

Article

Impact of Blood Glucose on Community Acquired Pneumonia - A Retrospective Observational Study

Article History:

Received: 12-10-2025

Revised: 05-11-2025

Accepted: 20-11-2025

Published: 30-12-2025

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How to cite this article:

C. Naveen Raj, R. Umarani, S.S. Moneshaa, K. Suresh, "Impact of Blood Glucose on Community Acquired Pneumonia - A Retrospective Observational Study" *European Journal of Clinical Pharmacy*, vol. 7, no. 1, 2025, pp. 4017-4022.

Abstract: *Background:* Community-acquired pneumonia (CAP) remains a leading cause of morbidity and mortality worldwide. Hyperglycemia is a frequent metabolic disturbance during infection and may adversely influence disease outcomes. This study aimed to evaluate the impact of admission blood glucose levels on the clinical outcomes of patients with CAP and to compare these outcomes between diabetic and non-diabetic individuals. *Methods:* A retrospective observational study was conducted in a tertiary care centre at Puducherry between January 2024 and January 2025. Forty adult patients with confirmed CAP and documented blood glucose levels within 24 hours of admission were included. Patients were categorized as normoglycemic (≤ 140 mg/dL), moderately hyperglycemic (141–250 mg/dL), and severely hyperglycemic (> 250 mg/dL). Clinical parameters, comorbidities, and outcomes such as intensive care unit (ICU) admission, need for mechanical ventilation, duration of hospital stay, and in-hospital mortality were analysed using appropriate statistical tests. *Results:* Of the forty patients analysed, twenty-three were diabetic and seventeen were non-diabetic. Hyperglycemia was observed in twenty-five patients, including several without pre-existing diabetes. Patients with elevated admission glucose levels showed significantly higher rates of ICU admission, mechanical ventilation, and mortality compared to normoglycemic patients ($p < 0.05$). The mean duration of hospital stay was also longer in the hyperglycemic group. Diabetic patients had worse outcomes overall; however, non-diabetic patients with stress-induced hyperglycemia exhibited similarly poor prognoses. *Conclusion:* Elevated admission blood glucose levels are strongly associated with increased disease severity, prolonged hospitalization, and higher mortality in patients with community-acquired pneumonia. Hyperglycemia, whether pre-existing or stress-induced, serves as an independent prognostic indicator of adverse outcomes. Routine glucose monitoring and appropriate glycemic control should be integral components of CAP management to improve patient prognosis.

Keywords: Community-acquired pneumonia, hyperglycemia, diabetes mellitus, blood glucose, clinical outcomes, mortality

INTRODUCTION

Globally, community-acquired pneumonia (CAP) continues to be a leading cause of morbidity and mortality, especially in adults and the elderly. Because of its high prevalence, frequent hospitalizations, and high case-fatality rates, CAP continues to be a major public health burden despite advancements in diagnostic and treatment techniques. The intensity and results of CAP are influenced by a number of host variables, such as age, comorbidities, and metabolic disorders. Among these, abnormalities in blood glucose control, including both hyperglycemia and hypoglycemia, have been identified as possible predictors of illness outcomes.

Patients with pneumonia frequently have hyperglycemia, a common metabolic reaction during acute illness, even if they have never been diagnosed with diabetes mellitus. This stress-induced hyperglycemia results from an increased release of stress hormones such as cortisol and catecholamines, leading to enhanced gluconeogenesis and insulin resistance. Increased blood glucose levels may affect infection outcomes by impairing immunological responses, increasing oxidative stress, and changing inflammatory pathways (Lepper et al., 2012) [1]. The relationship between admission glucose levels and CAP outcomes has been examined in a number of studies. Higher short-term and long-term mortality, an

increased chance of intensive care unit (ICU) admission, and longer hospital stays have all been associated with elevated blood glucose at hospital admission. For example, acute hyperglycemia was revealed to be a significant predictor of 28- and 90-day mortality in non-diabetic patients with CAP in a large multicenter cohort study (Lepper et al., 2012) [1]. Similarly, elevated entry glucose levels (6–13.9 mmol/L) were linked to higher ICU hospitalizations and 30-day mortality, particularly among non-diabetic patients, according to a retrospective investigation of more than 3,000 patients (Cheng et al., 2020) [2]. A systematic review and meta-analysis involving more than 34,000 pneumonia patients confirmed that elevated admission glucose levels significantly increased the odds of both short-term and long-term mortality and ICU admissions (Yuan & Chen, 2024) [3].

