Incidence and risk factors of ventilator associated pneumonia in a tertiary care hospital

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RESEARCH

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Abstract

Background

Ventilator associated pneumonia (VAP) is a type of nosocomial pneumonia associated with increased morbidity and mortality. Knowledge about the incidence and risk factors is necessary to implement preventive measures to reduce mortality in these patients.

Method

A prospective study was conducted at a tertiary care teaching hospital for a period of 20 months from November 2009 to July 2011. Patients who were on mechanical ventilation (MV) for more than 48 hours were monitored at frequent intervals for development of VAP using clinical and microbiological criteria until discharge or death.

Results

Of the 76 patients, 18 (23.7%) developed VAP during their ICU stay. The incidence of VAP was 53.25 per 1,000 ventilator days. About 94% of VAP cases occurred within the first week of MV. Early-onset and late-onset VAP was observed in 72.2% and 27.8%, respectively. Univariate analysis showed chronic lung failure, H_2 blockers usage, and supine head position were significant risk factors for VAP. Logistic regression revealed supine head position as an independent risk factor for VAP.

Conclusion

VAP occurred in a sizeable number of patients on MV. Chronic lung failure, H_2 blockers usage, and supine head position were the risk factors associated with VAP. Awareness about these risk factors can be used to inform simple and effective preventive measures.

Key Words

VAP; incidence; risk factors

Background

Ventilator associated pneumonia (VAP) is a type of nosocomial pneumonia which occurs in patients who receive mechanical ventilation (MV) via tracheal or tracheostomy tube.[1] Differences in VAP incidences have been based on the antibiotic profile, ICU environment, and the population of study.[2] According to The National Nosocomial Infection Surveillance Program the incidence of VAP is 7.6 cases per 1000 patient ventilator days.[3] The incidence of VAP ranges from 28-32%.[4,5] This difference is a result of the diversity of diagnostic methods used. Development of VAP ≤ 96 hours of MV is classified as early onset; a delay of more than 96 hours is termed as late onset.[6] Intubation alone is a risk factor for the development of pneumonia among hospitalised patients.[7] Both the host and intervention associated risk factors increase the mortality among these patients.[1] The end result is either colonisation or aspiration of the respiratory contents with potential pathogens.[8,9] The mortality rate among these patients ranges from 16-20%.[6,10] A study of both incidence and risk factors was necessary to implement preventive measures and thereby reduce mortality rate in these patients.

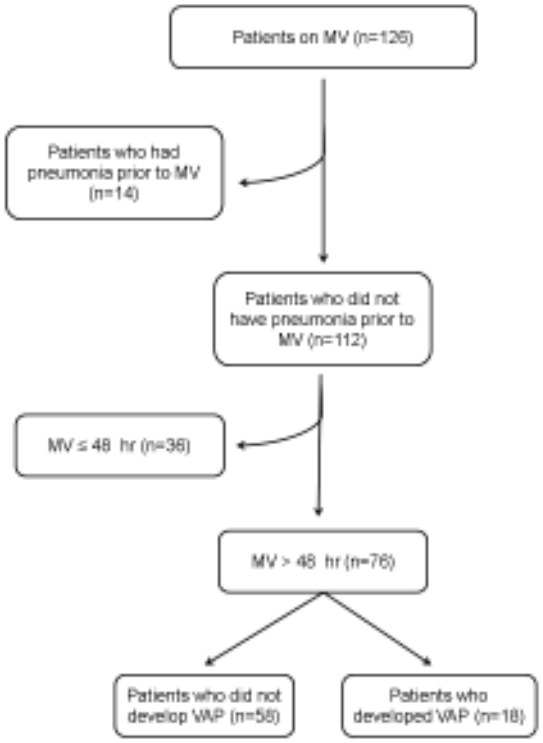
Method

Study design

A prospective study was conducted at a tertiary care teaching hospital over a period of 20 months from November 2009 to July 2011.

All patients admitted in the ICU who received MV were included in the study. Patients who were mechanically ventilated for less than 48 hours and those who had developed pneumonia prior to initiation of MV were excluded from the study. The study was approved by the institute ethics committee. Informed consent was obtained from the patient's next of kin.

Figure 1: Flowchart showing the inclusion and exclusion of patients



Data collection

The following variables were collected: age, sex, provisional diagnosis, date of hospital admission, and duration of MV. The patients included in this study were monitored at frequent intervals (every 48 hours) for the development of VAP using clinical and microbiological criteria till discharge or death. The parameters such as fever, chest X-ray, oxygenation, leukocytosis, and other risk factors were collected every 48 hours.

