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Research Article

Clinical study of ventilator associated pneumonia in a tertiary care centre

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ABSTRACT

Background: Ventilator associated pneumonia (VAP) remains to be the commonest cause of hospital morbidity and mortality in spite of advances in diagnostic techniques and management. VAP refers to bacterial pneumonia developing in patients who have been receiving mechanical ventilation for at least 48 hours. It is the commonest complication associated with mechanical ventilation. The objectives were to know the incidence and outcome of VAP in a tertiary care centre at Indira Gandhi Institute of child health (IGICH) and to identify the probable risk factors for ventilator associated pneumonia (VAP) and to identify the most common pathogenic bacteria causing VAP.
Methods: This is a prospective study of children mechanically ventilated in the pediatric intensive care unit of Indira Gandhi Institute of Child Health. Children between the age group of >1month to <18 years were included in the study. Ventilator associated pneumonia is defined as per the clinical pulmonary infection score given by Pugin et al, patients were monitored with various clinical and laboratory parameters like fever, purulent endotracheal aspirates, pulmonary radiological changes, leukocytosis, arterial blood gas analysis, blood culture and endotracheal tube aspirate grams stain and culture and sensitivity pattern and other relevant investigations.
Results: Out of the seventy five children requiring mechanical ventilation 17 developed VAP giving the incidence of 22.66%. Early onset VAP constituted 41.1% of the cases and the rest is late onset VAP (58.9%). Reintubation of more than 2 times, central venous lines, tracheostomy and prolonged ventilation are the risk factors for VAP. *Pseudomonas* (6), *Klebsiella* (8) were the most frequent and significant etiological agents causing VAP. *Pseudomonas* and *Klebsiella* are the common organisms in late onset VAP and *Staphylococcus aureus* (MRSA) (2) and *E coli* (1) are isolated in early onset VAP. There is no statistically significant difference in mortality between the VAP and Non-VAP cases. VAP prolongs the duration of mechanical ventilation, length of intensive care and the duration of hospital stay compared to the Non VAP cases. The average duration of ventilation in VAP cases is 6.68±4.12 days. The mean duration of PICU care (16.65days) and hospital stay in VAP children is also prolonged (20.53 days) and it is statistically significant.
Conclusions: VAP is an important nosocomial infection in PICU with the incidence of 22.66%. Prolonged ventilation and repeated intubations are the major risk factors. Central venous lines and tracheostomy are the added risk factors for VAP. Judicious use of ventilator support and early weaning will reduce the incidence of VAP. Gram negative organisms are the most common organisms causing VAP. VAP did not influence the mortality but it did prolong the duration of ventilation, intensive care and hospital stay in turn increasing the morbidity.

Keywords: Ventilator associated pneumonia (VAP), Intubation, Mechanical ventilation, Endotracheal aspirates

INTRODUCTION

Ventilator associated pneumonia (VAP) is defined as nosocomial pneumonia developing in a patient 48 hours after the initiation of mechanical ventilator support (by endotracheal tube (ETT) or tracheostomy tube).[1] Despite major advances in the techniques for the management of ventilator dependent patients, VAP continues to complicate the course of 8-28% of the patients receiving mechanical ventilation (MV).[1-5] Rates of pneumonia are considerably higher among patients hospitalized in intensive care units (ICUs) compared with those in the hospital wards. The risk of pneumonia is increased 3 to 10 folds for the intubated patient receiving mechanical ventilation.[1] The mortality with VAP is considerably high, varying from 24 to 50% and can reach as high as 76% in some specific settings or when lung infection is caused by high risk pathogens.[2]

For many years, VAP was diagnosed by clinical criteria such as fever, leukocytosis and purulent tracheobronchial secretions supported by the radiological evidence of new or persistent pulmonary infiltrates.[1] However, these criteria are non-specific. Studies have shown that clinical criteria have imperfect diagnostic reliability in ventilated patients, and therefore, additional procedures such as cultures of the lower respiratory tract are required for the accurate diagnosis and treatment of VAP.[6] However, clinical criteria do remain crucial for defining those patients who may require respiratory sampling.[1]

As several studies have shown that appropriate antimicrobial treatment of patients with VAP significantly improves outcome, early diagnosis and accurate selection of antimicrobial agents are extremely important.[3,4]

Identifying the risk factors which influence the final outcome in VAP may help in improving the mortality and morbidity in ICUs. Finally, it helps in taking steps for the prevention of VAP.

