

Frequency of Risk Factors for Ventilator Associated Pneumonia in Paediatric Population

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ABSTRACT

Objective: To determine the frequency of risk factors for Ventilator Associated Pneumonia (VAP) in a pediatric population. **Setting & Study Design:** It was a cross sectional survey conducted at the Neonatal and Pediatric Intensive Care Unit, (NICU and PICU), Sheikh Zayed Hospital, Lahore from 31-10-2009 till 2010. **Methods:** 175 cases of VAP were enrolled by non-probability, purposive sampling technique Patients from birth to 12 years (144 months), admitted in NICU and PICU, who received mechanical ventilation for >48 hours, were analyzed retrospectively for the presence of risk factors such as reintubation, nasogastric tube feeding and thoracostomy tube and eventual development of Ventilator Associated Pneumonia. **Results:** Out of total 175 patients, 55.3% were < 1 month (neonates) admitted in NICU while 44.7% were between 1 month and 12 years(144 months) and admitted in PICU. Mean \pm S.D age for NICU and PICU patients was 3.76 ± 1.10 days and 39.88 ± 33.78 months respectively. In both NICU (male 53.2% Vs female 46.8%) and PICU (71.1% male Vs 28.96 % female), there was male predominance. Regarding frequency of risk factors, in both NICU and PICU, reintubation was the most frequent risk factor (85.1% NICU, 73.1% PICU) followed by nasogastric tube feeding (17% NICU, 36.8% PICU) and tube thoracostomy (6.4% NICU, 10.5% PICU). **Conclusions:** VAP is a common infection associated with process of patient care and certain interventions (such as reintubation, nasogastric tube placement and tube thoracostomy) might affect the incidence of VAP. ICU clinicians should be aware of the risk factors for VAP, which could prove useful in identifying patients at high risk of VAP and thus modifying patient's care to minimize the risk of VAP.

Key words: Ventilator associated pneumonia, mechanical ventilation, risk factors, frequency.

INTRODUCTION

Ventilator associated pneumonia (VAP) is defined as nosocomial pneumonia in mechanically ventilated patients that was not present at the time of intubation.^{1,2} It is a common and severe complication of mechanical ventilation (MV).³

According to National Nosocomial Infection Surveillance (NNIS) Programme, VAP is the second most common cause of nosocomial infection, representing 20% of nosocomial infections. The highest age specific rates of VAP occurred in 2-12 month age group and the most common causative organism was *Pseudomonas aeruginosa*. Ventilator associated pneumonia adversely affects the patient

outcome including mortality and duration of hospital stay. In pediatric populations, the published data suggests that pediatric patients with VAP have excess mortality and length of PICU and NICU stay.⁴

The causes of VAP are varied and differ across different populations and different types of ICUs⁵. Incidence of some important risk factors identified are reintubation (12%) as there are increased chances of aspiration of gastric contents. Placement of thoracostomy tube (32%) is an intervention near lung parenchyma which influences lateral lung ventilation causing retention of secretions and possible development of VAP. Nasogastric tube feeding (100%) predisposes to VAP by elevating gastric pH leading to gastric

colonization and causing gastric distention thus increasing the risk of reflux and aspiration.⁶

There is no gold standard for the diagnosis of VAP in both adults and children. The National Nosocomial Infection Surveillance Programme (NNIS) and the Centre of Disease Control (CDC) have established the clinical criteria for the diagnosis of VAP. For microbiological diagnosis either bronchoscopic methods like bronchoalveolar lavage (BAL), protected specimen brushing (PSB) or non-bronchoscopic methods like quantitative endotracheal aspirate (ETA) is used in most ICUs.^{4,6,7}

VAP is a nosocomial infection associated with a diverse spectrum of bacteria, most of which are usually multi drug resistant.⁸ High frequency of nosocomial infection suggest more strict measures regarding invasive devices should be taken to control infection and limit the emergence of antibiotic resistant organisms.⁹

The epidemiology and risk factors for VAP are well described in adults but limited data exists for pediatric patients.^{10,11} This study aims to assess the risk factors associated with VAP so that interventions aimed at reducing these complications can be made.