Microbiological methods

EA was serially diluted in sterile normal saline as 1/10, 1/100, 1/1000 and 0.01 ml of 1/1000 dilution was inoculated on 5% sheep blood agar. After incubation at 37°C in 5% CO_2 incubator for 24 hours, colony count was completed and expressed as number of colony forming units per ml (CFU/ml). The number of CFU/ ml is equal to number of colonies on agar plate × dilution factor × inoculation factor. Therefore, the presence of a single colony on the blood agar after inoculating 0.01 ml of 1/ 1000 times diluted EA was interpreted as more than 10^5 CFU/ ml.[11] The isolates were identified based on standard bacteriological techniques.[12]

Diagnosis

VAP was diagnosed in patients who fulfilled both clinical and microbiological criteria. A clinical diagnosis was made with the use of the modified Clinical Pulmonary Infection Score (CPIS) based on six clinical assessments, each worth zero to two points.[13] VAP was confirmed microbiologically in patients with quantitative endotracheal aspirate culture indicative of ≥ 10^5 CFU/ml with a positive Gram stain (>10 Polymorphonuclear cells/ high power field and ≥ 1 bacteria/ oil immersion field).[14-16]

Method of analysis

Results were expressed as mean± SD. Continuous variables were compared using Student's *t* test for normally distributed variables. Univariate analysis with chi-square or Fisher's exact test was performed to compare the risk factors in patients with and without VAP. Univariate results were confirmed with logistic regression analysis using statistics software (SPSS 16.0, SPSS Inc, Chicago, Illinois). This was necessary to avoid producing spuriously significant results with multiple comparisons. A stepwise approach was used to enter new terms into the model with 0.05 as the limit for their acceptance or removal. Results of the logistic regression analyses were reported as estimated odd ratios with their 95% confidence intervals. All *p* values < 0.05 were considered statistically significant.

Results

During a 20-month period (November 2009 to July 2011), 112 consecutive patients admitted to the ICU were prospectively evaluated. Of these, 36 (32.1%) were excluded due to mechanical ventilation for less than 48 hours. The remaining 76 (67.9%) patients who received MV for > 48 h were studied.

Of the 76 patients, 18 (23.7%) developed VAP during their ICU stay. Early onset VAP occurred in 13 (72.2%), while late onset VAP was observed in the remaining 5 (27.8%) patients. Ninety-four per cent (17 out of 18) of VAP cases occurred within the first week of MV. The incidence of VAP was 53.25 per 1,000 ventilator day.

Of the 76 study patients, 56 were men (73.7%) and 20 (26.3%) were women. The mean ± SD age of patients receiving MV was 48.11 ± 18.2 years (range, 14 to 82 years). The comparison of the age and sex distribution of the patients with and without VAP is shown in Table 1. The most frequent cause of ICU admission was poisoning

(22.4%). There was no statistically significant difference in the distribution of the various primary illnesses in the patients with and without VAP (Table 2).

Table 1: Age and sex distribution of the patients with and without VAP

Parameter	Non-VAP (n = 58)	VAP (n = 18)	P value (2-tailed)
Age (mean ± SD)	48.2 ± 18.4	47.8 ± 17.8	0.94
Gender			
Male	41 (70.7%)	15 (83.3%)	0.36
Female	17 (23.3%)	03 (16.7%)	

Table 2: Primary diagnosis of the study patients

Primary diagnosis	Non-VAP (n = 58)	VAP (n = 18)	P value
Cardiovascular disease	9 (15.5)	4 (22.2)	0.49
CNS infections	4 (6.9)	1 (5.6)	1.00
Intra-abdominal diseases	8 (13.8)	4 (22.2)	0.46
Neurological disorders	6 (10.3)	-	
Poisoning	13 (22.4)	4 (22.2)	1.00
Respiratory disease	12 (20.7)	4 (22.2)	1.00
Trauma	1 (1.7)	1 (5.6)	0.42
Other	5 (8.6)	-	

Pseudomonas aeruginosa (33.3%) was the most common organism isolated from VAP patients. It was followed by *Klebsiella pneumoniae* (20.8%), *Staphylococcus aureus* (8.3%), *Candida albicans* (8.3%), *Escherichia coli* (8.3%), *Acinetobacter baumannii* (4.2%) and *Stenotrophomonas maltophilia* (4.2%).

Univariate analysis indicated that chronic lung failure, use of H_2 blockers, and supine head position were significantly associated with VAP (Table 3). Selected risk factors were entered into a logistic regression model to perform the multivariate analysis which revealed that supine head position was an independent risk factor for VAP (Table 4).

