



Beyond the Symptoms: Exploring the Clinical, Bacteriological, and Radiological Profiles and Outcomes of Community-Acquired, Hospital-Acquired, and Ventilator-Associated Pneumonia in a Tertiary Care Setting

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Abstract

Background: The lower respiratory tract infections (LRTIs), including pneumonia, are the fourth most common cause of mortality globally and the second most frequent reason for years of life lost. India is home to one-quarter of the world's pneumonia cases. **Aims and Objectives:** The present study was aimed to evaluate the clinical, bacteriological and radiological profile of CAP, HAP and VAP patients from a tertiary care teaching hospital. **Material & Methods:** This cross-sectional, observational study was conducted at the Department of Pulmonary Medicine, Bharati Vidyapeeth (DTU) Medical College and Hospital, Pune, India. The study included 100 clinically diagnosed patients of community-acquired pneumonia (CAP), hospital-acquired pneumonia (HAP), and ventilator-associated pneumonia (VAP). Patients were evaluated for clinical symptoms, microbiological investigations, radiological assessment, treatment given, and final outcome. Severity indices were calculated for CAP, HAP, and VAP patients to predict the severity and rate of mortality. **Results:** The most common symptoms are cough, fever, and shortness of breath. The most common organisms isolated in sputum cultures of patients with pneumonia are Streptococcus, Pseudomonas, and Acinetobacter. The most common site of consolidation on chest X-ray is bilateral. Mortality rates are highest in patients with ventilator-associated pneumonia (VAP), followed by hospital-acquired pneumonia (HAP) and community-acquired pneumonia (CAP). **Conclusion:** The most common symptoms of pneumonia are cough, fever, crepitation, and expectoration. Mortality rates are highest in patients with VAP, followed by HAP and CAP.

Keywords

Community acquired pneumonia (CAP), hospital acquired pneumonia (HAP), ventilator associated pneumonia (VAP), CURB-65 score, APACHE II, CPIS

Introduction

The lower respiratory tract infections are the most common infectious cause of death, worldwide.^[1]

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Manuscript Received: 12.05.2023; **Revision Accepted:** 22.07.2023;

Published Online First: 10 January, 2024.

Open Access at: <https://journal.jkscience.org>

Pneumonia is a disease known to mankind from antiquity. Despite the availability of potent antibiotics, community

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Cite this article as: Kelli SBR, Deoskar RB, Bhoite GM, Momin AA. Beyond the symptoms: exploring the clinical, bacteriological, and radiological profiles and outcomes of community-acquired, hospital-acquired, and ventilator-associated pneumonia in a tertiary care setting. JK Science 2024;26(1):40-6.



acquired pneumonia (CAP) remains common and serious illness with significant morbidity and mortality.^[2] Pneumonia is common illness affecting approximately 450 million people a year and occurring in all parts of the world. It is a major cause of death among all age groups resulting in 4 million deaths (7%) of world's total death rate yearly.^[3]

Estimates of the incidence of CAP range from 4 to 5 million cases per annum, of which, about 20% require hospitalization. But the problem is much greater in developing countries where the pneumonia is the most common cause of hospital attendance in adults. Though definite statistics are lacking, pneumonia remains a leading cause of death in India.^[2] India accounts for 23% of the global pneumonia burden and 36% of the WHO regional burden. National estimates may, however, hide significant sub-national disparities.^[4]

Over the last decade or two, however, patients presenting to the hospital have been found to be infected with MDR pathogens previously associated with hospital acquired pneumonia.^[3] The potential involvement of these MDR pathogens led a revised classification system in which infection is categorized as either community acquired pneumonia (CAP), hospital acquired pneumonia (HAP) and ventilator associated pneumonia (VAP).^[5]

Rates of pneumonia are considerably higher among hospitalized patients as well and the risk of developing pneumonia is 3-10 folds higher in ventilated patients. The prevalence of VAP varies from 6-52% depending on population studied.^[6] Although the diagnosis and the treatment of CAP, HAP, VAP has been studied widely and standard guidelines have been made there is need for further studies in view of changing presentation of the illness and development of antibiotic resistance, which is likely to vary from country to country and even within different parts of the same country. In view of this, we aimed to study pneumonia with its classification in our setting, and by the mode of this study as it helps in early detection of disease, and clinical, bacteriological, and radiological profile of pneumonia acquired in the community admitted in our geographical area.

