

## Correlation Between Chest X-Ray Findings and Clinical Severity in Patients with Community-Acquired Pneumonia

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### Abstract:

**Background:** Community-acquired pneumonia (CAP) represents a significant lower respiratory infection and constitutes one of the major causes of morbidity, admission to the hospital, and mortality in the world. The chest x-ray represents the key imaging tool for CAP diagnosis and serves a pivotal role in evaluating the degree of lung involvement and estimating the severity of the condition.

**Aim:** To assess the retrospective association between the chest X-ray results and the clinical severity of community-acquired pneumonia.

**Methodology:** A retrospective and observational study was carried out in the Department of Radiology, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India, for a period of one year. A total number of 150 medical records from patients with community acquired pneumonia were studied. Data on demographics, clinical presentation, laboratory findings, radiological findings (chest X-Ray), CURB-65 clinical scoring system, methods of management, and outcome of the disease were gathered and analyzed through descriptive statistics, Chi square test, and Spearman's rank correlation analysis.

**Results:** The majority of patients (45.3%) had the age range of 51–70 years old, and males constituted 61.3% of the studied population. The most prevalent comorbidities were diabetes mellitus (34.7%) and hypertension (30.7%). Most of the patients were characterized by moderate clinical severity in accordance with the CURB-65 score (46.7%), and severe pneumonia accounted for 20.0%. The most common laboratory abnormalities in the case of CAP included leukocytosis (73.3%), increased C-reactive protein (63.3%), and hypoxemia (54.7%). All patients were prescribed intravenous antibiotics, 54.7% required oxygen treatment, 21.3% were hospitalized in the ICU, and 12.0% were treated with mechanical ventilation. 92.0% of the patients were discharged successfully, and in-hospital mortality was 8.0%. There was a significant correlation between the chest X-ray results and clinical severity and outcomes of the patients.

**Conclusion:** Findings from chest X-rays were found to correlate significantly with clinical severity among cases of community-acquired pneumonia. Radiological findings combined with clinical severity scores contribute immensely to early detection, risk stratification, treatment, and prediction of clinical outcome. Timely detection of severe radiological findings can aid in appropriate action and improved management of community-acquired pneumonia cases.

**Keywords:** Community-acquired pneumonia, Chest X-ray, Clinical severity, CURB-65, Radiographic findings, Pulmonary infiltrates, Retrospective study.

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### Introduction

Community-acquired pneumonia (CAP) is among the most frequent lower respiratory tract infections and still the most prevalent cause of morbidity, hospitalizations, and death throughout the world [1]. The condition is described as an acute infection of the lung tissues, occurring in outpatient conditions and characterized by symptoms such as fever, cough, sputum, dyspnea, and chest pain as well as radiologic findings of pulmonary infiltrates [2]. CAP can be found in people of any age; however, it

is more often observed in elderly people and patients with certain co-morbid conditions like diabetes mellitus, chronic obstructive pulmonary disease (COPD), heart disease, and chronic renal disease [3]. Despite advances in antimicrobial therapy and supportive care, CAP continues to impose a significant burden on healthcare systems because of its high incidence and associated complications [4].

Proper assessment of the early onset and severity of illness plays a critical role in ensuring that patients get the right kind of medical attention and receive favorable outcomes [5]. Scoring systems for the clinical assessment of disease severity and mortality like CURB-65 and Pneumonia Severity Index (PSI) are commonly used to determine the severity of illness, predict mortality, and make decisions on whether the patients should be admitted to a hospital [6]. In addition to scoring tools, X-ray is also the standard method of imaging for CAP due to its cost-effectiveness and availability [7].

Common findings on chest radiography include lobar consolidation, multi-lobar consolidation, bilateral infiltrates, pleural effusion, and cavitation [8]. There are numerous reports in the literature showing that patients who have a large number of radiographic abnormalities also have severe disease, longer hospitalization period, ICU admissions, and high mortality [9]. Consequently, chest radiography is not only helpful in making a diagnosis but also useful for determining the severity of the disease [10].