Table 4: Logistic regression analysis of the risk factors for VAP

	Estimated Odds ratio	P value	95% confidence interval	
			Lower	Upper
Chronic lung failure	6.12	0.07	0.85	44.12
H_2 blockers	4.42	0.07	0.87	22.40
Supine head position	5.00	0.02	1.17	21.24

Discussion

Ventilator associated pneumonia is a type of nosocomial infection acquired in the ICU. We observed that the incidence of VAP was about 23.7%, which is comparable to the observations made in several other studies. In a study conducted from four multidisciplinary intensive care units from Greece the incidence was reported to be 32%.[4] In a evaluation made in Boston, VAP was reported at the rate of 10.2% per 1000 ventilator days.[17] Similarly Gupta A and coworkers, reported an incidence of 28.0%.[5] In a study from South India the incidence was reported to be 18%.[6]

Table 3: Univariate analysis of the risk factors for VAP

Risk factor	Non-VAP (n = 58) (%)	VAP (n = 18) (%)	Relative risk (95% confidence limits)	P value
Chronic lung failure	2 (3.4)	4 (22.2)	3.33 (1.60 to 6.95)	0.0255
H_2 blockers	34 (58.6)	16 (88.8)	4.16 (1.03 to 16.73)	0.0375
Supine head position	30 (51.7)	15 (83.3)	3.44 (1.09 to 10.90)	0.0349
Age ≥ 60 yrs	14 (24.1)	3 (16.7)	0.69 (0.23 to 2.12)	0.7473
Organ failure	4 (6.9)	3 (16.7)	1.97 (0.75 to 5.18)	0.3461
Abdomino-thoracic surgery	10 (17.2)	2 (11.1)	0.67 (0.18 to 2.53)	0.7199
ARDS	5 (8.6)	2 (11.1)	1.23 (0.35 to 4.29)	0.6667
Impaired consciousness	20 (34.5)	6 (33.3)	0.96 (0.41 to 2.27)	0.8457
Tracheostomy	2 (3.4)	1 (5.5)	1.43 (0.27 to 7.48)	0.5611
Nasogastric tube	49 (84.5)	15 (83.3)	0.94 (0.32 to 2.75)	1.0000
Steroids	5 (8.6)	1 (5.5)	0.69 (0.11 to 4.31)	1.0000
Emergency intubation	7 (12.1)	1 (5.5)	0.50 (0.08 to 3.27)	0.6716

VAP is generally classified as early onset and late onset based on the time of onset of VAP. In our study, early onset VAP occurred in 13 (72.2%) patients, while late onset VAP was observed in the remaining 5 (27.8%) individuals. Other studies have reported early-onset VAP in almost half of all VAP episodes.[18,19]

We observed that about 94% (17 out of 18) of VAP cases occurred within the first week of mechanical ventilation. Apostolopoulou et al also had documented that there was an increased risk of developing VAP during the first two weeks of MV. The increased risk is mainly attributed to the interaction of several risk factors during the initial days of MV.[4]

The patients who developed VAP in the present study were admitted for various clinical disorders. There was no significant association between the occurrence of VAP and the primary diagnosis of the patients, however the small number of patients in our study group could have resulted in our failure to find significant associations in our subgroups. For example, in a similar study from South India, patients with neurological disorders and CNS infections were observed to be significantly predisposed for the development of VAP.[6] In other studies intra-abdominal diseases and multiple injury were noted to be significant predisposing factors for VAP.[2,4,18]

Risk factors for the development of VAP were evaluated in the present study. The host and intervention factors such as, age ≥ 60 years, organ failure, abdominal or thoracic surgery, ARDS, chronic lung failure, impaired consciousness, tracheostomy, nasogastric tube, H_2 blockers, supine head position, steroids usage, and emergency intubation were evaluated. We observed chronic lung failure, H_2 blockers usage, and supine head position were significantly associated with VAP by univariate analysis, while supine head position was found to be the only independent risk factor for VAP by logistic regression. The defective lung function along with the pre-existing lung damage in patients with chronic lung failure may be responsible for the increased occurrence of VAP in these patients. Similarly, H_2 blockers usage was associated with an increased risk as it can alter the gastric pH thereby facilitating organism multiplication which, when aspirated, can lead to occurrence of VAP. Supine head position increases the risk of aspiration of the gastric contents and could explain some of the increase in the rate of VAP in critically ill patients. Awareness of these risk factors can aid in identification of patients at higher risk, guide institution of appropriate preventive measures, and modulate potential intervention measures while managing such patients. Supine head position, stress ulcer prophylaxis, surgery, burns, chronic renal failure, trauma, steroid therapy and duration of MV ≥ 5d were documented as risk factors in other studies.[2,18] In another study, impaired consciousness, tracheostomy, reintubation, emergency intubation, and nasogastric tube were found to be independent risk factors for VAP.[6] Awareness of these risk factors helps to overcome the adverse effects of VAP.

Conclusion

VAP, an important nosocomial infection among the critically ill patients, requires purposeful study to reduce mortality. Good knowledge of VAP and its associated parameters is important. Despite the small sample size which is a limitation of our study, our findings emphasize the importance of the several risk factors for VAP. Further studies on incidence and risk factors can facilitate knowledge translation activities about the disease and thereby minimise the occurrence of VAP through the implemention of simple, low cost preventive measures. Awareness about the various risk factors will aid in reduction of the morbidity and mortality associated with VAP.

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