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Original Research Article

Frequency of Ventilator-Associated Pneumonia in PICU at NICH

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Abstract: *Ventilator-associated pneumonia (VAP) is one of the most common and severe nosocomial infections in intensive care settings, especially in pediatric populations.* ***Objective:*** *To determine the frequency of VAP among mechanically ventilated children in the PICU of NICH, identify the causative pathogens, and assess their antimicrobial susceptibility patterns.* ***Methods:*** *This cross-sectional study was conducted at the PICU of NICH, Karachi, from May 2024 to November 2024, and enrolled pediatric patients aged 1 month to 15 years who required intensive care and mechanical ventilation. A total of 86 ventilated pediatric patients were enrolled. Patients who met the inclusion criteria were enrolled following informed consent. Clinical and demographic data were recorded on a structured, IERB-approved proforma, including patient age, gender, diagnosis, date and time of intubation, medications, and surgical interventions.* ***Results:*** *Out of 86 patients, 62 (72.09%) developed VAP. The mean duration of mechanical ventilation was 14.95 ± 4.5 days, and the mean hospital stay was 18.53 ± 6.0 days. The mortality rate among VAP patients was 56.45%. Acinetobacter spp. (59.68%) and Pseudomonas spp. (38.71%) were the most commonly isolated pathogens. Resistance rates were extremely high, with Acinetobacter spp. Showing 100% resistance to meropenem, ceftriaxone, amikacin, and other first-line antibiotics. Only 5.41% of isolates were sensitive to ciprofloxacin. The mean CPIS score was 6.68 ± 1.62.* ***Conclusion:*** *It is concluded that VAP is highly prevalent in the PICU at NICH and is associated with high mortality and prolonged hospital stay. The predominance of multidrug-resistant organisms, especially Acinetobacter spp., underscores the urgent need to implement stringent infection control practices, routine surveillance, and stewardship-driven antibiotic protocols to manage and reduce the burden of VAP.*

Keywords: Anti-Bacterial Agents, Cross-Sectional Studies, Intensive Care Units, Pneumonia, Respiration

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Introduction

Ventilator-associated pneumonia (VAP) is a significant nosocomial infection that arises 48 hours or more after endotracheal intubation and mechanical ventilation. It remains one of the most frequent healthcare-associated infections in intensive care settings, contributing to prolonged hospital stays, increased healthcare costs, and elevated morbidity and mortality—particularly among pediatric patients with critical illnesses. The pathogenesis of VAP is multifactorial, involving microaspiration of secretions, biofilm formation on endotracheal tubes, and impaired host immune responses. In resource-limited settings, the burden is often underreported due to diagnostic challenges and variability in surveillance practices. Mechanical ventilation has become the keystone in modern critical care. It has become one of the primary indications for admission to the pediatrics ICU and is often a lifesaving strategy. However, the use of mechanical ventilation can be associated with various complications in children, among which ventilator-associated pneumonia (VAP) is the most frequent (1). The major pathogens behind VAP are Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Acinetobacter baumannii. Moreover, Streptococcus pneumoniae and Haemophilus influenzae are also the causative agents, but their association with VAP is less frequent (2). The emergence of multidrug-resistant strains associated with VAP has created an alarming situation and mainly accounts for increased VAP-associated mortalities (3). Due to MDR etiological agents, the choice of antibiotic regimen has also become limited, thus hampering the management of VAP in ICU settings (4).

VAP accounts for up to 20% of all HAIs in the ICU settings, with a prevalence rate of up to 86% that varies significantly among different age groups and regions (5). It is linked to increased hospital stays (by an average of 7-9 days per patient) and mortalities (up to 68%) (6). This also contributes to the financial burden on patients and healthcare institutions, especially in developing countries. In Pakistan, there are minimal studies that have reported the prevalence of VAP in overall ICU settings of various health care institutes. This accounts for the large gap in local VAP prevalence and incidence studies. The frequency of VAP in PICU settings needs a regular surveillance program to combat extended hospital stays and associated mortality rates. In 2018, a single-centre study at the PICU of Services Hospital Lahore reported a VAP incidence of 8.5%, predominantly caused by Pseudomonas aeruginosa (52.94%) (7). The reported frequencies of VAP in various studies range from 3 to 50% in ventilated PICU admissions (8). Several studies have been conducted to determine the best method for diagnosing VAP, the most common of which is the Clinical Pulmonary Infection Score (CPIS), which uses clinical, radiological, and microbiological criteria. Although the CPIS criteria require rather invasive methods, CPIS has a good diagnostic value (sensitivity 72% and specificity 85%) (5). The incidence of VAP varies widely, influenced by factors such as duration of ventilation, infection control practices, underlying comorbidities, and the availability of trained personnel. Pediatric Intensive Care Units (PICUs) are particularly vulnerable due to the delicate immune status of children and the frequent use of invasive interventions. Furthermore, multidrug-resistant organisms (MDROs) are increasingly implicated in VAP, raising serious concerns about therapeutic limitations and infection control.