METHODS

Setting

The study was conducted in the pediatric intensive care unit (PICU) at Indira Gandhi institute of child health (IGICH).

The PICU in IGICH has 16 beds where pediatric patients from the age of 1 month to the age of 18 years are admitted. It predominantly deals with pediatric emergencies and those with surgical problems are treated in surgical ICU. The PICU is well equipped with 4 ventilators and state of the art monitoring equipment's with centralized monitoring.

Study period

The study period is between the months of January 2009 to December 2009. The patients admitted during the study period in PICU requiring ventilator support were evaluated. The inclusion and exclusion criteria for the study are as follows:

Inclusion criteria

1. Age >1 month and <18 years.
2. Patients mechanically ventilated for more than 48 hours in PICU during the study period.

Exclusion criteria

1. Age less than 1 month and more than 18 years.
2. Patients with pre-existing radiological infiltrates at the beginning of ventilation.
3. Patients referred to PICU with prior intubations and ventilation done outside our hospital.

Definition

The diagnostic criteria for VAP were modified from those established by Pugin et al as adapted by Singh et al.[7,8]

VAP is considered in those mechanically ventilated for >48 hours with clinical pulmonary infection score (CPIS) of 6 or more. A cut off of 96 hours of mechanical ventilation is used to distinguish early onset of VAP from late onset VAP.

ARDS defined as PaO_2/FiO_2<200 or PaWP <18mm of Hg and acute bilateral infiltrates (Data from Pugin et al as adapted by Singh et al.[7,8]

Blood and pleural fluid cultures had to be obtained within 48 hours before or after the clinical suspicion of ventilator-associated pneumonia.

A new radiographic infiltrate is prospectively defined as one occurring >48 hours after the start of mechanical ventilation or within 48 hours of extubation. Persistence is defined as the infiltrate presenting radiographically for at least 72 hours. Fever is defined as an increase in the core temperature of ≥1ºC and a core temperature of >38.5ºc. Leucocytosis is defined as a 25% increase circulating leucocytes from baseline and a leucocyte count of >10,000/mm.[3] Tracheal aspirates will be considered purulent if a Gram's stain showed >25 neutrophils per high-power field. Bacterial growth is considered heavy if the colony count is more than 10^5 counts/ml, moderate growth when the colony count is between 10^3-10^5/ml, and scanty when it is less than 10^3/ml.

Data collection

The clinical details of the patients included in the study group are entered in the well-designed proforma for the study. The data was obtained by daily examination of the patients. The details of the patient demographics, underlying illness and the day and time of ventilation is recorded. The medications administered and any surgical procedures done on the patient also noted. The investigations performed on the patient for the primary illness and VAP are reviewed and findings are noted. All patients were subjected for the X-rays prior to the initiation of ventilation for the diagnosis of underlying condition, soon after the onset of ventilation, subsequently during ventilation whenever a deterioration of ventilator parameters were found, prior to a planned extubation and post extubation. Endotracheal aspirates were performed with sterile precautions, were sent for grams' stain, culture and sensitivity after 48 hours of ventilation in all cases, and whenever there is a suspicion of VAP and when cases of VAP did not respond to the administered antibiotics as per the protocol. The culture and sensitivity pattern of the organism obtained are analyzed and appropriate management protocol is undertaken.

***Statistical methods*[9-11]**

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on mean±SD (min-max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Analysis of variance (ANOVA) has been used to find the significance of study chi-square/Fisher exact test has been used to find the significance of study parameters on categorical scale between two groups. Odds ratio has been used to assess the influence of risk factors in relation to the incidence of VAP.

1. *Chi-Square Test*

$$\chi^2 = \frac{\sum (Oi - Ei)^2}{Ei}$$, Where Oi is observed frequency and Ei is expected frequency

2. *Fisher Exact Test*

	Class 1	Class 2	Total
Sample 1	a	B	a+b
Sample 2	c	D	c+d
Total	a+c	b+d	N

Fisher Exact Test statistic =

$$\sum p = \frac{(a+b)!(c+d)!(a+c)!(b+d)!}{n!} \frac{1}{\sum a!b!c!d!}$$

3. *Significant figures*
   - +Suggestive significance (p value: 0.05<p<0.10)
   - *Moderately significant (p value: 0.01<p≤0.05)
   - **Strongly significant (p value: p≤0.01)

Statistical software

The statistical software namely SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and microsoft word and excel have been used to generate graphs, tables.