Objective

To determine the frequency of risk factors for ventilator associated pneumonia (VAP) in pediatric population

Setting & study design

This study was conducted in Neonatal Intensive Care Unit (NICU) and Pediatric Intensive Care Unit (PICU) at Sheikh Zayed Hospital, Lahore. It was a cross-sectional survey.

PATIENTS AND METHODS

This study was completed over a period of one year, from 31-10-2009 till 2010. Inclusion criteria for the study were children of either sex, from birth to 12 years of age, and those who were mechanically ventilated for >48 hours. Patients excluded from the study were those with congenital pneumonia, pneumonia on the day of intubation, congenital anomalies such as tracheoesophageal

fistula, thoracic cage deformities and diaphragmatic hernia. Those children were also excluded who were mechanically ventilated for <48 hours or whose gestational age was < 28 weeks. A non-probability purposive sampling technique was employed.

Ventilator associated pneumonia was defined as the nosocomial pneumonia in mechanically ventilated patients with onset after 48 hours of ventilation, identified on the basis of lung infiltrates on chest x-ray (new and persistent for at least 72 hrs) and any two of the following: A) Axillary temperature >38°C, B) WBC count >12000 / mm³, C) Purulent endotracheal secretions >25 neutrophils/hpf on gram stain.

Risk factors under study were defined as: A) Thoracostomy tube more than 48 hours in situ during mechanical ventilation, B) Reintubation: more than one attempts, C) Nasogastric tube feeding >24 hours during mechanical ventilation

175 patients admitted to the Neonatal and Paediatric ICUs of Paediatrics Department, Sheikh Zayed Hospital, Lahore during the study period fulfilled the inclusion criteria and were selected according to the calculated sample size. Informed consent was taken from the parents, ensuring that there were no risk factors involved.

Medical records including charts, daily flow sheets, laboratory and radiographic reports were reviewed. Relevant information including demographic data and presence of risk factors as reintubation, presence of thoracostomy tube and nasogastric tube feeding were recorded and analyzed.

Statistical analysis

Regarding statistical analysis, all the collected data was entered in the SPSS version 10 and was analyzed through this programme.

The variables included age, gender and risk factors. The quantitative variable like age was presented by calculating Mean \pm Standard Deviation (S.D). Qualitative variables like gender and risk factors (reintubation, thoracostomy tube and nasogastric tube feeding) were presented by calculating frequency and percentage.

Data was stratified for age (<01 month and \geq 01- 144 months) to explain effect modifiers.

RESULTS

Total 175 patients with VAP admitted in NICU and PICU of SZH were enrolled from October 2009 till October 2010. Out of these 175 patients, 97 were from NICU (55.3%) and 78 were from PICU (44.7%). (Table 1)

Table 1: Distribution of patients according to the type of ICU (n=175).

Type of ICU	No.	%	Mean±SD
NICU (Days)	97	55.3%	3.76±1.10
PICU (Months)	78	44.7%	9.88±33.78
Total	175	100.0%	

Data was stratified for age to explain effect modifiers. According to age, patients were distributed in various groups *i.e.* those less than one month (neonates) and those between 1-12, 12-60, 60-144 months of age. (Table 2)

Table 2: Distribution of patients according to age (n=175)

Age	Number	Percent
<1 month (NICU)	97	55.43%
1 month-1 year (>1-≤12 months) (PICU)	42	24.0%
1-5 years (>12-≤60 months) (PICU)	24	13.71%
5-12 years (>60 -≤144 months) (PICU)	12	6.86%
Total	175	100.0%

Out of 175 patients, 97 (55.3%) were neonates and admitted in NICU, the mean ±S.D age (days) for NICU patients was 3.76 ± 1.10 days. 78 (44.7%) patients were between 1 month and 144 months, admitted in PICU. The mean ±S.D age (months) for PICU patients was 39.88±33.78 months (Table 2).