The problem of community-acquired pneumonia remains significant even nowadays due to such factors as late diagnosis, lack of proper health care facilities, and high prevalence of comorbid conditions [11]. Considering the availability of chest x-ray even in underdeveloped countries, the assessment of association between this imaging method and the severity of disease will help to stratify patients' risks [12,13].

The objective of this current study is to examine the relationship between chest x-ray findings and clinical severity in patients with community-acquired pneumonia [14]. Through the analysis of the clinical and radiological information of the patients who had been admitted to the Lord Buddha Koshi Medical College & Hospital, Saharsa, Bihar, India, the objective of the study would be to explore the importance of chest x-ray findings and their utility in managing community-acquired pneumonia clinically [15].

## Methodology

**Study Design:** The current study will be a retrospective observational study that will assess the relationship between chest X-ray findings and clinical severity of CAP patients. This study is interested in identifying the relationship between chest X-ray results and clinical severity of illness in patients suffering from community-acquired pneumonia using standardized methods for assessing the severity of illness. A retrospective design is chosen since it allows analyzing patient's files for a certain period of time and obtaining an insight into the radiographic pattern in relation to clinical severity among CAP patients.

**Study Area:** This study is carried out in the Department of Radiodiagnosis, Lord Buddha Koshi Medical College & Hospital, Saharsa, Bihar, India.

**Study Duration:** This research is performed within a one-year period.

## Study Participants

### Inclusion Criteria

- Adults with the age of 18 years and above suffering from community-acquired pneumonia.
- Patients with chest x-ray results that suggest community-acquired pneumonia upon admission to the hospital.
- All patients with complete demographic information, laboratory test results, radiology results, and CURB-65 clinical assessment in their medical records.
- Patients admitted to the hospital during the research period.

### Exclusion Criteria

- Patients with hospital acquired pneumonia or ventilator associated pneumonia.
- Patients having pulmonary tuberculosis, lung cancer or chronic interstitial lung diseases.
- Immunosuppressed patients such as HIV/AIDS, organ transplantation or chemotherapy patients.
- Patients having incomplete patient history or poor-quality chest x-rays.

**Sample Size:** The total number of patients involved in the study who meet the inclusion criteria is 150. The sample is chosen in such a way that it would have adequate representation from all ages, radiologic features, and severity levels of community-acquired pneumonia.

**Procedure:** The data about the patients' records is collected from the medical records department of the hospital and analyzed. Demographics, symptoms, comorbidity, laboratory investigation results, chest X-ray results, clinical severity (CURB-65), treatment, and the outcome are noted. Chest X-rays are analyzed for the presence of lobar consolidation, multilobar consolidation, bilateral pulmonary infiltration, pleural effusion, cavitory lesion, and other related abnormal imaging features. Clinical severity is then categorized based on the CURB-65 score as low risk, moderate risk, or high risk. The outcome variables such as oxygen therapy, ICU admission, length of stay, mechanical ventilation, and outcome are also documented. The process of collecting data is done through proforma. Confidentiality is ensured through de-identification of patient data. Ethical clearance is sought from the Institutional Ethics Committee of the hospital.