Material and Methods

The present cross sectional, observational study was conducted in Department of Pulmonary Medicine, Bharati Vidyapeeth (DTU) Medical College and Hospital, Pune. The study included 100 diagnosed cases of CAP, HAP, VAP by convenient sampling, admitted to inpatient Department of Pulmonary Medicine of Bharati Hospital. All Diagnosed cases of CAP, HAP, VAP during this period

who were willing for the study and who could be followed up during their hospital stay were recruited above the age of 18 years. Patient going on discharge against medical advice and cases of Pulmonary tuberculosis and fungal pneumonias were excluded from the study. The study was approved by the institutional ethics committee, and the consent was taken from all participants.

Methodology

100 clinically diagnosed patients of CAP, HAP, VAP presenting to IPD of Pulmonary Medicine Department were enrolled in this study. After admission, patients were evaluated regarding clinical symptoms, microbiological investigations, radiological assessment, treatment given and final outcome. For the severity of the condition the severity indices viz. CURB-65, APACHE II and CPIS scores were calculated for CAP, VAP and HAP patients respectively to predict the severity and rate of mortality.

Statistical Analysis

The collected data was entered in Microsoft . The results were presented in tabular and graphical format. The qualitative data was presented as ratios and percentage (%). The categorical variables were compared using Chi-square test. The value of 'p' <0.05 was considered as significant.

Results

A study of 100 pneumonia patients showed a mean age of 59 years, with most patients in the 50 to 69 years age group. The male-to-female ratio was 2:1 in CAP, HAP, and VAP groups. VAP patients had higher rates of smoking and alcohol use. Symptoms persisted for more than 7 days in 36.36% of CAP, 30.77% of HAP, and 41% of VAP patients. Common comorbidities included diabetes mellitus, hypertension, and COPD. Cough, fever, crepitation, and expectoration were prevalent symptoms, along with dyspnea, cyanosis, and hemoptysis.

Sputum samples were analyzed for culture in CAP, HAP, and VAP patients, revealing that 30.30% of CAP, 61.54% of HAP, and 100% of VAP patients had gram-negative bacteria. Additionally, 42.42% of CAP, 23.08% of HAP, and 7.41% of VAP patients showed positive cultures for gram-positive cocci. Only one VAP patient had gram-positive bacteria, and gram-negative cocci were present in 9.09% of CAP and 7.69% of HAP patients. Multiple observations were noted in some patients.

The study population was categorized into three groups: CAP, HAP, and VAP. No growth was observed in 51.52% of CAP patients, 7.69% of HAP patients, and 0% of VAP patients. Among CAP patients, the most common isolated organism was Streptococcus, followed by

Table 1: Organisms isolated in the Study Population

ORGANISMS	CAP (n=33)		HAP(n=13)		VAP (n=54)	
	N	%	N	%	N	%
Streptococcus	8	24.24	3	23.08	0	0.00
Staphylococcus	5	15.15	0	0.00	0	0.00
Acinetobacter	0	0.00	0	0.00	23	42.59
Klebsiella	0	0.00	2	15.38	6	11.11
Pseudomonas	3	9.09	6	46.15	14	25.93
Escherichia coli	0	0.00	1	7.69	6	11.11
Mixed	0	0.00	0	0.00	5	9.26
No Growth	17	51.52	1	7.69	0	0.00

