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Original Research Article

Risk factors and outcome of ventilator associated pneumonia in children aged 1 month to 12 years admitted in paediatric intensive care unit of a tertiary care hospital in Northern India

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) is pneumonia that occurs after the patient has been on mechanical ventilation for more than 48 hours. There is a paucity of literature depicting the severity of VAP in the North Indian population. The current study was taken up to study the risk factors and outcomes of ventilator-associated pneumonia in children aged 1 month-12 years admitted in pediatric intensive care unit (PICU).
Methods: A prospective observational study was conducted in the department of pediatrics, VMMC and Safdarjung Hospital, New Delhi for 18 months. The children aged 1 month to 12 years who were mechanically ventilated in the PICU for more than 48 hours were included in the study. Demographic details, nutritional status, and underlying primary diagnosis were recorded along with details about the duration of hospital stay, ventilator days and reintubation, clinical pulmonary infection score (CPIS), and paediatric risk of mortality (PRISM) score.
Results: A significant positive correlation was seen between PRISM score with duration of ventilator and hospital stay. A higher PRISM III score was found to have a significant association with the development of VAP in the patients. Duration of ventilator stay and duration of hospital stay were the major risk factors for the incidence of VAP.
Conclusions: The major risk factors that contributed to the development of VAP were the duration of ventilator stay and hospital stay. PRISM III score was found as a useful tool in predicting the development of VAP in the patients. Further larger prospective and multicentric studies are required to evaluate the risk factors and outcome of VAP.

Keywords: Ventilator-associated pneumonia, PRISM score, CPIS, Ventilator, Hospital stay

INTRODUCTION

Ventilator-associated pneumonia (VAP) is defined as pneumonia that occurs after the patient has been on mechanical ventilation for more than 48 hours.[1] The prevalence ranges from 8-23% in pediatric intensive care unit (PICU).[2,3] Histopathology and culture of lung tissue remain the gold standard in the diagnosis of VAP but this is not feasible in most children and hence the combination of clinical, radiological, and microbiological pieces of evidence are used. VAP that occurs within the first 72 hours of mechanical ventilation (MV) is referred to as early VAP while that which occurs after 72 hours of MV is referred to as late VAP. According to the clinical pulmonary infection score (CPIS), a score of >6 within the first 72 hours and after 72 hours of mechanical breathing, respectively is referred to as early and late VAP.[4,5] Early and late VAP differ in various aspects such as pathophysiology, causative bacteria, antibiotic sensitivity, prognosis, and treatments.

The etiology of VAP is categorized into host-related, device-related, and personnel-related risk factors. Associated co-morbidities like acute respiratory distress syndrome, cardiovascular and central nervous system

disorders, multiple organ system failure (MOSF), level of consciousness, patient positioning, number of intubations, and medications like sedatives and previously administered antibiotics are a few examples of host-related factors. The endotracheal tube, the ventilation circuit, and the existence of a nasogastric or orogastric tube are all device-related factors. Cross-contamination between patients is caused by personnel-related issues such as poor hand hygiene and insufficient usage of personal protective equipment by the nursing staff. The pediatric age group has specific characteristics about susceptibility to infection and co-morbid disorders, from most preterm newborns to young babies, children, and adolescents.[6] Various scores have been proposed to predict mortality in PICU patients like the paediatric index of mortality (PIM) and paediatric risk of mortality (PRISM) but only the paediatric index of mortality 3 (PIM 3) score was correlated by Vijay et al to predict mortality among VAP patients which they found non-significant and the most common organisms found to be responsible for VAP were gram-negative bacilli.[7]

Research indicates gram-negative bacteria to be the most common isolates (42–65%).[8,9] According to a review of all the studies that are currently accessible, Acinetobacter is considered an emerging microorganism of interest in Asian nations, including India.[10] There is a paucity of literature available on this topic in northern India as well as most of the studies done were retrospective and a limited scoring system was used to predict the severity of VAP. So, the current study was planned to evaluate the risk factors and outcome (in terms of mortality and length of ventilator stay) in VAP patients admitted to PICU and to assess the validity of the PRISM III score as to whether this scoring system indicates the severity of the disease and predicts the development of VAP.

METHODS

The current study was a prospective observational study conducted in the department of paediatrics, VMMC and Safdarjung Hospital, New Delhi for a period of 18 months in which 70 children aged 1 month to 12 years who were mechanically ventilated in PICU for more than 48 hours were included in the study while cases of readmission in PICU and patients intubated for more than 12 hours before PICU admission were excluded from the study. VAP was defined as the development of new pneumonia after 48 hours of endotracheal intubation.