RESULTS

Total number of study population (n) = 75. Out of the 75 patients studied 17 were VAP accounting for 22.66% of the cases. VAP is considered when the CPIS score is more than 6. 41.17% of the VAP cases are early onset VAP and the remaining 58.83% are late onset VAP (Figure 1).

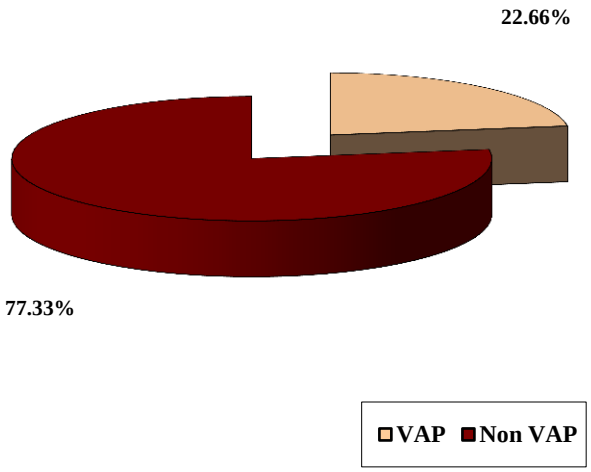

Figure 1: Number of cases enrolled.

The indication for PICU admission requiring ventilator support is given in Table 1 where central nervous system (60%) involved in the majority of the cases followed by dengue (6.66%), sepsis (6.66%) and others (28.5%). Others include organophosphorus poisoning (2), snake bite (2), Guillian Barre syndrome (2), cerebral malaria (1), acute laryngotracheobronchitis (1), Tay Sach's disease (1), hepatic encephalopathy (1) and organic academia (1).

The commonest age group studied was between 1 to 5 years accounting to 44% of the patients, 28% belongs to the age less than 1 year, 22.7% were in the age group between 5 to 10 years.

Table 1: Spectrum of cases admitted in PICU among the study group.

PICU	Number	%
Viral encephalitis	13	17.33
Status epilepticus	11	14.66
Pyogenic meningitis	10	13.33
TBM	6	8
Dengue	5	6.66
Sepsis	5	6.66
Rickettsial fever	5	6.66
Others	20	28.5
Total	75	100

The age distribution of the patients studied showed there was no significant difference between the VAP and Non-VAP cases. 44 (58.7%) out of 75 were boys and the rest (41.3%) were girls. There is no statistically significant difference in gender between VAP and Non-VAP cases. 54 cases received H_2 receptor blockers, 15 developed VAP which is not statistically significant (Table 2). 76% of the patients who had 3-4 intubations developed VAP and all the 3 children who had intubations of 5 or more developed VAP which is statistically significant. Higher the number of intubation greater the chances of developing VAP and also there is chance of VAP with 2 or less intubations (Table 3 and Figure 2).

Table 2: Assessing the influence of risk factors in predicting the VAP.

Risk factors	Total	Non VAP		VAP		P value	OR
		No	%	No	%		
Age in years							
<1 year	21	15	71.43	6	28.57	0.541	1.56
1-5 years	33	29	87.88	4	12.12	0.053+	0.31
5-10 years	17	11	64.71	6	35.29	0.192	2.33
>10 years	4	3	75.00	1	25.00	1.000	1.15
Gender							
Male	44	36	81.82	8	18.18	0.269	0.54
Female	31	22	70.97	9	29.03	0.269	1.84
H2RB	54	39	72.22	15	27.78	0.090+	3.65
Intubation >2	16	3	18.75	13	81.25	<0.001**	59.58
ET-cuffed	17	11	64.71	6	35.29	0.192	2.33
Tracheostomy	2	0	0.00	2	100.00	0.049*	-
Central venous line in situ	18	7	38.89	11	61.11	<0.001**	13.36
NGT	52	37	71.15	15	28.85	0.055+	4.26
Chest X-ray +ve	24	7	29.17	17	70.83	<0.001**	~240.4
Fever	18	2	11.11	16	88.89	<0.001**	~448.0
Leucocytosis	19	2	10.53	17	89.47	<0.001**	~924.0
Purulent aspirate	18	1	5.56	17	94.44	<0.001**	~1881.0
Blood culture +ve	6	1	16.67	5	83.33	0.002**	23.75
Pus cell +ve	31	15	48.39	16	51.61	<0.001*	45.87

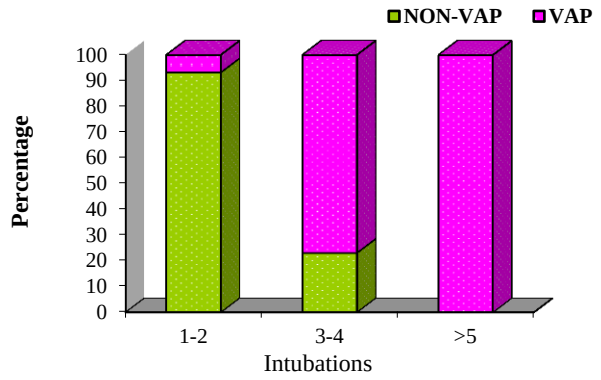

Figure 2: Comparison of the number of intubations with VAP and Non-VAP cases.