Regarding sex distribution, among NICU patients, there was slight male predominance. Out of 97 NICU patients, 51 (53.2%) were male and 46 (46.8%) were female. Among PICU patients there

was male predominance also. Out of total 78 PICU patients, 55 (71.1%) were male and 23 (28.9%) female (Table 3).

Table 3: Distribution of patients according to sex (n=175)

Sex	Neonatal Intensive Care Unit		Pediatric Intensive Care Unit	
	No.	%	No.	%
Male	51	53.2%	55	71.1%
Female	46	46.8%	23	28.9%
Total	97	55.3%	78	44.7%

Specific medical care processes during ICU stay were examined as potential risk factors for development of VAP; these included reintubation, tube thoracostomy and nasogastric tube feeding.

When studied for the frequency of risk factors, among NICU patients reintubation was the most important risk factor observed (85.1%) followed by nasogastric tube feeding (17%) and tube thoracostomy (6.4%). Similar results were observed in PICU patients. Reintubation was the most frequent risk factor observed (73.1%) followed by nasogastric tube feeding (36.8%) and tube thoracostomy (10.5%) One or more than one risk factors were present in each patient (Table 4).

Table 4: Risk factors observed (Overlapping) (n=175).

Risk factors	Neonatal Intensive Care Unit		Pediatric Intensive Care Unit	
	No.	%	No.	%
Reintubation	82	85.1	57	73.1
Nasogastric tube feeding	16	17.0	29	36.8
Tube thoracostomy	06	6.4	08	10.5

DISCUSSION

The clinical data of patients who received mechanical ventilation and developed VAP from October 2009 till October 2010 were enrolled into the study. Diagnosis of VAP was made by guidelines provided by the NNIS (National Nosocomial Infection Surveillance).

In our study, majority of patients were

neonates (<1 month), constituting 55.3% admitted to NICU, and 44.7% between 1 month- 144 months/12years, comprising PICU patients.

Neonates have unique characteristics predisposing them to nosocomial infections. Their immature immune system predisposes them to infection. Decreased activity of complement, particularly complement opsonization occurs in newborns. Lastly, hypogammaglobulinemia occurs in premature newborns. Maternal immunoglobulin IgG is transported to fetus in second and last trimester of pregnancy and reach maternal level by term.^{1,2.}

Our study population was demographically similar to those of other NICU and PICU in large academic tertiary care centers with regard to age and gender. In our study among neonates there was slight male predominance constituting 53.2% male and 46.8% female. The mean \pm S.D for age was 3.76 ± 1.10 days. These results were coherent to another study conducted in NICU of a tertiary care teaching hospital in India.³

Patients aged between 1 month and 144 months/12 years admitted in PICU also showed male predominance. The mean \pm S.D age was 39.88 ± 33.78 months. These results were coherent with the results of other published studies.^{2,5.} However the highest age specific infection rates in NNIS data were in 2-12 months age group. The effect of these parameters on VAP rate is uncertain.⁵

Reintubation, nasogastric tube feeding and tube thoracostomy have been described by previous studies as significant risk factors for VAP.^{1,4,6,9,10.} All of these were case controlled studies conducted in neonatal, pediatric and adult ICUs comparing the incidence of these risk factors among mechanically ventilated patients with and without VAP.

Our study, a cross-sectional survey, determined how frequently these risk factors were present among NICU and PICU patients. When observed for frequency of these risk factors among NICU patients, reintubation was the most frequent risk factor observed (85.1%) followed by nasogastric tube feeding (17%) and tube thoracostomy (6.4%). Similar results were observed in PICU patients, reintubation being the most common risk factor observed (73.1%) followed by nasogastric tube feeding (36.8%) and tube

thoracostomy (10.5%) in our study there was higher incidence of reintubation as compared to other risk factors. This finding was consistent with other studies conducted in neonatal and pediatric ICUs, describing reintubation as an independent predictor of VAP by logistic regression analysis.

The most likely mechanism is aspiration of gastrointestinal contents during reintubation. It is possible that patients may be more likely to be emergently reintubated because of tube blockage or after unplanned extubation^{6.} Careful assessment should be made on ventilated patients before extubation and steps should be taken to prevent accidental extubation with a view to prevent further complications in critically ill patients. However, data on number of reintubations and circumstances surrounding reintubations were not collected in this study.