Sample size calculation

Proton pump inhibitor (PPI) use (OR 8.47) and enteral feeding (OR 12.2) were found to be separate risk factors for VAP in the study by Gadappa et al.[10] Using these figures as a guide, the sample size worked out to be 61 at 95% power and a 5% level of significance. A total sample size of 70 was thought to be appropriate to lower the margin of error. The formula used was given below.

$$n = (4 \times (Z\alpha + Z\beta)^2)/(log\ (OR))^2$$

Data collection included demographic information, nutritional condition, and the underlying main diagnosis. Specifics regarding the length of hospital stay, ventilator days, and reintubation (patients who have received more than one endotracheal intubation and tracheostomy were documented). Early versus late VAP diagnosis was made using the CPIS. CPIS included temperature, leucocyte count, PaO_2/FiO_2 ratio, chest X-ray infiltrates, tracheal secretions and microbiology. At 48 and 96 hours after the start of mechanical ventilation, the aforementioned variables were noted on patient charts. Early and late VAP were deemed to exist in patients with a CPIS score >6 at 48-72 hours and 72-96 hours following intubation, respectively. The age group of the study was divided into 3 categories: 1 month-1 year, 1-5 years, and 5-12 years. The first 12 hours of care were evaluated using the PRISM III score. The primary study outcome was recorded as the duration of ventilator stay and/or mortality.

Statistical analysis

The categorical variables were presented as proportion/percentage. The quantitative were shown as means with standard deviations. The final analysis was carried out using the statistical package for social sciences (SPSS) software, manufactured by IBM, Chicago, USA, version 25.0 after the data had been entered into a Microsoft excel spreadsheet. The association of the variables which were qualitative in nature were analysed using Chi-square test. If any cell had an expected value of less than 5 then Fisher's exact test was used. Spearman rank correlation coefficient was used for correlation of PRISM score with duration of ventilator stay (days) and duration of hospital stay (days). A p value of ≤0.05 was regarded as significant for declaring any statistical differences.

RESULTS

The findings of 70 study participants have been described. Among 70, 42.86% of patients belonged to the age group 1-5 years followed by >5-12 years (32.86%). The mean age of study subjects was 3.74±3.5 years. A male predominance was observed with 62.86% males (Table 1).

Table 1: Distribution of study subjects according to age and gender (n=70).

Variables	Frequency	Percentage
Age (years)		
<1	17	24.29
1-5	30	42.86
>5 to 12	23	32.86
Mean±SD	3.74±3.5	
Median (IQR)	2 (1-6.75)	
Gender		
Female	26	37.14
Male	44	62.86
Total	70	100.00

The mean value of the PRISM score of the study subjects was 28.54±3.25 (Table 2). The subjects were on ventilators for a mean duration of 14.7±15.88 days whereas the mean hospital stay was for 23.8±23.14 days. All three variables were found to be significantly associated with the occurrence of VAP (p<0.05).

Table 3 shows the association of tracheal culture with VAP which was found to be statistically significant. Tracheal culture with acinetobacter was found in the majority of those who had VAP.

The median (IQR) PRISM score in discharged patients was 29.5 (27.5-31.25), in those shifted to ward was 28 (26-30), and for those who expired was 28 (26-30) with no significant association between them (p value=0.725) (Table 4).

Table 2: Association of presence or absence of VAP with other clinical variables (n=70).

Variables	With VAP	Without VAP	Total	P value
PRISM score				
Mean±SD	30.5±3.58	27.76±2.77	28.54±3.25	
Median (IQR)	30 (28-32.75)	28 (26-30)	28 (26-30)	0.002
Range	22-35	24-35	22-35	
Duration of ventilator stay (days)				
Mean±SD	23.15±20.55	11.32±12.27	14.7±15.88	
Median (IQR)	15 (10-30)	7 (4.25-10)	10 (5-15)	0.005
Range	3-60	3-60	3-60	
Duration of hospital stay (days)				
Mean±SD	38.05±32.67	18.1±14.97	23.8±23.14	
Median (IQR)	25 (20-40.5)	15 (7-20)	18 (10-25)	0.0005
Range	7-120	3-70	3-120	

Table 3: Association of tracheal culture with VAP (n=70).