Table 3: Comparison of the number of intubations with VAP and Non-VAP cases.

Intubations	Total	NON-VAP	VAP	p value
1-2	59	55 (93.2%)	4(6.8%)	<0.001**
3-4	13	3 (23.1%)	10(76.9%)	<0.001**
>5	3	0	3(100%)	0.029*
Total	75	58	17	-

Cuffed ET tubes were used in 17 patients and the remaining was uncuffed. There was no statistically significant difference between the cuffed and uncuffed endotracheal tubes in the incidence of VAP (p=0.192).

One patient undergone peritoneal dialysis, 2 had tracheostomy done. Central venous lines were in situ in 18 patients out of 75. Fifty two had enteral feeding with nasogastric tube in situ.

Two children undergone tracheostomy and both developed VAP (p=0.049) which is statistically significant.18 patients had central venous line in situ, out of which 11 developed VAP (p value <0.001). Nasogastric tube was in situ for enteral feeding in 52 children. 71.15% of them did not develop VAP and 28.85% developed VAP. 24 patients developed radiological infiltrates but only 17 had developed VAP. The remaining 7 were attributed to ARDS, CCF and pulmonary hemorrhage. 24 out of 75 patients studied developed radiological infiltrates of which 17 had VAP which is statistically significant (p<0.001). All the patients who have not developed radiological infiltrates did not develop VAP which is also statistically significant (p<0.001). Out of 75 patients studied, 18 each developed fever and leukocytosis and 19 patients had purulent tracheal aspirates. 16 VAP cases had fever (p<0.001), all the VAP cases had leukocytosis and purulent endotracheal aspirates (p<0.001).

PaO_2/FiO_2 ratio was compared in both the groups (VAP and non-VAP) and was significantly lower in VAP group (p<0.001) (Table 4).

Table 4: Analyzing the oxygenation in VAP and Non VAP cases.

Oxygenation PaO_2/FiO_2 ratio	VAP	Non VAP	Total	p value
>240	3	56	59	<0.001
<240	14	2	16	<0.001
Total (75)	17	58	75	-

Table 5: Table showing blood culture isolates.

Blood culture	Total	Non-VAP	VAP	p value
No growth	69	57(82.6%)	12(17.4%)	0.002**
Acinetobacter	2	0	2(100%)	0.049*
Enterobacter	1	0	1(100%)	0.227
Klebsiella	2	0	2(100%)	0.049*
Staph aureus	1	1(100%)	0	1.000
Total	75	58 (77.3%)	17 (22.7%)	-

Majority of the cases did not have any growth in the blood (92%). 24.9% of VAP children had positive blood cultures. 2 each of VAP cases had grown *Acinetobacter* and *Klebsiella*. *Enterobacter* was isolated from one case of VAP and *staphylococcus aureus* was isolated from a child without VAP (Table 5).

ET aspirates of all the cases who developed pneumonia showed plenty of pus cells and it was statistically significant (p<0.001).

Acinetobacter, *Pseudomonas* and *Klebsiella* were the most common organisms isolated in cases of VAP. But Klebsiella and Pseudomonas were isolated more frequently from patients with VAP which was statistically significant (Table 6). Most of the cases who did not develop VAP had no growth which was also statistically significant. Polymicrobial flora was seen in 3 of the VAP cases accounting for 20 isolates in 17 cases. There were 20 isolates in 17 VAP cases. Moderate and heavy tracheal isolates are significantly associated with VAP with p<0.001**. Moderate and heavy growth of the organisms isolated from the ET aspirates was significantly associated with VAP.

Table 6: Spectrum of organisms obtained by endotracheal aspiration.

