Ventilator - Associated Pneumonia in Paediatric Intensive Care Unit at the Indira Gandhi Institute of Child Health

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Abstract

Introduction: This is prospective study undertaken at the PICU of Indira Gandhi Institute of Child health to assess the risk factors causative organisms and outcome of paediatric Ventilator-Associated Pneumonia (VAP).

Materials and Method: A total of 1079 patients who received Mechanical Ventilation (MV) were included in this prospective study during the period from January 2015 till September 2016. Cases were defined as VAP as per CDC guidelines. The causative organisms were isolated and identified along with their antibiogram. The clinical details and prognosis was noted of each patient until discharge or death.

Results: VAP was detected in 74 patients among 1079 ventilated patients. VAP rate was 6.85 %, incidence density was 16.04. Gram negative bacteria was most frequent causative organism, Acinetobacter was the common causative 46 (62.1%); Pseudomonas aeroginousa 23(31%); Klebsiella 17 (22.97%); Enterobacter 10 (13.51%); E. coli 3(4 %) and Citrobacter in 2 (2.7%). Staphylococcus aureus and Candida were isolated in 1 sample each. Polymicrobial infection in 23 cases. Most of the isolates were multidrug resistant. The mortality rate was 28.38%.

Conclusions: Identification of risk factors, causative organisms along with their antibiotic sensitivity pattern and outcome of patients with VAP in PICUs may help in reducing the incidence. This shall further help in formulating better Hospital infection control Policies and practices in the Paediatric intensive care unit.

Keywords: Hospital acquired infection; Mechanical ventilation; Paediatric intensive care; Ventilator associated pneumonia

Introduction

Mechanical ventilation is the cornerstone for the management of critically ill children in intensive care setting. This modality has its own complications and hazards. One such complication as the chance of developing pneumonia termed the ventilator-associated pneumonia (VAP) [1].

Ventilator-associated pneumonia (VAP) is defined as nosocomial pneumonia developing 48 hrs or more after initiation of mechanical ventilation. It is the most common hospital-associated infection (HAI) in critically ill adult patients, and is the second most common after bloodstream infection for the paediatric population [2-4]. VAP accounts for about 20% of all HAI among patients in paediatric intensive care unit (PICU) and has a rate of (2.9-21.6)/1,000 ventilator days [5,6]. Furthermore, some data suggested higher mortality rate for mechanically ventilated paediatric patients with VAP compared with those without VAP [7].

Amongst the challenges in any intensive care settings, curtailing nosocomial infections like VAP is an important issue [8,9]. The prevalence of VAP in different setups varies [10-12]. It is important to identify the burden of VAP in any setup, so that prevention strategies can be implemented and strengthened. VAP is not only associated with increased mortality but also increases with the length of ICU stay, the cost of treatment and the chances of ventilator dependence. Various risk factors have been identified that may predispose to the development of VAP [2,13].

The epidemiology, pathogenesis, and outcome of VAP are well described in adults, however, few data exist regarding VAP in paediatric patients [2]. Because of different anatomy, physiology and underlying illnesses from adults, it is important to identify specific prevention for this population in preventing VAP [2,13].

This study was conducted to access the risk factors and to determine the incidence rate, bacteriological profile and antibiotic sensitivity pattern organisms causing VAP in paediatric intensive care unit at the Indira Gandhi institute of Child Health.

Materials and Method

This was a prospective type of study, after clearance by ethical committee was conducted from January 2015 for 21 months at the Indira Gandhi Institute of Child Health, Bengaluru, Karnataka.

Inclusion criteria: Study subjects were patients aged between one month and 16 years in the PICU and subjected to mechanical ventilation for more than 48 hours and showed clinical/radiological evidence of pneumonia along with bacteriological culture showing a significant colony count ($\geq 10^5$ CFU/ml) as per the Centre for Disease Control and Prevention (CDC) guidelines [14].

Exclusion criteria: Patients already having pneumonia at the time of ICU admission and patients who

developed pneumonia in the first 48 hours of the mechanical ventilation. Also excluded were the patients who had traumatic lung injury and patients who were intubated at other centres and referred to our hospital for further management.

Case definition: The Clinical Pulmonary Infection Score (CPIS) was developed to serve as a surrogate tool for diagnosis of VAP [15]. The CPIS is calculated on the basis of points assigned for various signs and symptoms of pneumonia) and studies suggest that a CPIS >6 may correlate with VAP [15]. In this study, the CPIS scoring was adapted to recognise the VAP cases.