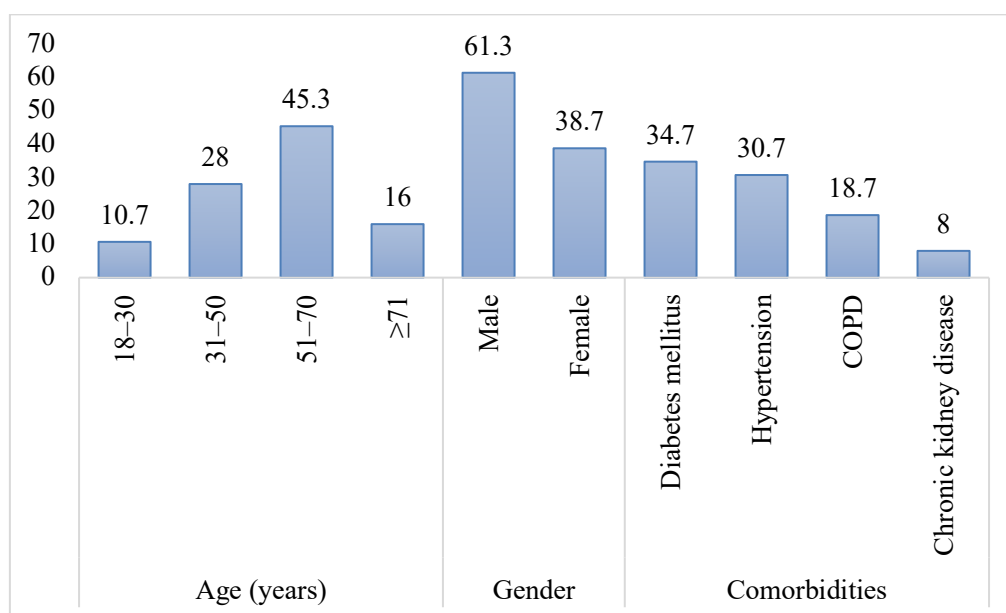
**Statistical Analysis:** The collected data are analyzed using SPSS version 27.0 (IBM, USA). For

the continuous variables, mean, standard deviation, frequency, and percentage are computed. The relationship between demographic variables, findings on chest X-ray, and clinical severity groups is determined by Chi-square and independent t-tests for categorical and continuous variables, respectively. The association between findings on chest X-ray and CURB-65 clinical severity scores is determined by using Spearman's rank correlation analysis. To determine the independent radiological factors predicting severe community-acquired pneumonia, binary logistic regression analysis will be done after adjusting for potential confounders.

## Result

**Table 1: Demographic and Clinical Characteristics of Study Participants (n = 150)**

| Parameter     | Category               | Frequency (n) | Percentage (%) |
|---------------|------------------------|---------------|----------------|
| Age (years)   | 18–30                  | 16            | 10.7           |
|               | 31–50                  | 42            | 28.0           |
|               | 51–70                  | 68            | 45.3           |
|               | ≥71                    | 24            | 16.0           |
| Gender        | Male                   | 92            | 61.3           |
|               | Female                 | 58            | 38.7           |
| Comorbidities | Diabetes mellitus      | 52            | 34.7           |
|               | Hypertension           | 46            | 30.7           |
|               | COPD                   | 28            | 18.7           |
|               | Chronic kidney disease | 12            | 8.0            |



**Figure 1: Visual Representation of Demographic and Clinical Characteristics of Study Participants**

The results reveal that community-acquired pneumonia is mostly common in middle-aged and elderly people with a high incidence noted among individuals between the ages of 51–70 years. The increased number of males among the study population implies that there is a higher predisposition for males due to various factors such as lifestyle as well as an increase in the number of underlying risk factors. The increased number of diabetic and hypertensive individuals in the study

Table 1 below shows the demographic and baseline clinical characteristics of the 150 patients in the study. The age categories indicated that the majority of the patients were from the age group of 51–70 years, which had 68 (45.3%) patients; followed by 31–50 years (42, 28.0%); ≥71 years (24, 16.0%) and 18–30 years (16, 10.7%). Male patients made up the majority of the total number of patients who formed the study group, being 92 (61.3%), while the females were 58 (38.7%). As far as the comorbidities are concerned, diabetes mellitus was the leading one having affected 52 (34.7%) patients; followed by hypertension (46, 30.7%), COPD (28, 18.7%) and chronic kidney