Tracheal isolate	Total	Non-VAP	VAP	p value
Acinetobacter	7	4	3	0.339
CONS	2	2	0	1.000
E. coli	4	3	1	1.000
Enterobacter	1	1	0	1.000
Klebsiella	13	5	8	0.001**
Pseudomonas	11	5	6	0.013*
Staph. aureus	2	0	2	1.000
No growth	40	40 (100.0%)	0	<0.001**
Total	80	60 (66.66%)	20	-

When each organism was considered, Fifty percent of *Klebsiella* species are sensitive to netilmycin, and ceftazidime (25%), meropenem (75%), piperacillin tazobactum (75%) and ofloxacin (37.5%). When *Pseudomonas* organisms are considered, 83% sensitive to piperacillin tazobactum, meropenem (75%), carbenicillin (66%), and netilmycin (50%), ceftazidime (50%) and 33.33% each for amikacin, gentamycin, quinolones and ceftriaxone. *E. coli* showed 100% sensitivity to netilmycin, meropenem and piperacillin tazobactum.

Staphylococcus aureus were resistant to methicillin and were fully sensitive to vancomycin (100%). 66% of *Acinetobacter* were sensitive to netilmycin and piperacillin tazobatum and 33% sensitive to meropenem (Table 7).

Total numbers of organisms isolated were 20 in 17 VAP cases. Majority of *Pseudomonas* (5), *Klebsiella* (6) and *Acinetobacter* (3) were isolated from late onset VAP cases (Table 8).

Table 7: Percentage antibiotic sensitivity patterns of organisms isolated from endotracheal aspirates.

Organism	*Klebsiella* (8)	*Pseudomonas* (6)	*Acinetobacter* (3)	*E. coli* (1)	*Staphylococcus aureus* (2)
Methicillin	-	-	-	-	R
Vancomycin	-	-	-	-	100%
Cloxacillin	-	-	-	-	50%
Penicillin	-	-	-	-	R
Meropenem	75%	75%	33%	100%	-
Piperacillin + Azobactum	75%	83%	66%	100%	-
Ofloxacin	37.5%	33%	R	R	R
Ciprofloxacin	R	33%	R	R	-
Ceftriaxone	R	33%	R	R	-
Ceftazidime	25%	50%	R	R	-
Cefotaxime	R	R	R	R	-
Netilmycin	50%	50%	66%	100%	50%
Amikacin	R	33%	R	R	50%
Gentamycin	R	33%	R	R	50%
Augmentin	R	R	R	R	R
Carbenicillin	R	66%	R	R	R
Ampicillin	R	R	R	R	R

R- Resistant

Table 8: Endotracheal isolates showing the spectrum of organisms in early and late onset of VAP.

Organism	Total (n=20)	Early onset (n=7)	Late onset (n=13)
Acinetobacter	3	1(33.3%)	2 (66.7%)
E. coli	1	1(100%)	0
Klebsiella	8	2(25%)	6 (75.0%)
Pseudomonas	6	1(16.7%)	5 (83.3%)
Staphylococcus aureus (MRSA)	2	2(100%)	0

Table 9: Distribution of cumulative risk of VAP with duration of MV.

Duration of MV (days)	Total (n)	No. of new VAP	Free from VAP	Cum. no. of VAP	Cum. risk of VAP (%)
2-4	75	5	70	5	6.7
5-6	25	4	21	9	13.2
7-8	11	5	6	14	22.5
9-10	4	2	2	16	27.0
>10	2	1	1	17	29.5

The cumulative risk of VAP increases as the number of days of ventilation increases (Table 9).