Table 1: Clinical Pulmonary Infection Scoring (CPIS)

Temperature	≥36.5 ≤ 38.4	0
	≥38.4 ≤ 38.9	1
	<36 or ≥39	2
White blood count	≥4000 ≤ 11,000	0
	<4000 or >11,000	1
Secretions	≤small/day	0
	Moderate/large	1
	Purulent	2
Chest radiograph	No infiltrate	0
	Diffuse/patchy infiltrate	1
	Localized infiltrate	2
PaO_2/FiO_2 ratio	>240 without ARDS	0
	<240 without ARDS	2
Culture	<10,000 bacteria or no growth	0
	>10,000 bacteria	1
	Positive Gram stain	1

Microbiological study: all samples received were processed as per standard operative procedure. Gram's staining performed for microscopic analysis. The samples were cultured onto Nutrient Agar, 5% Sheep Blood Agar, MacConkey Agar and Chocolate agar and incubated overnight at 37^0 C. Organism growth of $\geq 10^5$ cfu/ml of one or more colonies over the streaking area was considered significant. The isolates were further identified by their colony morphology and routine biochemical reactions. Antimicrobial susceptibility testing of the bacterial isolates was done by disk diffusion technique using Kirby Bauer's method as per Clinical Laboratory Standards Institute guidelines (CLSI).

VAP analysis: We noted down number of admissions, patients on ventilators, ventilator-days and discharges and deaths during the study period. Incidence rate and incidence density of VAP was calculated for each month of the study period.

VAP rate per = (Number of cases with VAP/ Number of ventilator days x100)

VAP Incidence Density = (Number of cases with VAP/ Total number of patients who received MV x 1000

Results: Of the total of 11,423 admissions to the PICU during the study period, 1079 children were on ventilator support. Number of patients on mechanical ventilation was noted down each day and ventilator-days and VAP rates were calculated monthly.

Chart 1: VAP incidence density

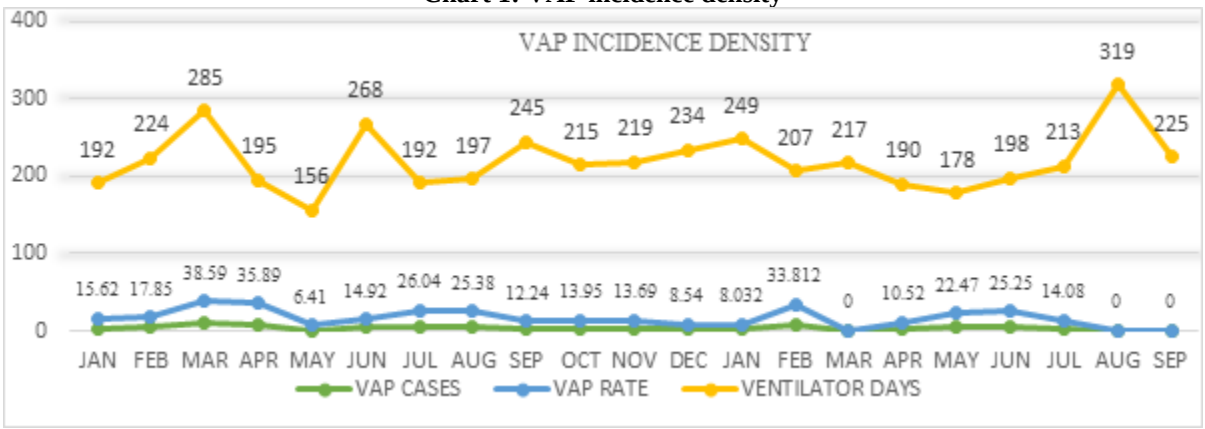
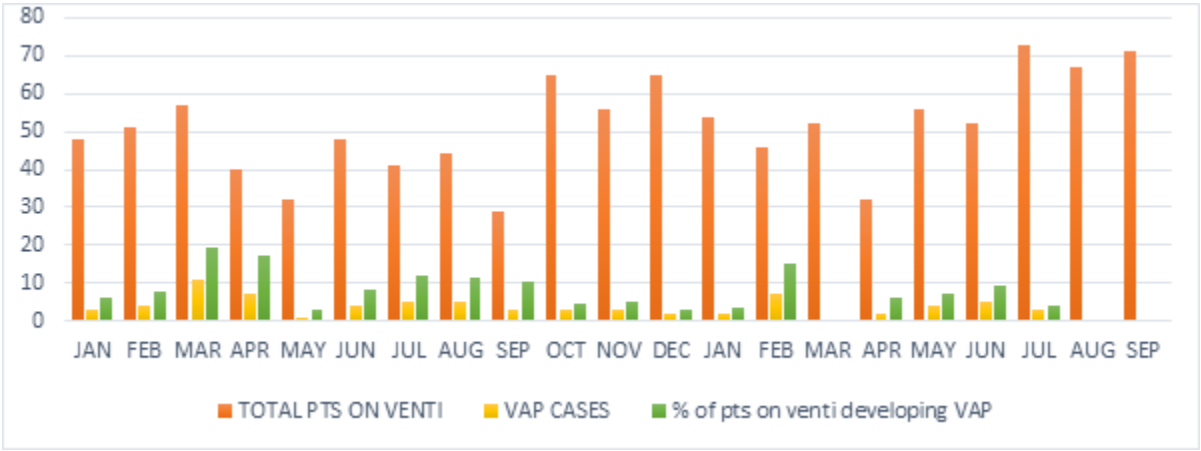