Thus, the objective of the study is to determine the frequency of Ventilator-associated pneumonia in PICU settings of NICH, evaluate which pathogens are most prevalent, and decipher the drug susceptibility pattern of the most frequent VAP pathogens.

Methodology

This cross-sectional study was conducted at the PICU of NICH, Karachi, from May 2024 to November 2024, which admits pediatric patients aged 1 month to 15 years who require intensive care and mechanical ventilation. A total of 86 ventilated pediatric patients were enrolled. The sample size was calculated using OpenEpi software, based on a 95% confidence level, 5% margin of error, and a previously reported VAP incidence of 8.5%. Non-probability convenience sampling was used to select participants.

The study included children of either gender, aged between 1 month and 15 years, who were admitted to the Pediatric Intensive Care Unit (PICU) of the National Institute of Child Health (NICH) and required mechanical ventilation for more than 48 hours. Children meeting these criteria were eligible for enrollment.

Patients were excluded if they had pre-existing lower respiratory tract infections or radiological findings suggestive of pneumonia at the time of admission. Those with a history of prior intubation and ventilation before the current PICU admission were also excluded. Furthermore, immunocompromised patients were not enrolled, including those with an absolute neutrophil count or total leukocyte count below 500/mm³, diagnoses of leukemia, lymphoma, or HIV infection with a CD4 count below 200 cells/mm³, as well as individuals with a history of solid organ or hematopoietic stem cell transplantation. Patients receiving cytotoxic chemotherapy or long-term corticosteroid therapy, and those with a history of splenectomy, were also excluded from the study.

Ethical approval was obtained from the Institutional Ethical Review Board (IERB) of NICH. Written informed consent was taken from parents or legal guardians before enrolling each patient.

Patients who met the inclusion criteria were enrolled following informed consent. Clinical and demographic data were recorded on a structured IERB-approved proforma, including patient age, gender, diagnosis, date and time of intubation, medications, and surgical interventions. Each patient underwent Clinical Pulmonary Infection Scoring (CPIS) on days 1, 3, 7, 10, and 14 of mechanical ventilation. Endotracheal aspirates were collected using sterile precautions after 48 hours of ventilation and were sent for microbial culture and sensitivity analysis to the microbiology laboratory at NICH.

Data were entered and analyzed using SPSS version 23. Descriptive statistics such as means, frequencies, and percentages were used to summarize demographic variables and clinical characteristics. The frequency of VAP, the distribution of causative pathogens, and their antimicrobial susceptibility patterns were reported.

Results

Out of 86 pediatric patients on mechanical ventilation, 62 developed ventilator-associated pneumonia, resulting in a frequency of 72.09 percent. Among these, 37 were male with a mean age of 5.96 ± 1.8 years, while 25 were female with a mean age of 4.45 ± 1.2 years. The most frequently isolated organism was Acenatobacter spp. (59.68 percent), followed by Pseudomonas spp. (38.71 percent), With one case showing no growth. The mean duration of mechanical ventilation was 14.95 ± 4.5 days, and the average hospital stay was 18.53 ± 6.0 days. The Clinical Pulmonary Infection Score was recorded in all 62 cases, with a mean score of 6.68 ± 1.62, indicating a considerable burden of infection among the ventilated patients.

Table 1: Demographic, Clinical, and Microbiological Characteristics of VAP Patients (n = 62)

Parameter	Value
Total Patients	86
Patients with VAP	62
Frequency of VAP (%)	72.09%
Female Patients (n, Mean Age ± SD)	25 (4.45 ± 1.2 years)
Male Patients (n, Mean Age ± SD)	37 (5.96 ± 1.8 years)
Acenatobacter spp. Isolates	37 (59.68%)
Pseudomonas spp. Isolates	24 (38.71%)
No Growth (Negative Culture)	1 (1.61%)
Ventilator Days (Mean ± SD)	14.95 ± 4.5 days
Hospital Stay (Mean ± SD)	18.53 ± 6.0 days
CPIS Score - Count	62
CPIS Score - Mean ± SD	6.68 ± 1.62

Among the 62 patients diagnosed with ventilator-associated pneumonia, 35 (56.45%) unfortunately died, while 27 (43.55%) survived, indicating a high mortality rate in this population. The most frequent underlying condition was tetanus, seen in 8 patients (12.9%), followed by meningitis in 6 patients (9.68%) and Guillain-Barré Syndrome in 5 patients (8.06%). Several other conditions were observed with lower frequencies. These included seizure disorders, hepatic encephalopathy, and meningoencephalitis, each accounting for three patients (4.84%). Other diagnoses such as CKD, ANEC, sepsis, and measles-related complications were seen in 2 patients each (3.23%). A wide range of less common conditions, such as neuroblastoma, viral meningitis, liver abscess, encephalitis, and foreign body aspiration, were each documented in one patient (1.61%), reflecting the clinical diversity of the PICU population.