Table 2: X ray findings and radiological outcomes in the Study Population

	CAP (n=33)		HAP (n=13)		VAP (n=54)	
	N	%	N	%	N	%
Bilateral	7	21.21	5	38.46	39	72.22
Right	4	12.12	2	15.38	2	3.70
Left	3	9.09	3	23.08	11	20.37
Cleared	16	48.48	9	69.23	10	18.52
Partial clearing	10	30.30	3	23.08	24	44.44
Worsening	5	15.15	1	7.69	20	37.04
Complicated with effusion	2	6.06	0	0.00	9	16.67

Table 3: Comparison of CURB-65 score with outcome among CAP (n=33)

	Died		Discharged	
	N	%	N	%
CURB-65				
1	0	0	0	0
2	0	0	0	0
3	0	0	10	30.30
4	0	0	15	45.46
5	8	24.24	0	0
APACHE II				
<25	0	0	8	61.54
> or =25	5	38.46	0	0
CPIS score				
<7	02	3.70	27	50.00
> or =7	22	40.74	03	5.56

Table 4: Laboratory investigations

		CAP (n=33)		HAP (n=13)		VAP (n=54)	
		N	%	N	%	N	%
RFTs	Normal	24	72.73	9	69.23	12	22.22
	Abnormal	9	27.27	4	30.77	42	77.78
LFTs	Normal	20	60.61	8	61.54	30	55.56
	Abnormal	13	39.39	5	38.46	24	44.44
Hemoglobin	<7	0	0.00	0	0.00	4	7.41
	7-9	13	39.39	5	38.46	30	55.56
	10-14	20	60.61	8	61.54	20	37.04
TLC	<4000	0	0.00	0	0.00	0	0.00
	4000-11000	0	0.00	0	0.00	0	0.00
	>11000	33	100.00	13	100.00	54	100.00
Procalcitonin	Normal	23	69.70	2	15.38	49	90.74
	Abnormal	10	30.30	11	84.62	5	9.26

Staphylococcus, and Pseudomonas. In HAP patients, Pseudomonas was the most prevalent organism, followed by Streptococcus, Klebsiella, and E. Coli. Acinetobacter was the most prevalent organism among VAP patients, followed by Pseudomonas, Klebsiella, and E. Coli. Multiple observations were recorded in some patients. Blood cultures were positive in 30% of CAP patients, 61.54% of HAP patients, and 77.78% of VAP patients. ETT cultures were positive in 74.07% of VAP patients. (Table No. 1)

The most common site of consolidation was bilateral, followed by the left and right lobes. After treatment, chest X-rays showed improvement in all three pneumonia groups. However, X-rays worsened in 15.15% CAP patients, 7.69% HAP patient, and 37.04% VAP patients. Effusion was observed in 6.06% CAP patients, none in HAP patients, and 16.67% VAP patients. (Table 2)

In the study groups, 24.24%, 38.46%, and 44.44% patients died in CAP, HAP, and VAP, respectively, while all remaining patients were discharged. The CURB-65 score for CAP patients was 3 or more in all groups. 30.30% patients had a score of 3; 45.46% had a score of 4; and 24.24% patients had a CURB-65 score of 5. CAP patients with a CURB-score of 5 (24.24%) were transferred to the ICU due to various complications, resulting in death. The APACHE II score was found to be a good predictor of mortality, with a mortality rate of 38.46% in HAP patients with an APACHE II score of > or equal to "25. The CPIS score was also found to be a good predictor of mortality, with a mortality rate of 40.74%

in patients with a CPIS score of > or equal to "7. (Table 3)

The RFTs were found to be deranged in most of the patients with VAP (77.78%), while LFTs were deranged among all three types of pneumonia. More than half of the patients had the hemoglobin level of <9 gm/dL, all patients in all types of pneumonia had TLC of >11000 and Procalcitonin level was abnormal among 30.30% CAP, 84.62% HAP and 9.26% of VAP patients. (Table 4)

The antibiotic drugs prescribed varied among the study population, with penicillin being used in the majority of HAP and VAP patients (100% and 29.63%, respectively), while it was only used in a smaller percentage of CAP patients (21.21%). Carbopenems were only used in a small percentage of HAP and VAP patients (30.77% and 29.63%, respectively). Macrolides were prescribed to the majority of CAP patients (78.79%), while colistin was used in a larger percentage of HAP and VAP patients (15.38% and 70.37%, respectively).

