement 7. Aztreonam: the expanding Clinical profile: 640-644. doi: 10.1093/clinids/13.supplement_7. s640.
17. Herve Dupont, Sandra Marciniak. Use of Aztreonam in association with cefepime for the treatments of nosocomial infections. Anaesthesia, Critical Care and Pain Medicine. 2015; V. 34. Issue 3: 141-144. doi: 101016/j. accpm.2015.02.004
18. Thomas Fekete, Michael Castellano, Suzanne Gagnon. A randomized comparative trial of Aztreonam plus cefazolin versus ceftazidime for the treatment of nosocomial pneumonia. Drug Investigation. 1994; 7: 117-126. doi: 10.1007/BF03258463.