

Retrospective cohort study evaluating the incidence of ventilator associated pneumonia in adult patients with traumatic brain injury in a tertiary care centre in central Kerala

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Abstract

Background and aims: The amount of trauma related deaths in India are more than a million, of which half of it is due to traumatic brain injury. Most of the traumatic brain injury patients have low Glasgow coma scale (<8) requiring intubation and mechanical ventilation. This exposes the lower respiratory tract to microorganisms which could lead to ventilator associated pneumonia, sepsis and even death. This study aims to estimate the incidence of VAP in TBI patients and evaluate the impact of various risk factors on the prognosis. This

helps to improve preventive strategies and patient outcomes.

Methods: A retrospective cohort study was conducted on 93 ventilated TBI patients admitted in past two years. Data were extracted from medical records covering demographic details, clinical symptoms, microbiology reports, co-existing medical conditions and presence of VAP.

Results: The incidence of VAP was 50.5% with early onset VAP 44.7% and late onset VAP 55.3%. Recovery rate was higher in younger age group ($p=0.01$). Associating antimicrobial susceptibility with prognosis

showed a higher non-recovery rate in resistant group ($p = 0.007$). Risk of early VAP was higher in Immunosuppressed patients ($p=0.23$). Hypertensive patients had significant association in the prognosis of late VAP ($p=0.04$)

Conclusion : This study underscores the importance of considering comorbidities, particularly hypertension and immunosuppression, in the management of VAP among TBI patients. It also highlights the need for early intervention and vigilant monitoring in these high-risk groups to improve outcomes.

Keywords : Retrospective Cohort, Trauma Tic Brain Injuries, Ventilator -Associated Pneumonia

Introduction

Traumatic brain injuries are very common in the present era due to the increase in road traffic accidents, falls and assaults. The amount of trauma related deaths in India are more than a million, of which half of it is due to traumatic brain injury.^{1,3} Most of the traumatic brain injury patients have low Glasgow coma scale (<8) and hence would require intubation and mechanical ventilation so as to prevent hypoxemia, hyper capnia and aspiration.⁴ This exposes the lower respiratory tract to microorganisms which could lead to ventilator associated pneumonia, sepsis and even death.⁵

Ventilator-associated pneumonia is seen in patients who have been under mechanical ventilation for over 48 hours. We arrive at the diagnosis of VAP based on clinical symptoms, radiological scans and laboratory analysis of the secretions taken from the pharynx.⁶ There is a strong brain-lung interaction in patients with traumatic brain injury.^{7,8}

Ventilator associated pneumonia has been divided into two types-early onset and late onset VAP. Early onset VAP develops during the first 4 days of intubation and

usually has better prognosis and good sensitivity to antimicrobials whereas late onset VAP develops after 4 days of intubation and it has poor prognosis and mostly caused due to multi-drug resistant microbes.^{9,10} Age and GCS were the two main independent factors which were used to categorize TBI patients as early-onset or late-onset VAP.¹¹

Various researches have shown that, traumatic brain injury causes immunosuppression leading to pulmonary damage which in turn creates an opportunity for the development of VAP.^{7,12}

The primary objective of this study is to estimate the incidence of ventilator associated pneumonia in traumatic brain injury. The secondary objectives are to determine the most common causative organism of ventilator associated pneumonia in traumatic brain injury and to analyze the antimicrobial susceptibility and evaluate the prognosis of the patients.

Methods

This was a retrospective cohort study done in TBI patients in a tertiary care hospital in a rural setting for a period of two months. Approval from the Institutional Ethics Committee was obtained and the study was registered under CTRI (CTRI/2023/01/062030). The inclusion criteria was traumatic brain injury adult patients intubated within the hospital from december 2020 to december 2022. TBI patients intubated in other hospitals and those with pre-existing lung pathology were excluded. Patients were selected using convenient sampling method. The sample size was calculated using $n = Z^2_{1-\alpha/2} pq / (p\epsilon)^2$ based on a previous study by B Jovanovic et al(11). Power of the study was 90% at confidence interval of 0.95.

A cohort of 93 TBI patients satisfying the inclusion and exclusion criteria were selected to be analyzed

retrospectively. As there was no contact between the researcher and the patient, waiver of consent was received from the IRB and IEC with approval. Confidentiality was strictly maintained regarding the personal details of the patient.

Data was collected from the medical records department. The information regarding the age, gender, clinical symptoms, radiological feature, microbiology reports and co-existing medical conditions were collected from the patients record and presence or absence of VAP was recorded.

Data entry was done using Excel Spreadsheet and Data Analysis using SPSS and EZR software.

Statistical analysis

All the categorical variables like gender, onset of disease, etc., were summarised using frequency and percentages. Continuous variable like age were summarised using Mean/SD or Median/quartiles depending upon the normality of the data.