Table 2: Clinical Outcomes and Primary Diagnoses Among VAP Patients (n = 62)

Category	Description	Number of Patients	Percentage (%)
Clinical Outcome	Died	35	56.45
	Survived	27	43.55
Primary Diagnosis	Tetanus	8	12.90
	Meningitis	6	9.68
	Guillain-Barré Syndrome (GBS)	5	8.06
	Seizure Disorder	3	4.84
	Hepatic Encephalopathy (total)	3	4.84
	Meningoencephalitis (total)	3	4.84

	Chronic Kidney Disease (CKD)	2	3.23
	Acute Necrotizing Encephalopathy (ANEC)	2	3.23
	Sepsis	2	3.23
	Measles/Post-measles Complication	2	3.23
	Metabolic Disorder	1	1.61
	Liver Abscess	1	1.61
	Atypical Encephalitis	1	1.61
	Neuroganglioma	1	1.61
	AGE (Acute Gastroenteritis)	1	1.61
	Bronchiolitis	1	1.61
	Enteric Fever	1	1.61
	Pneumoperitoneum	1	1.61
	Viral Hepatitis	1	1.61
	Hiatal Hernia	1	1.61
	Neuroblastoma	1	1.61
	Encephalitis	1	1.61
	Tuberculosis of the Spine	1	1.61
	Myocarditis	1	1.61
	Bronchopneumonia	1	1.61
	Viral Meningitis	1	1.61
	Foreign Body Aspiration	1	1.61

All tested isolates showed complete resistance to Amikacin, Meropenem, Cefexime, Ceftriaxone, and Ampicillin. Among the 37 samples, two were not tested with Tanzo, while the remaining 35 were resistant. Aztreonam was not tested in any of the isolates. Ciprofloxacin was the only antibiotic with minimal sensitivity, showing two sensitive isolates and 35 resistant ones, highlighting a resistance rate of over 94 percent.

Table 3: Antibiotic Susceptibility - Acenatobacter spp

Antibiotic	Not Tested (N)	Resistant (R)	Sensitive (S)
Aztreonam	37	0	0
Amikacin	0	37	0
Meropenem	0	37	0
Cefexime	0	37	0
Ceftriaxone	0	37	0
Tanzo	2	35	0
Ampicillin	0	37	0
CiproFloxacin	0	35	2

All tested isolates (100%) were resistant to Amikacin, Meropenem, Cefexime, Ceftriaxone, Tanzo, and Ampicillin. Ciprofloxacin had a slightly lower resistance rate at 94.59%, with only two isolates showing sensitivity. Aztreonam was not tested in any case, and thus no data were available for its resistance rate. Amikacin, Meropenem, and Ciprofloxacin were the most commonly tested antibiotics.

Table 4: Antibiotic Resistance Rate

Antibiotic	Tested	Resistant	Resistance Rate (%)
Aztreonam	0	0	nan
Amikacin	37	37	100.0
Meropenem	37	37	100.0
Cefexime	37	37	100.0
Ceftriaxone	37	37	100.0
Tanzo	35	35	100.0
Ampicillin	37	37	100.0
CiproFloxacin	37	35	94.59