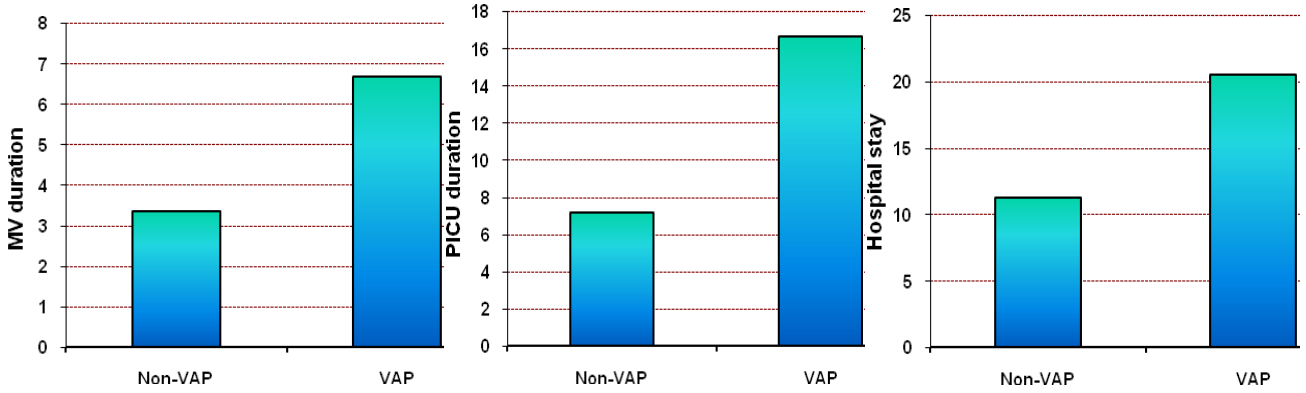

Figure 3: MV duration, PICU duration and hospital stay in days in Non-VAP and VAP cases.

Of the 75 patients, 56 improved, 9 died and 10 went against medical advice due to severity of the illness and financial reasons. Though 10 went DAMA it has not affected the outcome because p value is not significant between the two groups.

There was no statistically significant difference in the mortality between VAP and Non-VAP cases.

Out of 75 patients 56 improved, 9 died and 10 went against medical advice because of financial reasons. VAP Cases are associated with prolonged ventilation, PICU and hospital stay (Table 10 and Figure 3).

Table 10: MV duration, PICU duration and hospital stay in days in Non-VAP and VAP cases.

	Non-VAP	VAP	p Value
MV duration	3.35±1.42	6.68±4.12	<0.001**
PICU duration	7.19±2.59	16.65±22.48	0.002**
Hospital stay	11.25±4.91	20.53±21.93	0.003**

Out of the 7 early onset VAP patients 3 recovered, 1 died and 3 went against medical advice. Out of the 10 late onset VAP patients, 7 recovered, 2 died and 1 went DAMA.

DISCUSSION

The present study is a prospective study over a period of 1 year between January 2009 and December 2009 which included 75 children requiring mechanical ventilation for more than 48 hours and in these children the incidence of VAP, the risk factors and the outcome are analysed.

Incidence

Table 11: Comparison of incidence of VAP with other studies.

S. No.	Study	Place of study	Year	Incidence of VAP
1	Tullu MS, Deshmukh CT, Baveja SM	K. E. M. Hospital, Mumbai	2000	32.2%
2.	Alexis M. Elwald	St Louis, Missouri	2002	5.1%
3	Khaled Amro	Royal Medical Services, Jordan	2006	30.5%
4.	Patra PK, Jayashree M	PGI, Chandigarh	2007	30.5%
5.	Present study	IGICH, Bangalore	2009	22.66%

The incidence of VAP in the present study is 22.66%. The incidence in different studies varied from 5.1% to 32.2% (Table 11).

The present study correlates with the other Indian studies.

This difference with other studies could be mainly due to the different methods used for the diagnosis, sample size and the underlying disease state requiring ventilator support.

Risk Factors for VAP

The risk factors for VAP were studied by comparing the group with VAP and those without VAP (Table 12). The age and sex distribution and the indication for shifting to PICU were compared between the two groups there was no statistically significant difference between the two groups.

Table 12: Comparison of risk factors for VAP with other studies.

S. No.	Study	Year	Place of study	Risk factors
1	Patra PK, Jayashree M	2007	PGI, Chandigarh	Reintubation
2	Khaled Amro	2006	Royal Medical Services, Jordan	Reintubation, Prolonged duration of mechanical ventilation
3	Alexis M. Elwald et al	2002	St Louis, Mo	Tracheostomy, Use of antacids, H2RB, Central venous line insertions, Reintubation, Blood transfusion, Genetic syndrome
4	Tullu MS, Deshmukh CT, Baveja SM	2000	K. E. M. Hospital, Mumbai	Duration of MV
5	Present study	2009	IGICH, Bangalore	Reintubation, Central Venous line insertions, Prolonged ventilation and tracheostomy

The duration of ventilation is an important risk factor for development of VAP. The longer the duration of ventilation, the greater is the risk of developing VAP. As seen in the present study. The time of onset of VAP in cases was compared to the duration of ventilation, the longer the duration of MV higher the risk of developing VAP. Tullu MS observed that prolonged duration of ventilation is a significant risk factor for VAP.[12]

Fagon et al had done a similar analysis in their study. It was found that the cumulative risk of pneumonia in that

study was estimated to be 7% by 10 day and 19% at 20 day after the onset of MV. The incremental risk of pneumonia was virtually constant throughout the entire ventilation period with a mean rate of ~1% per day.[13]