Discussion

Pneumonia is an important cause of morbidity and mortality, it is a constellation of symptoms and signs including fever, chills, cough, pleuritic chest pain, sputum production, increased respiratory rate etc., in combination with at least one opacity on chest radiography. Pneumonia can be broadly categorized as community-acquired and hospital-acquired (nosocomial) pneumonia.^[7,8]

The burden of pneumonia in India is high, with significant mortality rate. Streptococcus pneumoniae is a common



bacterial cause of pneumonia in India.^[9,10] Females were more affected in CAP patients, while males were more affected in HAP patients.^[11,12] Similarly, the age group affected also varies, with VAP patients being adults in the 21-40 age group, and CAP patients being mostly in the 60-79 age group.^[13,14]

The present study shows that the majority of pneumonia patients were males, and the most common age group affected was 50-69 years. The most common symptoms observed were fever and crepitation, followed by cough, expectoration, bronchial breath sounds, and dyspnea. These findings are consistent with previous studies reporting fever, cough, sputum production, and pleuritic chest pain as common clinical findings in patients with CAP.^[15,16] Diabetes mellitus was the most common comorbidity among pneumonia patients in the present study, which is consistent with previous studies.^[2,17] Smoking was reported as the most common predisposing factor among CAP patients, followed by COPD, structural lung disease, diabetes mellitus, decreased level of consciousness following seizure, and chronic alcoholism.^[16,17,18] Therefore, identifying and managing these factors is crucial in reducing the burden of pneumonia in India.

In present study the most commonly isolated organism in CAP patients was Streptococcus, while in HAP and VAP, it was Pseudomonas and Acinetobacter respectively. Other organisms isolated in CAP patients included Staphylococcus and Pseudomonas. The causative agents and their prevalence in different types of pneumonia have been investigated by several studies. Shah *et al*^[16] and Pushpa Kumari RS^[19] reported that gram-negative bacteria were the most common cause of CAP, with Pseudomonas aeruginosa being a common pathogen. In contrast, Streptococcus pneumoniae was the most commonly isolated organism in CAP patients by Kejriwal *et al*^[20] and the present study.

In hospital-acquired pneumonia (HAP), Pseudomonas and Acinetobacter were the most prevalent organisms in the present study, while K. pneumoniae was reported as the most common pathogen by Varghese^[12]. In VAP, multidrug-resistant Acinetobacterbaumannii was predominantly isolated by Mukhopadhyay *et al*^[9], whereas Patro *et al*^[21] found Enterobacteriaceae and Staphylococcus aureus as the most common causing agents in early-onset VAP. Klebsiella pneumoniae was reported as the most frequent organism by Shah *et al*^[11] and Ravi *et al*^[13] in CAP and VAP patients, respectively.

The etiology of pneumonia may vary depending on the study population, geographical location, and clinical settings. Hence, it is important to identify the causative agents in pneumonia patients to provide appropriate treatment and prevent complications. The use of combined clinical, radiological, and microbiological approaches can be successful in the management and further follow-up of pneumonia patients.^[10]

In several studies, lobar pneumonia was reported to be the most common radiological presentation on chest X-ray.^[17] Specifically, in the study conducted by Shah S *et al*^[11], lobar pneumonia was observed in 99% of the cases, with the right lower zone being the most commonly involved zone. Kejriwal A *et al*^[20] found that the right lower zone was the most involved zone in 28% of patients with CAP, while bilateral involvement was seen in only 6.7% cases.