Chart 2: VAP rate



During this study period 74 cases were diagnosed as VAP as per CDC guidelines. In our study age group of 1 month to 1 year were 24 (32.4%); 1 to 3 years were 22(29.7%) and 28 in the age group of more than 3 years (37.8%). Among the positive 74 cases we had more of female (55.4%) patients than male (44.6%) (Table 2).

In our study 27 cases were early VAP (36.48%) whereas majority of the cases were late VAP with signs & symptoms developing after 5 days of admission to PICU (63.51%). This study showed that indwelling nasogastric tubes played a major role as risk factor 64 cases (86%). It was seen that of 74 positive cases 64 were on central venous catheter and 60 patients were on more than 2 types of broad spectrum antibiotics. It was observed that 44 of 74 cases were on steroids therapy and 48 cases were treated with H2 blockers. (Table 2)

Table 2: Variables

Age	Number	Percentage
1Month-1 Year	24	32.4
1-3 Years	22	29.7
>3 Years	28	37.8
Sex		
Male	33	44.6
Female	41	55.4
VAP		
Early (<5 Days)	27	36.48
Late (≥5 Days)	47	63.51
Risk factors		
Indwelling nasogastric tube	69	93.24
Use of steroids	44	59.45
≥ 2 broad spectrum antibiotics	60	81.08
H_2 blockers or proton pump inhibitors	48	64.8
Central venous catheter	64	86.48

Table 3: Gram negative organism isolated and their sensitivity pattern

Gram negative Organims	Acinetobacter	Pseudomonas	Klebsiella	Enterobacter	Escherichia coli	Citrobacter
Number/ Antibiotic	N=46	N=23	N=17	N=10	N=3	N=2
Ampicillin	0	-	0	0	0	0
Ceftazidime	09	8	5	3	0	1
Ciprofloxacin	15	07	7	3	1	1
Meropenem	21	09	11	5	2	1
Imipenem	25	11	10	4	1	2
Gentamycin	17	8	9	6	1	1
Tobramycin	12	13	10	4	2	1
Amikacin	17	9	9	6	1	1
Pip-Taz	22	11	14	4	1	1
Cefepime	25	10	11	4	1	1
Cefotaxime	13	-	5	3	0	0
Ceftrioxone	10	-	-	-	-	-
Doxycycllin	18	-	-	-	-	-
Cotrimoxazole	29	-	9	4	1	1
Aztreonam	-	19	11	5	2	1
Cefazolin	-	-	2	3	1	0
Cefuroxime	-	-	9	3	0	2
Amoxy-Clav			1	0	0	0

*** were sensitive to the antibiotic tested as per CLSI guidelines.**
Polymicrobial in 23 cases.
Candida isolated from 1 sample. *Staphylococcus aureus* from 1 sample

Etiological organisms: All the isolates except two were Gram negative bacilli. *Acinetobacter* being the most predominant isolate in 46 (62.1%) *Pseudomonas aeroginousa* 23(31%), *Klebsiella* 17(22.97%),

Enterobacter 10(13.51%), *E. coli* 3(4 %) and *Citrobacter* in 2(2.7%). Isolated organisms showed reduced sensitivity to most of the antibiotics. (Table 3). *Staphylococcus aureus* was seen in one patient sensitive to Clindamycin, Cefoxitin, Cotrimoxazole, Linezolid, Doxycycllin, Vancomycin, Ciprofloxacin, Gentamycin, Cefepime and Resistant to Ampicillin, Amoxy-Clavulinic acid, Erythromycin, Cefuroxime, Penicillin. One patient sample showed growth of Candida. Polymicrobial infection was seen in 23 cases. Hence from 74 VAP cases isolated pathogens were 103.

Outcome: A total of 48 patients with VAP recovered (64.8%), 5 patients went against medical advice (6.75%) and 21 children with VAP did not survive. The crude mortality rate calculated was 28.3%. During the study period among 563 deaths in PICU, 21 deaths were attributed to VAP.

Discussion

It is difficult to diagnose accurately, and a high index of suspicion is required. The incidence density in our study was 16.02 as compared to various other studies done (Table 4).