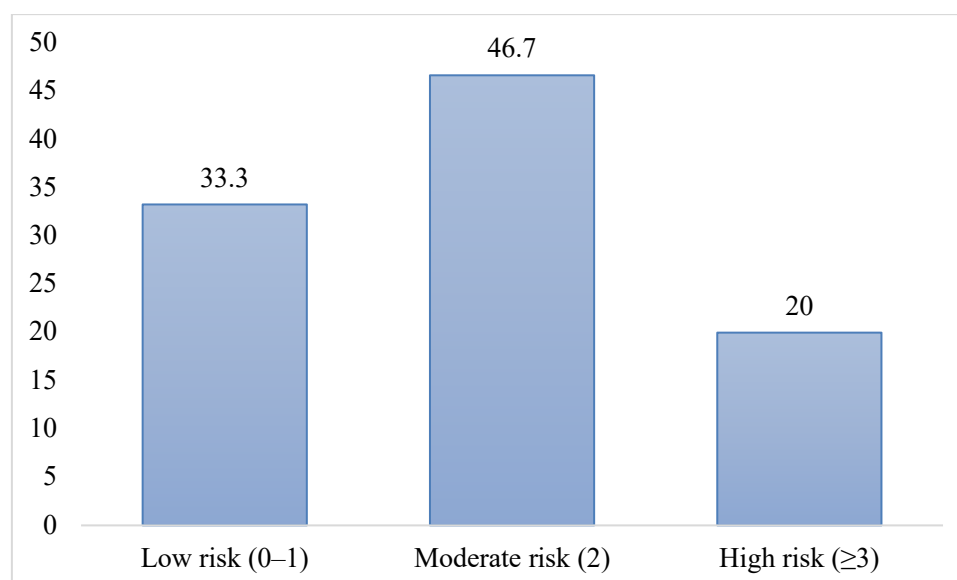
population reveals the significance of having chronic conditions as one of the factors responsible for the increase in risk and severity of community-acquired pneumonia.

The patient distribution based on the CURB-65 clinical scoring system is shown in Table 2. The majority of patients were in the moderate risk group (70, 46.7%) and followed by the low risk group (50, 33.3%). The high risk group had 30 patients

(20.0%), suggesting that about one-fifth of the sample population had severe CAP.

**Table 2: Clinical Severity Classification According to CURB-65 Score**

| CURB-65 Severity Category | Frequency (n) | Percentage (%) |
|---------------------------|---------------|----------------|
| Low risk (0–1)            | 50            | 33.3           |
| Moderate risk (2)         | 70            | 46.7           |
| High risk ( $\geq 3$ )    | 30            | 20.0           |



**Figure 2: Visual Representation of Clinical Severity Classification According to CURB-65 Score**

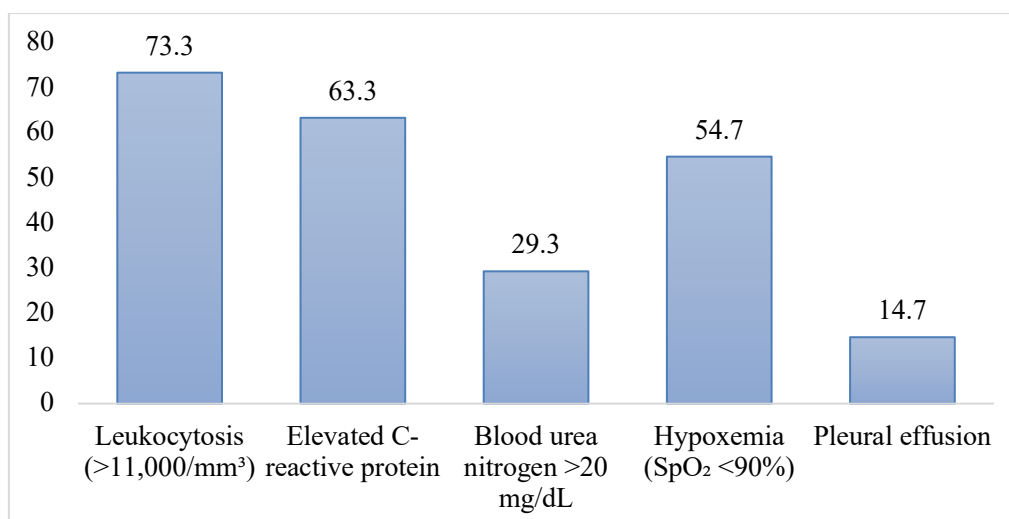
The results indicate that moderate clinical severity was the most prevalent form in patients with community-acquired pneumonia. While about one-third of patients had a mild condition, the prevalence of high clinical severity among 20.0% of the patients underlines the necessity for prompt diagnosis, regular monitoring, and effective treatment to avoid complications.