A unique, although statistically less significant risk factor identified in our study was tube thoracostomy. This variable has been described as a risk factor for VAP in one study conducted in adult ICU by Eleni Apostolopoulou et al. This suggests that intervention near the lung parenchyma may play a role in the development of VAP.¹²

In our study tube thoracostomy was applied in 3 NICU and 4 PICU patients admitted with primary diagnosis of pneumothorax or large pleural effusion. Interestingly, in all patients who underwent tube thoracostomy VAP involved at least the lateral lung. This would support the hypothesis that the cause that leads to tube thoracostomy affects the ventilation of lateral parts of lungs, which in turn may lead to the retention of secretions and possibly development of VAP. Alternatively, the lung parenchyma injury caused by pneumothorax or hemothorax may play a role in the development of VAP.^{12,13}

In our study patients receiving MV, nasogastric tube (NG) was placed for evacuation of gastric secretions and for nutritional support. Presence of NG tube alone has been described as a risk factor for VAP because it is thought to cause maxillary sinusitis that in turn leads to VAP.^{6,14.}

Nasogastric tube (NG) feeding is preferred over parenteral nutrition in most critically ill patients because former is thought to prevent integrity of gut and cause fewer complications.

However, NG tube feeding has associated risks. The most serious potential complication is tracheobronchial aspiration of gastric contents. Far more common than witnessed large volume aspirations is a series of clinically silent microaspirations.¹⁵ This is because there is dysfunction of upper and lower esophageal sphincters and associated gastro-esophageal reflux secondary to the presence of tube.^{6,14,15.}

Hence modulating enteral feeding might limit gastro pulmonary colonization, thus reducing incidence of VAP. This is very important because provision of adequate nutritional support to patients receiving MV is believed to prevent VAP. According to a randomized controlled study conducted in adult patients receiving MV for stroke or head injury, it was suggested that administration of enteral feeding via percutaneous gastrostomy, performed early, is associated with lower incidence of VAP as compared to nutrition via NG tube.^{14,15.}

In our study enteral feeding via NG tube was started in those patients who were difficult to wean off from MV and may require prolonged ventilation, especially those with depressed level of consciousness of different etiology such as head injury, seizure disorder requiring heavy sedation, CNS infections and birth asphyxia, patients with renal or cardiac failure necessitating strict fluid restriction and high caloric intake.

Enteral feeding has been found to be a risk factor for VAP alone or in combination with supine body position.¹² In our study, patients had intermittent NG feeding with head end elevated. Our study showed NG tube feeding as a potential risk factor for VAP in 17% and 36.8% of NICU and PICU patients respectively. This is contrary to the results of another retrospective study conducted in surgical ICU head trauma patients demonstrating early enteral feeding as protective factor for early onset VAP. While in another prospective study including non-trauma ICU patients, enteral nutrition was associated with late onset VAP^{16.} Enteral feeding may predispose to VAP by elevating gastric pH leading to gastric colonization and by causing gastric distention, thus increasing the risk of reflux and aspiration.¹⁴

As suggested by some studies that type of ICU population did not influence occurrence of

VAP.^{8,11.} Likewise, we did not find any significant difference in frequency of risk factors among different ICU populations increasing neonatal and pediatric ICU comprising medical and surgical patients. Reintubation is the statistically most significant risk factor while NG feeding and tube thoracostomy are less significant in both NICU and PICU.

CONCLUSION

VAP is a common nosocomial infection and certain interventions affecting its incidence may be devised if predisposing factors are known. Specific medical care processes serve as potential risk factors for development of VAP; these include reintubation, nasogastric tube feeding and tube thoracostomy in order of priority. Knowledge of the important risk factors predisposing to VAP may prove to be useful in implementing simple and effective preventive measures including precaution during emergency intubations, minimizing the occurrence of reintubations such as avoiding unplanned extubation and modulating enteral feeding.

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