Interestingly, the impact of hyperglycemia appears to differ between diabetic and non-diabetic individuals. Several studies have shown that while stress-induced hyperglycemia is associated with worse outcomes in non-diabetic patients, its predictive value is less pronounced among those with pre-existing diabetes (Jensen et al., 2017) [4]. Additionally, compared to individuals without diabetes, diabetic patients with CAP frequently have longer hospital admissions, require more mechanical ventilation, and have higher severity scores (Hashemi et al., 2023) [5]. These results imply that pneumonia outcomes are significantly influenced by dysglycemia, regardless of diabetes status.

Further research is necessary to clarify the connection between blood glucose levels and clinical outcomes in patients with CAP, given the conflicting results across populations and the scant data from the Indian subcontinent. Comprehending this correlation may aid in the early detection of high-risk individuals, direct glycemic control tactics during hospital stays, and possibly enhance patient outcomes.

Thus, the current study is to assess how administered blood glucose levels affect the clinical outcomes of patients with community-acquired pneumonia. In order to further characterize the predictive relevance of blood glucose in the therapy of CAP, it also compares mortality and morbidity between patients with and without diabetes.

METHODOLOGY

Study Design and Setting

This study was designed as a hospital-based retrospective observational study conducted in a Tertiary Care Centre at Ariyur, Puducherry. The study's objective was to assess how admission blood glucose levels affected patients with community-acquired pneumonia's clinical outcomes. The study received ethical approval from Institutional Ethics Committee. A waiver of informed consent was approved because the study only reviewed pre-existing hospital records and did not involve any direct patient involvement. To

maintain confidentiality, all data were handled in compliance with institutional and ethical requirements.

Study Period

The study was carried out using hospital records of patients admitted between January 1, 2024, and January 1, 2025. Data extraction and analysis were performed between February and April 2025.

Study Population

The study included adult patients aged 18 years and above who were admitted to the hospital with a confirmed diagnosis of community-acquired pneumonia. The diagnosis of pneumonia was based on clinical symptoms such as fever, cough, sputum production, and dyspnea, along with radiological evidence of new pulmonary infiltrates on chest X-ray or computed tomography scan. Both diabetic and non-diabetic patients were included in order to assess the influence of glycemic status on disease outcomes.

Inclusion Criteria

All patients with a confirmed diagnosis of community-acquired pneumonia who were at least eighteen years old, regardless of gender, were eligible to participate. The investigation only included patients whose complete medical records were accessible and whose blood glucose levels were assessed within the first 24 hours of admission.

Exclusion Criteria

Patients diagnosed with hospital-acquired or ventilator-associated pneumonia, defined as pneumonia developing 48 hours or more after hospital admission or following mechanical ventilation, were excluded. Patients with immunocompromised conditions such as HIV/AIDS, malignancy receiving chemotherapy or radiotherapy, or those on long-term corticosteroid therapy were also excluded. Individuals with chronic respiratory diseases such as chronic obstructive pulmonary disease or interstitial lung disease were not included if pneumonia was secondary to an exacerbation of the underlying disease. Records with missing glucose values or incomplete data were excluded from the study.

Sample Size and Sampling Method

A total of forty patients were included in the study based on the availability of complete hospital records that satisfied the inclusion and exclusion criteria during the study period. A purposive sampling technique was used to select eligible patient files from the Medical Records Department.

Data Collection

Data were collected retrospectively from the Medical Records Department using a structured data collection form. The data included demographic variables such as age and sex, clinical information including comorbidities such as diabetes mellitus, hypertension, and cardiovascular disease, as well as laboratory parameters such as blood glucose at admission,

complete blood count, and renal and liver function tests. Radiological findings confirming pneumonia were recorded from patient case sheets. The length of hospital stay, the necessity for mechanical breathing, the need for intensive care unit admission, and in-hospital mortality were among the outcome factors evaluated. Blood glucose levels were classified as normoglycemia if they were less than 140 mg/dL, moderate hyperglycemia if they were between 141 and 250 mg/dL, and severe hyperglycemia if they were more than 250 mg/dL. To evaluate subgroup outcomes, patients were further divided into groups based on whether they had diabetes or not.

Outcome Measures

The primary objective of the study was to determine the relationship between admission blood glucose levels and clinical outcomes in patients with community-acquired pneumonia. The secondary objectives were to compare mortality, intensive care unit admission, need for mechanical ventilation, and duration of hospital stay between diabetic and non-diabetic patients and among different blood glucose categories.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean and standard deviation, and categorical variables were presented as frequency and percentage. The chi-square test or Fisher's exact test was used to analyze the association between categorical variables such as blood glucose levels and clinical outcomes. The independent t-test or Mann-Whitney U test was applied to compare continuous variables. Multivariate logistic regression analysis was performed to identify independent predictors of adverse outcomes such as mortality or intensive care unit admission after adjusting for potential confounding factors including age, comorbidities, and diabetic status. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee (Ref no: 198/SVMCH/IEC-Cert/Oct.25).