Cook and co-workers demonstrated that although the cumulative risk of VAP increased over time, the daily hazard rate decreased after day 5. The risk per day was evaluated at 3% on day 5, 2% on day 10 and 1% on day 15.[14]

When the number of intubations were considered, in the present study VAP was significantly associated with higher number of intubations, with intubations 3 or more having p<0.001. This finding is consistent with that of Torres et al, who in a case control study had demonstrated that the pneumonia rate was 47% for reintubated patients compared with 4% for control subjects matched for the duration of MV.[15] Similar results were obtained in the previous studies (Alexis M. Elwald et al[16], Patra PK et al[17]). Reintubation was the only independent risk factor for development of ventilator associated pneumonia as observed by Patra PK et al in the year 2007 (p<0.001) and Khalid Amro, Jordon in 2006.[17,18]

The type of endotracheal tube used did not have any statistically significant difference. The type of endotracheal tube whether cuffed or uncuffed is found to be a risk factor for development of VAP by Spray et al. Use of low-volume, high pressure cuffs reduced the rate of VAP to 56% and high-volume, low pressure cuffs further lowered it to 20%.[19]

In the present study, H_2 receptor blockers are used to prevent stress ulcers in mechanically ventilated patients 54 out of 75 cases received H_2 receptor blockers of which 15 developed VAP (p=0.090) which is not statistically significant . 52 out of 75 cases had NG tube in situ for the purpose of enteral feeding, of which 15 developed VAP (p=0.055) which is not statistically significant. This shows both the presence of NG tube in situ and the use of H2RBs prior to the diagnosis of VAP may not act as risk factors for VAP. Similar results were obtained in the study by Patra PK et al.[17] But Elwald MA et al have observed that H_2 Receptor blockers act as risk factors for VAP.[16] This shows the inconsistencies in H2RBs as a risk factor for VAP.

Two patients had undergone tracheostomy and both developed VAP (p=0.049) which is statistically significant. Similar results were obtained in the study by Elwald MA et al.[16]

Presence of central venous catheter is a significant risk factor in predicting VAP. Out of the 18 children with central venous catheters in situ, 11 had developed VAP (p<0.001). Similar results were obtained in the study by Elwald MA et al.[16]

Only in 3 (17.64%) cases of VAP, blood culture grew the same organism with the similar antibiogram pattern as that of endotracheal aspirate. Carlos M. Luna et al have concluded in their study that blood cultures have a low sensitivity for detecting the same pathogenic organism as BAL culture in patients with VAP.[20] They also emphasized that blood cultures have limited value in predicting the severity of illness and as a diagnostic tool in VAP.

Bacteria isolated

The organisms isolated from the endotracheal aspirates were *Acinetobacter species, Escherichia coli, Klebsiella pneumoniae* and *Pseudomonas aeruginosa, Enterobacter and Methicillin resistant Staphylococcus aureus.*

Klebsiella is the predominant organism isolated constituting 40% followed by *Pseudomonas* (30%) and *Acinetobacter* (15%). The isolation of *Acinetobacter sp* and *Pseudomonas*, from clinical specimens may not necessarily mean infections but rather may result from colonization and hence it is very difficult to assess the true frequency of infection causes by this group of organisms. This is reflected in our study where *Acinetobacter* has also been isolated from the endotracheal aspirates of cases without VAP.

Table 13: Comparison of pathogen isolated with VAP.

S. No.	Study	Place of study	Year	Organism isolated in descending order
1	Tullu MS, Deshmukh CT, Baveja SM	K. E. M. Hospital, Mumbai	2000	*E. coli*, *Klebsiella*, *Pseudomonas*
2	Alexis M. Elwald et al	St Louis, Mo	2002	*Pseudomonas*, *Klebsiella*, *Staphylococcus aureus*
3	Khaled Amro	Royal Medical Services, Jordan	2006	*Pseudomonas aeroginousa*, *Acinetobacter anitratus*, and *Klebsiella*
4	Patra PK, Jayashree M	PGI, India	2007	*Pseudomonas*
5	Present study	IGICH, Bangalore	2009	*Klebsiella*, *Pseudomonas*

Thus, organisms considered high risk pathogens like *Klebsiella* and *Pseudomonas aeruginosa* figure prominently in the cases of VAP in the present study.[22] Polymicrobial infection was seen only in 3 cases of VAP

in the present study. Polymicrobial infection in VAP is high as identified by Fagon et al.[13]

The present study correlates with other studies where gram negative pathogens are the most common organisms isolated (Table 13). The antibiotic susceptibility of the bacteria has been listed in Table 7.