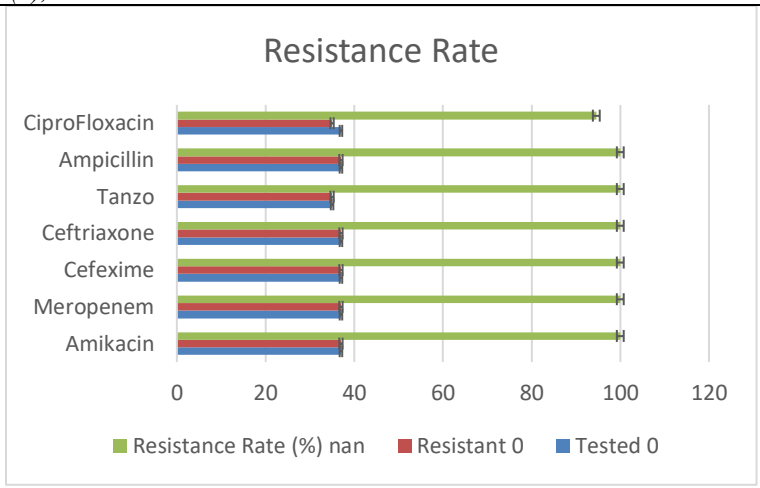

Figure 1: Antibiotic Resistance Rate

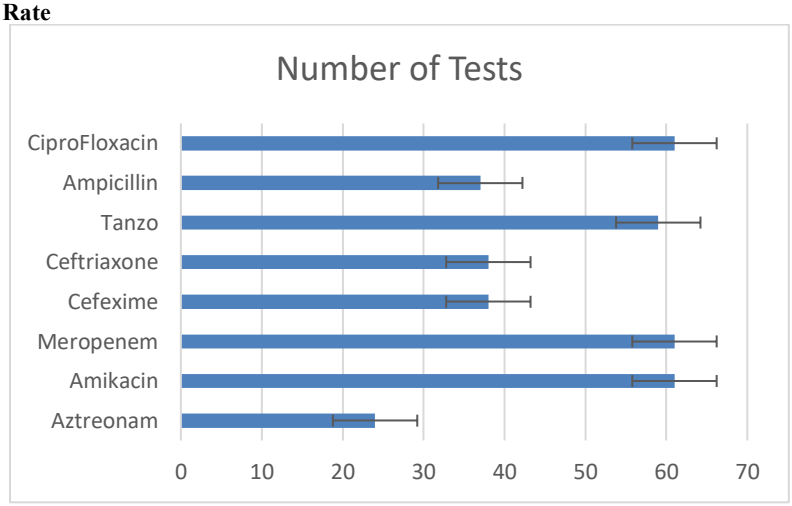

Figure 2: Antibiotic Testing Frequency

Discussion

This study demonstrated a notably high frequency of ventilator-associated pneumonia (VAP) in pediatric patients admitted to the PICU, with 72.09% of ventilated patients developing VAP. This rate is much higher than those found in most international PICU studies, where VAP is reported to be 10% to 30% on average. In a similar case, a research group from Iran found that 24% of mechanically ventilated children had VAP, hinting that preventative measures may be lacking at our center or that patients admitted here tend to be in poorer health (9). Most of the bacterial species found (59.68% Acinetobacter spp. and 38.71% Pseudomonas spp.) are well-known for their virulence and ability to resist various antibiotics in the hospital environment. Khalil et al. (2025) have observed similar results, stating that Acinetobacter was responsible for the majority of VAP cases in children and was highly resistant to common antibiotics (10). According to the study, resistance to Amikacin, Meropenem, Ceftriaxone, Tanzo, and even Ciprofloxacin (with just 5.41% sensitivity) was found among all tested isolates. According to data from studies and the WHO's 2024 antimicrobial resistance report, the incidence of carbapenem-resistant gram-negative bacteria is concerning and continues to increase globally (11).

Both the average length of mechanical ventilation and hospital stay in our patients with VAP were 14.95 ± 4.5 days and 18.53 ± 6.0 days, in agreement with what is seen in similar institutions (12). Evidence from the CDC and IDSA shows that keeping a person on a ventilator for a prolonged period raises the risk of VAP. For this reason, they encourage early weaning. Moreover, the average CPIS score of 6.68 ± 1.62 in our population indicates that pneumonia was likely present and that there was significant infection. We found that 56.45% of patients died during the study, which is much higher than what has been reported in other studies. For example, a multicenter review by Joseph et al. reported a pediatric VAP mortality of 30% in India (13). The increased mortality in our setting may be attributed to delays in diagnosis, limited therapeutic options due to antimicrobial resistance, and a higher proportion of patients with complex neurological or infectious comorbidities, such as tetanus, GBS, and meningoencephalitis (14).

In terms of primary diagnoses, tetanus (12.9%) was the most frequent underlying condition among VAP cases. This reflects the unique case mix in our PICU and the continued burden of vaccine-preventable diseases in low- and middle-income countries (15). It also raises concern about the need for strengthening primary immunization coverage and neonatal care (16). Overall, our findings point to a critical need for implementing strict VAP prevention protocols, including ventilator care bundles, regular oral hygiene, head-of-bed elevation, and antimicrobial stewardship. Additionally, enhancing microbiological surveillance, optimizing empiric therapy based on local antibiograms, and investing in staff training are essential steps toward reducing the incidence and improving outcomes of VAP in pediatric critical care settings.

Conclusion

It is concluded that ventilator-associated pneumonia poses a significant clinical burden in the pediatric intensive care unit at NICH, with a high frequency of 72.09% among mechanically ventilated patients. The predominant pathogens were multidrug-resistant Acinetobacter spp. and Pseudomonas spp., with alarming resistance patterns to commonly used

antibiotics, including complete resistance to meropenem, amikacin, and ceftriaxone. Prolonged ventilation, extended hospital stay, and a high mortality rate of 56.45% further underscore the critical need for effective prevention strategies, early diagnosis, and rational antibiotic use.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-24)
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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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