Kolmogorov-Smirnov test and Shapiro test was used to check the normality of the data. Robust Poisson regression was used to identify the risk factors associated with early and late VAP. Relative risk along with 95% CI was estimated.

The entire analysis was performed using SPSS version 16. A p-value less than 0.05 was found to be statistically significant.

Results

Study population

Among the total 93 patients, 81 was male and 12 were female (12.9%)

Incidence of VAP was 50.5% (n=47) of which early onset VAP was 44.7% and late onset VAP 55.3%

Among those who developed VAP, Klebsiella pneumoniae (21.9%) was the major causative

microorganism for VAP followed by Pseudomonas aeruginosa (18.8%), Acinetobacter baumannii (15.6%), Escherichia coli (12.5%), Staphylococcus aureus (12.5%) and Non fermenting Gram Negative Bacilli together contribute the rest (18.7%) of causative organisms.

On associating antimicrobial susceptibility with prognosis of the patients, non-recovery rate was higher in the resistant group when compared to the Susceptible group, p-value=0.007. The proportion of patients who recovered were higher among the younger age group when compared to the older age group, p-value=0.01

Age and prognosis of Patients

Statistically significant association was observed between age categories and prognosis (p-value=0.01). The proportion of patients who recovered were higher among the younger age group when compared to the older age group.

Table 1:

Antimicrobial susceptibility		
Susceptibility	Number of patients	Percentage of patients
NIL	1	2.1
Susceptible	30	63.8
Resistant	16	34.0
Total	47	100.0

Table 2:

		Status						Fisher's exact test p- value
		Recovered		Did not recover		Mortality		
Age in years	n	%	n	%	n	%		
18 – 39	28	96.6%	1	3.4%	0	0.0%	0.01	
40 – 59	22	73.3%	3	10.0%	5	16.7%		
60+	21	61.8%	6	17.6%	7	20.6%		

Association of outcome and different co-morbidities among VAP patients

A significant association was observed between hypertension and prognosis, p -value=0.04. Proportion of patients who died was (26.7%) significantly higher among those who had hypertension when compared to those without any hypertension. (3.1%)

Table 3:

Co-morbidity (N)	Recovered n	Recovered %	Not Recover n	Not Recover %	Died n	Died %
Diabetes Mellitus (11)	7	63.6	2	18.2	2	18.2
Hypertension (15)	10	66.7	1	6.7	4	26.7
Dyslipidemia (3)	2	66.7	0	0	1	33.3
Cardiac Disease (8)	4	50	1	12.5	3	37.5
Neurological Disease (8)	5	62.5	2	25	1	12.5

Table 4: Early VAP

		Early VAP				Chi-square test statistic (p-value)/ fisher’s exact test p-value	Relative Risk (95% CI)
		Not Developed		Who developed Early VAP			
				n	%		
Age	Young age 18-39 years	21	75.0%	7	25.0%	0.69 (0.71)	
	Middle age 40 – 59 years	25	83.3%	5	16.7%		0.67
	Old age (60+)	26	76.5%	8	23.5%		0.94
Diabetes Mellitus	No	55	78.6%	15	21.4%	0.22 (0.64)	
	Yes	17	73.9%	6	26.1%		1.22
Hypertension	No	51	82.3%	11	17.7%	2.49 (0.11)	
	Yes	21	67.7%	10	32.3%		1.82
Dyslipidemia	No	64	77.1%	19	22.9%	1.00	
	Yes	8	80.0%	2	20.0%		0.87
Immunosuppr ession	No	72	78.3%	20	21.7%	0.23	
	Yes	0	0.0%	1	100.0%		4.60(3.12,6.78)
Cardiac d/s	No	63	79.7%	16	20.3%	0.29	
	Yes	9	64.3%	5	35.7%		1.76
Renal d/s	No	66	76.7%	20	23.3%	1.00	

	Yes	6	85.7%	1	14.3%		0.61
Liver d/s	No	67	76.1%	21	23.9%	0.58	
	Yes	5	100.0%	0	0.0%		
Neurological d/s	No	65	79.3%	17	20.7%	0.26	
	Yes	7	63.6%	4	36.4%		1.75

The risk of developing early VAP was found to be 4.60 times higher [RR=4.60(95% Ci:3.12,6.78)] among those who had Immunosuppression when compared to those who did not had any Immunosuppression. None of the other factors were found to be associated with Early VAP. Late VAP

Table 5:

		Late VAP				Chi-square test statistic (p-value)/ exact test p-value	Relative Risk (95% CI)
		Who did not develop Late VAP		Who developed Late VAP			
		n	%	n	%		
Age	Young age 18-39 years	20	71.4%	8	28.6%	1.35 (0.51)	
	Middle age 40 – 59 years	20	66.7%	10	33.3%		1.16
	Old age (60+)	27	79.4%	7	20.6%		0.72
Diabetes Mellitus	No	49	70.0%	21	30.0%	1.40 (0.24)	
	Yes	19	82.6%	4	17.4%		0.58
Hypertension	No	41	66.1%	21	33.9%	4.62 (0.03*)	
	Yes	27	87.1%	4	12.9%		0.38
Dyslipidemia	No	59	71.1%	24	28.9%	0.28 ^s	
	Yes	9	90.0%	1	10.0%		0.35
Immunosuppression	No	67	72.8%	25	27.2%	1.00 ^s	
	Yes	1	100.0%	0	0.0%		
Cardiac d/s	No	57	72.2%	22	27.8%	0.75 ^s	
	Yes	11	78.6%	3	21.4%		0.77
Renal d/s	No	63	73.3%	23	26.7%	1.00 ^s	
	Yes	5	71.4%	2	28.6%		1.07
Liver d/s	No	64	72.7%	24	27.3%	1.00 ^s	
	Yes	4	80.0%	1	20.0%		0.73
Neurologic al d/s	No	60	73.2%	22	26.8%	1.00 ^s	
	Yes	8	72.7%	3	27.3%		1.02

*statistically significant

None of the variables were found to be significantly associated with Late VAP other than hypertension. The proportion of people who developed late VAP significantly higher (87.1%) among those who had hypertension when compared to those who did not had hypertension (66.1%), p -value=0.03.

Discussion

The study evaluated the impact of various co morbidities on the prognosis of patients with ventilator-associated pneumonia (VAP) and examined the association between age, co morbidities, and the occurrence of early and late VAP among patients with traumatic brain injury (TBI).

The analysis revealed a significant association between hypertension and patient outcomes, with a p -value of 0.04. Patients with hypertension had a higher mortality rate compared to those without hypertension. This finding aligns with previous researcher done by Dellinger RP et al indicating that hypertension exacerbates the risk of adverse outcomes in critically ill patients, potentially due to its impact on cardiovascular and cerebrovascular systems, leading to complications during the recovery process¹³. Furthermore, the study found a borderline significant association between cardiac disease and patient outcomes ($p=0.047$). This suggests that the presence of cardiac disease might also contribute to worse outcomes, possibly due to the increased strain on the cardiovascular system when managing VAP in these patients.

Other co morbidities such as diabetes mellitus, dyslipidemia, renal disease, liver disease, and neurological disorders did not show a statistically significant impact on the prognosis of VAP patients in this study. However, the trends observed, particularly in cases of immunosuppression where 100% mortality was recorded among the Immunosuppressed, highlight the potential vulnerability of these patient groups to VAP and poor outcomes¹⁴. This underscores the need for

further research with larger sample sizes to better understand these relationships.

Age was another critical factor examined in the study. The findings indicated a statistically significant association between age categories and patient prognosis ($p=0.01$). Younger patients were more likely to recover from VAP, while older patients had higher mortality rates. This is consistent with other studies where age is recognized as a key determinant of survival in critically ill patients, with older age being associated with reduced physiological reserve and higher susceptibility to complications^{15,16}.

No significant association was found between age and the development of VAP ($p=0.64$). However, when age was evaluated in relation to early and late VAP, the data suggested that younger patients were more likely to develop early VAP, although this was not statistically significant. The lack of significant findings might be due to the small sample size or the presence of other confounding factors that were not accounted for in this analysis.

The study used robust Poisson regression to identify risk factors for early and late VAP. Immunosuppression was identified as a significant risk factor for early VAP, with a relative risk of 4.60 (95% CI: 3.12, 6.78). This finding is crucial as it indicates the heightened vulnerability of Immunosuppressed patients to early-onset infections, which can rapidly deteriorate without prompt and appropriate intervention¹⁷. For late VAP, hypertension emerged as a significant factor, with a higher proportion of hypertensive patients developing late VAP ($p=0.03$). This association may be linked to the prolonged hospital

stays and extended mechanical ventilation often required by hypertensive patients, increasing their exposure to nosocomial infections¹⁸.

Comparing these findings with existing literature, the association between hypertension and poor VAP outcomes has been corroborated by studies such as those by Dellinger et al.¹³, where hypertensive patients were found to have a higher risk of mortality due to the compounded effects of cardiovascular strain and infection. Similarly, the role of immunosuppression in increasing the risk of early VAP has been supported by studies highlighting the impaired immune response in such patients, leading to higher rates of infection and mortality¹⁹.

Conclusion

This study underscores the importance of considering comorbidities, particularly hypertension and immunosuppression, in the management of VAP among TBI patients. It also highlights the need for early intervention and vigilant monitoring in these high-risk groups to improve outcomes.

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