Early and late onset VAP

Out of the 17 cases, 7 had early onset VAP and the rest were late onset VAP. *Klebsiella* and *Pseudomonas* were the predominant organisms isolated from patients with late onset VAP. Similar results were observed by Ibrahim EH et al in his comparative analysis of patients with early onset VAP vs. late onset VAP where *Pseudomonas* was significantly isolated in late onset VAP. *Pseudomonas*, *Klebsiella* and ofloxacin resistant *Staphylococcus aureus* were the most commonly isolated organisms in late onset VAP as observed by Kollef et al in 1995.[21,22]

Outcome of VAP

In the present study, out of the 17 children with VAP 3 (17.67%) expired. The mortality in cases of VAP was no different from cases without VAP in the study (p=0.415). However, VAP is associated with a significantly longer duration of intensive care of 16.65 days (p=0.002**) and prolonged duration of mechanical ventilation 6.68 days (p<0.001**). It is also associated with prolonged hospital stay 20.53 days (p=0.003) increasing the morbidity. Similar observations were done by Khalid Amro and Patra PK et al.[17,18] The median duration of PICU stay was significantly longer in patients with NP as compared to those without (22 days versus 14 days; p = 0.021). The percentage mortality in the group with nosocomial pneumonia and no nosocomial pneumonia was 31.8% and 16% respectively (p=NS).

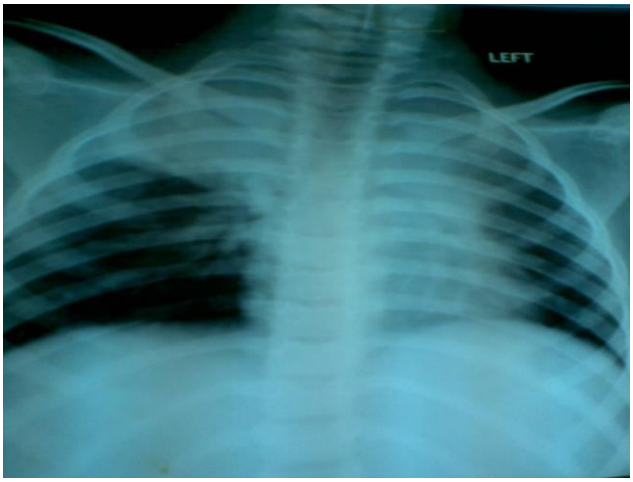

Figure 4: Chest X-ray showing ventilator associated pneumonia of the right upper zone.

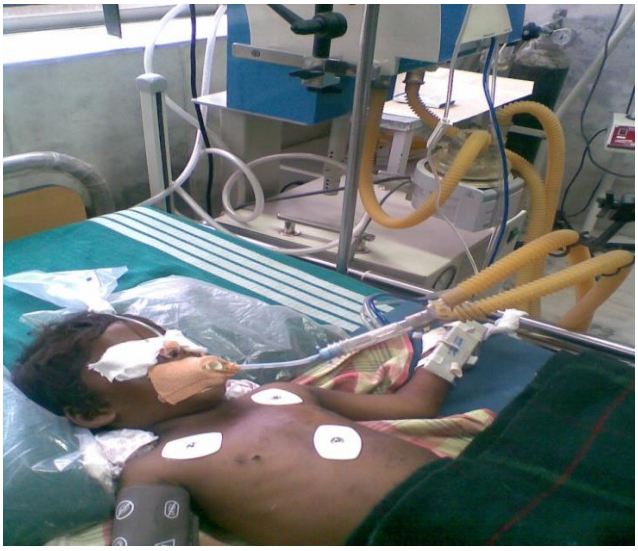

Figure 5: Five-year old child on ventilator with VAP.

Limitations of the present study

1. Sample size is small.

2. Relative importance of individual risk factors using univariate and multiregression analysis models not studied.

CONCLUSION

VAP is an important nosocomial infection in PICU with the incidence of 22.66% prolonged ventilation and repeated intubations are the major risk factors. Central venous lines and tracheostomy are the added risk factors for VAP.

Gram negative organisms are the most common organisms causing VAP.

VAP did not influence the mortality but it did prolong the duration of ventilation, intensive care and hospital stay in turn increasing the morbidity.

Recommendations

Judicious use of ventilator support and early weaning will reduce the incidence of VAP

More large metacentric studies are required for the further evaluation of VAP in pediatric population.

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