Table 3 illustrates the laboratory abnormalities and corresponding clinical symptoms found in the 150

patients suffering from community-acquired pneumonia. Leukocytosis was the most common laboratory abnormality and was noted in 110 patients (73.3%), followed by high levels of CRP in 95 patients (63.3%). Hypoxemia ( $\text{SpO}_2 < 90\%$ ) was diagnosed in 82 patients (54.7%), while BUN levels  $> 20 \text{ mg/dL}$  were found in 44 patients (29.3%). The least prevalent symptom was pleural effusion (14.7%).

**Table 3: Laboratory and Associated Clinical Findings**

| Investigation                            | Abnormal Findings (n) | Percentage (%) |
|------------------------------------------|-----------------------|----------------|
| Leukocytosis ( $> 11,000/\text{mm}^3$ )  | 110                   | 73.3           |
| Elevated C-reactive protein              | 95                    | 63.3           |
| Blood urea nitrogen $> 20 \text{ mg/dL}$ | 44                    | 29.3           |
| Hypoxemia ( $\text{SpO}_2 < 90\%$ )      | 82                    | 54.7           |
| Pleural effusion                         | 22                    | 14.7           |



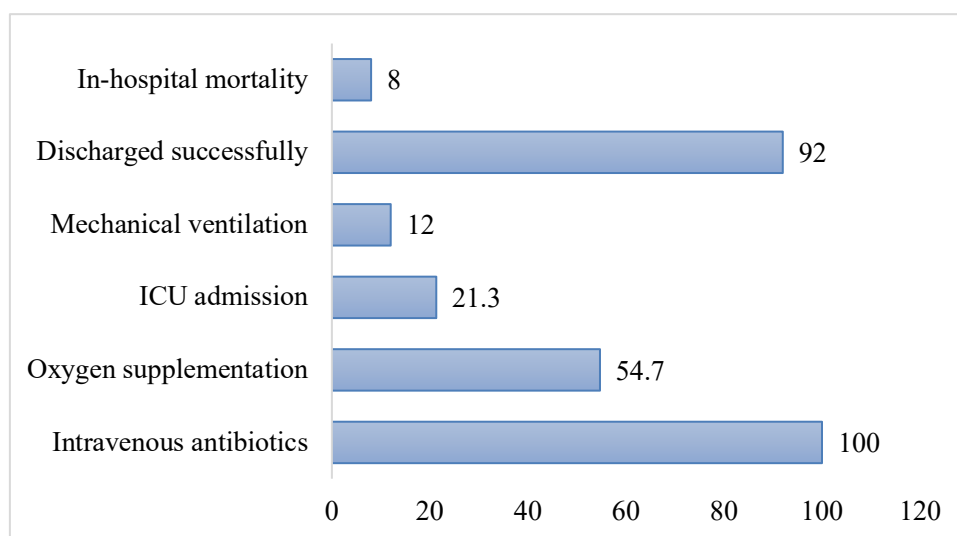
**Figure 3: Visual Representation of Laboratory and Associated Clinical Findings**

According to the results, the presence of systemic inflammation and respiratory dysfunction was prevalent in the patients with community-acquired pneumonia. Prevalence of leukocytosis and increased levels of CRP showed an ongoing inflammation caused by infection, and hypoxemia could be considered as an indicator of significant lungs' involvement in more than half of the patients. Though pleural effusion was detected less often in this group of patients, its presence indicates the severity of the illness and possible complications.