Tracheal culture	VAP (n=20), N (%)	No VAP (n=50), N (%)	Total, N (%)	P value
No growth	12 (60.0)	49 (98.0)	61 (87.14)	
Acinetobacter	6 (30.0)	0 (0.0)	6 (8.57)	
Klebsiella	2 (10.0)	0 (0.0)	2 (2.86)	<0.0001
Pseudomonas	0 (0.0)	1 (2.0)	1 (1.43)	
Total	20 (100.0)	50 (100.0)	70 (100)	

Table 4: Association of PRISM score with outcome (n=70).

PRISM score	Discharged (n=8)	Shifted toward (n=45)	Expired (n=17)	Total (n=70)	P value
Mean±SD	29.62±3.89	28.36±3.1	28.53±3.43	28.54±3.25	
Median (IQR)	29.5 (27.5-31.25)	28 (26-30)	28 (26-30)	28 (26-30)	0.725
Range	24-35	22-35	24-35	22-35	

A significant positive correlation was seen between the PRISM score with duration of ventilator stay(days), and duration of hospital stay (days) with correlation coefficients of 0.503, and 0.488 respectively (Table 5).

Table 5: Correlation of PRISM score with duration of ventilator stay and hospital stay.

Variables	Duration of ventilator stay (days)	Duration of hospital stay (days)
PRISM score		
Correlation coefficient*	0.503	0.488
P value	<0.0001	<0.0001

*Spearman rank correlation coefficient

DISCUSSION

VAP is a common pediatric problem, especially in developing countries including India. In the current study, the incidence of VAP was 28.5%. The incidence of pediatric VAP as reported by Sharma et al in their study in 2009 was 20%.[11] Some other studies have reported a higher prevalence of 35.2% by Kulkarni et al and 40% by Gadappa et al.[10,12]

Out of the various variables considered in this study, the risk factors significantly associated with VAP were the duration of ventilator stay and hospital stay. This finding is similar to the findings reported by Kulkarni et al and Gadappa et al.[10,12] However, about the tracheal culture, contradictory findings have been reported by Yasmine et

al where it was found that Gram-negative bacteria were more common in the majority of VAP patients (75.7%) while in our study 60% of VAP patients did not show any growth.[13]

Diagnosis of VAP may differ significantly, depending on the methods used. The early prediction of outcomes in diseases with high short-term mortality can significantly aid in identifying children who require urgent medical intervention. The PRISM III score, which includes 17 physiological parameters such as mental status, arterial blood pressure, and ABGs, does not account for the modes, parameters, and impacts of mechanical ventilation (MV).[14] Nevertheless, it serves as a clear indicator of disease severity. Testing the PRISM III score in different settings from where it was initially developed will help evaluate its clinical relevance. Assessing its predictive capacity in critically ill children is crucial. However, there is limited data on the PRISM score's effectiveness specifically for VAP. Therefore, as the study aimed to assess the validity of the PRISM score with diagnosis of VAP, it was found to be significantly higher among patients with VAP (p=0.002). The correlation coefficient with risk factors were also found to be significantly associated with PRISM score (p<0.001). This shows that PRISM III score can be used a reliable predictor for VAP and its outcomes as reported by other studies as well.[15] In another study conducted by Rsovac et al with the objective of analyzing the PRISM III score as a potential predictor of the short-term outcome in MV subjects with paediatric acute respiratory distress syndrome (PARDS) found that the PRISM III score values were significantly higher in those who died, as well as in subjects requiring high-frequency oscillatory mode (HFOV) of mechanical ventilation (MV).[16] Considering the correlation between length of hospital stay and PRISM score, the score also provides us with a valuable tool for prediction of hospital stay duration which has been reported by other studies as well.[17-19]

Limitations

Limitations of the study were that a smaller sample size was taken as compared to other studies, risk factors like parenteral feeding and use of PPIs were not assessed and lung biopsy was not done in our setting which limited the accuracy of the correlation with risk factors and outcomes.

CONCLUSION

The incidence of VAP in our study was 28.5%. Duration of hospital stay was found to be the most common risk factor for the incidence of VAP in children admitted to PICU and the most common age group with the highest incidence of VAP was 1-2 years. Acinetobacter was the most common organism (30%) isolated from the tracheal aspirates of VAP patients. PRISM 3 score was a useful tool in predicting VAP development in patients admitted to PICU as it showed a significant association (p value=0.002). Further larger prospective and multicentric studies are required to evaluate the risk factors and outcome of VAP.

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