Table 4: Incidence densities and ventilator-associated pneumonia rates various studies done in paediatric ICU's

Region Reference (Author, Country, Year of publication, Ref No)	Patients	VAP*	VD*	Incidence density (N/1000 ventilation-days)	**%
Present study	1079	74	4618	16.02	6.85
Almuneef, Saudi Arabia, 2004[16]	361	37	4173	8.9	10.3
South Asia Awasthi, India, 2013[17]	105	38	-	-	36.2
Navoa-Ng, Philippines, 2011[18]	252	6	391	0.44	2.4
Patria, Italy, 2013[19]	451	30	-	-	6.7
Oezdemir, Turkey, 2011[20]	203	-	-	15.7	-
Jordan Garcia, Spain, 2014[21]	300	4	422	9.5	1.3
Edwards, USA, 2008[22]	-	176	85809	2.1	-
Abramczyk, Brazil, 2003[23]	515	40	2120	18.7	7.8
Duenas, Argentina, 2011[24]	1145	93	7709	12.1	8.1
Becerra, Peru, 2010[25]	414	27	3420	7.9	6.5
Rasslan , Egypt, 2012[26]	143	18	567	31.8	12.6
Gautam, Australia, 2012[27]	269	18	2564	7.0	6.7

In comparison to studies included in the meta-analysis of paediatric VAP done by Aelami et al.

****Proportion of patients with ventilator-associated pneumonia compared to patients included in the study (admissions /patients on ventilation)** [28].

The mortality in our case was 28.38%, comparable to study by Patra et al., which showed 31.8% death rate due to VAP in PICU patients 23% in study done by Hamid et al. [10,12]. But less when compared to studies by Modi et al. which revealed 52.0% mortality rate [29].

VAP cases were in more in patients with number days on ventilator (Table 2). The significant risk factors noted in this study were indwelling nasogastric tubes, use of steroids, using more than 2 antibiotics, H_2 blockers and presence of central line catheter (Table 2). This correlates with studies conducted in paediatric setup by Elward et al., Almuneef et al. and Srinivasan et al., regarding risk factors associated with VAP [4,16,9].

Bacteria from aerodigestive tract above the vocal cords or stomach could be aspirated to the trachea or lung which induces VAP. In general, a complex array of host defence mechanisms protects the trachea and lungs from bacterial infection [30]. However, for critically ill patients especially with mechanical ventilation, host defences may be impaired due to malnutrition, chronic diseases or immunosuppression [2].

Our study that showed *Acinetobacter* was the most commonly isolated causative bacteria in 46 (62.1%) followed by *Pseudomonas aeroginousa* in 23 (31%), *Klebsiella* in 17 (22.97%), Enterobacter 10 (13.51%) and *E. coli* in 3 (4 %) Citrobacter in 2 (2.7%). The predominance of Gram negative bacteria isolation was observed in similar in studies done by Patra et al. *Acinetobacter* 12 (54.5%), *Pseudomonas aeroginousa* in 5 (22.7%), *Klebsiella* in 3 (13.6%) and *E.coli* in 1 (4.5%). *Staphylococcus aureus* (MRSA) in 1 case [10]. Modi et al. showed Klebseilla spp (35%), Acinetobactor spp.(26%), Psedomonas spp.(15%),other enterobactriacae(13%), Gram positive cocci(8%) and candida spp (3%) [29]. Sneka et al. showed 7 (41.1%) isolates of Acinetobacter spp. 4(23.5%) isolates of Klebsiella pneumoniae, 2(11.7 %) isolates of Pseudomonas aeroginosa, 2(11.7%) isolates of Escherichia coli and 2 (11.7 %) isolates of CONS [30]. Yasmine et al. showed *Pseudomonas* (47.7%), *Acinetobacter* (18.2%) and Methicillin-Resistant *Staphylococcus aureus* (MRSA) (14.4%) [31]. Srinivasan et al. showed Gram-negative bacteria (42%), Staphylococcus aureus (22%), and *Haemophilus influenzae* (11%) [9].

It was also noticed that 23 (31%) samples were polymicrobial with more than one causative organisms as also noticed in many studies such as Apisarnthanarak et al. (Polymicrobial 58%), Deng et al. (Polymicrobial 24.8%) [32,33]. Multi-drug resistance has been a common outcome in most of the VAP studies conducted.

Conclusions

VAP is the commonest of life threatening hospital acquired infections with high mortality and morbidity. The knowledge of common causative organisms and their antibiotic susceptibility can help the institution formulate the antibiotic policy and it should to be revised periodically. In diagnosed cases of VAP, bacteriological findings should always be used to tailor antibiotic therapy. The hospital infection control programs should to be made combining multiple interventions to reduce cases of VAP. The healthcare providers should be made well aware of the importance of hand hygiene and use of glove and gown in intensive care units.

Conflict of interest: None declared

Acknowledgements: We thank all the Medical & Nursing Faculty of Department of Paediatric Intensive Care Unit and the Technicians of Department of Microbiology, Indira Gandhi Institute of Child Health.

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