Table 4 shows the methods of treatment and patient outcomes in 150 patients with community-acquired pneumonia. All patients (150, 100%) received intravenous antibiotic therapy. The oxygen therapy was needed in 82 patients (54.7%), and 32 patients (21.3%) had to be admitted to the ICU. In 18 patients (12.0%) mechanical ventilation was indicated. 138 patients (92.0%) were discharged successfully, and 12 patients (8.0%) died during the hospitalization.

**Table 4: Treatment Modalities and Clinical Outcomes**

| Treatment/Outcome       | Frequency (n) | Percentage (%) |
|-------------------------|---------------|----------------|
| Intravenous antibiotics | 150           | 100            |
| Oxygen supplementation  | 82            | 54.7           |
| ICU admission           | 32            | 21.3           |
| Mechanical ventilation  | 18            | 12.0           |
| Discharged successfully | 138           | 92.0           |
| In-hospital mortality   | 12            | 8.0            |



**Figure 4: Visual Representation of Treatment Modalities and Clinical Outcomes**

Results show that the standard method used for treatment among all patients was IV antibiotic treatment, with more than half of them needing extra oxygenation because of respiratory impairment. One fifth of the patients needed ICU admission, while fewer needed mechanical ventilation, which indicates that there were severe cases among them. High discharge rate shows that the treatment had positive outcomes in most cases, whereas in-hospital deaths show that early diagnosis and treatment are crucial for patients with community-acquired pneumonia.

### Discussion

The current retrospective study analyzed the association between the chest X-ray and the severity of the disease among 150 cases of CAP (Pantzaris et al., 2018) [16]. The results revealed that the main age groups suffering from CAP were middle-aged and elderly patients, especially the group of ages 51-70 years, where males were predominant. Diabetes mellitus and hypertension were the most frequent comorbid diseases, thus highlighting the importance of these two diseases as risk factors for developing pneumonia (Keramat et al., 2018) [17]. The results of the research are in accordance with other previous researches that identified age, gender, and presence of diseases as risk factors for CAP.

CURB-65 clinical severity assessment showed that the majority of patients had moderate risk, while one-fifth of patients had severe CAP. Lab results showed a very high presence of leukocytosis, high levels of C-reactive protein, and hypoxemia in patients (Lu et al., 2019) [18]. The results show how the lab markers and clinical signs indicate an infection and breathing difficulties in the patient. These results confirm previous studies indicating that the higher inflammation and poor oxygenation lead to increased severity of the disease (Tarigan et al., 2019) [19].

Concerning treatment results, all patients were given intravenous antibiotics, with more than half of them needing oxygen therapy, whereas fewer of them needed to be admitted to the ICU for ventilator support. The majority of patients were able to be discharged, and the in-hospital mortality rate was 8.0% (Farah et al., 2018) [20]. In general, from the results, it is clear that the use of chest X-ray results and clinical severity assessment is useful in the diagnosis of CAP.

### Conclusion

The current retrospective study revealed a statistically significant association between chest X-ray results and disease severity among patients diagnosed with community-acquired pneumonia. The disease was characterized by its predilection for middle-age and elderly patients, especially men, and the presence of diabetes mellitus and hypertension

was the most common comorbidities. Most patients were assigned to the category of moderate disease severity based on the CURB-65 score, whereas laboratory signs of active infection and significant lung involvement, including leukocytosis, elevated C-reactive protein, and hypoxemia were rather frequent. Despite the administration of antibiotics through the intravenous route to all the patients, many of them needed oxygen therapy, ICU admission, and mechanical ventilation. The high rate of recovery and relatively low in-hospital mortality can be considered as evidence of the effectiveness of early diagnostics and adequate therapy. In general, it is possible to assume that chest X-ray is not only a useful method of diagnostics, but also an indicator of disease severity and its outcome.

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