In the present study, the most common site for consolidation on chest X-ray was found to be bilateral, followed by left and then right lobe. The chest X-ray findings also improved after treatment in all three types of pneumonia, with a worsening of the condition seen in some patients, and the development of complications, such as effusion, in a small percentage of cases.

The radiological presentation of pneumonia has been studied extensively and the findings have been consistent with lobar pneumonia being the most common presentation. This was also reported by Jain *et al*^[2], who found lobar pneumonia to be the most common radiological presentation of pneumonia. Similarly, Patil *et al*^[15] and colleagues reported the presence of bronchopneumonia, lobar pneumonia, interstitial pneumonia, and pleural effusion in CAP patients.

Several studies have reported mortality rates associated with different types of pneumonia. Kejriwal *et al*^[20] reported 9 deaths out of 60 community-acquired pneumonia (CAP) patients. Varghese *et al*^[12] reported a mortality rate of 44% for HAP patients. In VAP patients, Ravi *et al*^[13] reported a mortality rate of 13.3% with an average duration of intubation of 13.1 days. The highest attributable mortality rate was reported by Mukhopadhyay *et al*^[9] i.e. 61.9% which rose with duration of stay.

Factors predicting mortality include age over 62 years, comorbidities, hypotension, altered sensorium, respiratory failure, leucocytosis, and staphylococcus pneumonia.^[16] The CURB-65 score is a simple tool used for identifying severely ill individuals.^[22,23] Shah *et al*^[24] reported that the CURB-65 score is sensitive to predict death from



CAP in an Indian setting, with high specificity.

In the present study, all CAP patients had a CURB-65 score of 3 or more, and HAP patients with an APACHE II score of $>$ or equal to ≥ 25 were shifted to ICU for complications and died. The mortality rate was found to be 54% among VAP patients. The present study also found that more than half of the patients had hemoglobin levels of < 9 gm/dL. The liver function tests were found to be deranged among all types of pneumonia, while the renal function tests were found to be deranged in most VAP patients. Some patients developed complications such as ARDS, para-pneumonic effusion, and septic shock during the course of stay.

The results of present study suggest that pulmonary infections are associated with significant physiological disturbances. The study found that renal function was mostly affected in VAP patients, while LFTs were deranged across all three types of pneumonia. Additionally, anemia was common among patients, and TLC was elevated in all types of pneumonia. Procalcitonin levels were also found to be abnormal in a large percentage of HAP patients, indicating the potential usefulness of this biomarker in the diagnosis and management of hospital-acquired infections. Overall, the findings highlight the importance of regular monitoring of laboratory parameters in patients with pneumonia to aid in their management and recovery.

The main causes of admission vary among different groups of patients with pneumonia, with trauma being the most common cause in VAP patients and CKD being the most common cause in HAP patients.

Regarding antibiotic treatment, there were differences among the groups, with penicillin being the most commonly used drug in HAP and VAP patients, while macrolides were the most commonly used in CAP patients. Carbopenems were used in a smaller percentage of patients overall, and colistin was used in a larger percentage of HAP and VAP patients. These findings suggest that appropriate selection of antibiotics may depend on the type and severity of pneumonia and underlying medical conditions.

Conclusion

Pneumonia, a word that invokes a sense of discomfort, is a common ailment that has plagued mankind for ages. This respiratory infection can strike anyone, but the elderly and males seem to be more susceptible. A host of underlying health conditions such as diabetes mellitus, hypertension, COPD, and liver disease can make one more vulnerable to contracting pneumonia. The bacterial

origin of this infection is most prevalent in patients diagnosed with CAP, HAP, and VAP. To assess the severity and predict complications, doctors use scores such as CURB-65, APACHE II, and CPIS. These scores help determine the best course of treatment and can also predict the patient's mortality. Hospital stays are often extended, especially for those who score high on these severity scales.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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