RESULTS

Baseline Characteristics

The final analysis included forty patients who satisfied the inclusion and exclusion criteria. Male and female patients between the ages of 18 and 85 made up the study population; their mean age was 56.4 ± 15.2 years. The percentage of men in the study group was marginally higher than that of women. Twenty-three of the individuals in the study were known to have diabetes, while seventeen were not. The most prevalent comorbidity was hypertension, which was followed by chronic renal disease and ischemic heart disease. High-grade fever, active cough, and dyspnea were the most common symptoms in most individuals. Every case's radiological results revealed fresh pulmonary infiltrates that were consistent with pneumonia, primarily affecting one lung lobe (Table 1).

Table 1: Baseline characteristics of patients with community-acquired pneumonia (n = 40)

Variable	Total (n = 40)	Diabetic (n = 23)	Non-diabetic (n = 17)	p-value
Age (years), mean $\pm$ SD	56.4 $\pm$ 15.2	60.2 $\pm$ 12.8	51.1 $\pm$ 14.9	0.04*
Male sex, n (%)	24 (60%)	15 (65.2%)	9 (52.9%)	0.42
Hypertension, n (%)	18 (45%)	13 (56.5%)	5 (29.4%)	0.09
Ischemic heart disease, n (%)	6 (15%)	5 (21.7%)	1 (5.9%)	0.16
Chronic kidney disease, n (%)	4 (10%)	3 (13.0%)	1 (5.9%)	0.44
Smoking history, n (%)	10 (25%)	5 (21.7%)	5 (29.4%)	0.56

Duration of symptoms (days), mean $\pm$ SD	4.2 $\pm$ 1.8	4.5 $\pm$ 2.1	3.9 $\pm$ 1.5	0.29
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Values are presented as mean $\pm$ SD or number (%). $p < 0.05$ considered statistically significant.

Admission Blood Glucose Distribution

The admission blood glucose values of the patients ranged from 86 mg/dL to 428 mg/dL. Based on the defined categories, 15 patients had normoglycemia with glucose levels up to 140 mg/dL, 16 patients had moderate hyperglycemia with values between 141 and 250 mg/dL, and 9 patients had severe hyperglycemia exceeding 250 mg/dL. Among the non-diabetic patients, a significant number exhibited transient stress-induced hyperglycemia at the time of admission. Diabetic patients, as expected, showed a higher mean glucose value compared to non-diabetic patients.

Clinical Course and Outcomes

Twelve of the forty patients had a complex clinical course that required close observation or sophisticated respiratory assistance, while twenty-eight recovered without any significant difficulties. During their hospital stays, ten patients needed to be admitted to an intensive care unit, and six of them needed mechanical ventilation. The average duration of hospital stay for the total study group was 8.2 ± 3.6 days. The duration of hospitalization was shorter in patients with normoglycemia compared to those with moderate or severe hyperglycemia. Compared to the non-diabetic group, the diabetes group experienced longer hospital stays and more problems (Table 2).

Table 2: Distribution of patients by admission blood glucose category and clinical outcomes

Blood glucose category	No. of patients (%)	ICU admission, n (%)	Mechanical ventilation, n (%)	Mean hospital stay (days) $\pm$ SD	Mortality, n (%)
≤ 140 mg/dL (Normoglycemia)	15 (37.5%)	1 (6.7%)	0 (0%)	6.3 $\pm$ 2.1	0 (0%)
141–250 mg/dL (Moderate hyperglycemia)	16 (40.0%)	4 (25%)	2 (12.5%)	8.7 $\pm$ 3.0	2 (12.5%)
> 250 mg/dL (Severe hyperglycemia)	9 (22.5%)	5 (55.6%)	4 (44.4%)	11.4 $\pm$ 3.8	4 (44.4%)
Total	40 (100%)	10 (25%)	6 (15%)	8.2 $\pm$ 3.6	6 (15%)

Chi-square test showed significant association between blood glucose category and ICU admission, mechanical ventilation, and mortality ($p < 0.05$).

Relationship between Blood Glucose and Clinical Outcomes

Higher blood glucose levels at admission were clearly associated with adverse clinical outcomes. Compared to patients with normal glucose levels, individuals with severe hyperglycemia were more likely to be admitted to an intensive care unit and require mechanical breathing. Patients with glucose levels greater than 250 mg/dL had an increased mortality rate, especially if they already had diabetes. Four of the six deaths that were recorded throughout the research period involved individuals with diabetes, while the other two involved non-diabetic patients who had hyperglycemia brought on by stress. On the other hand, none of the patients who had normoglycemia died from the disease. There was a statistically significant correlation between high blood glucose levels and unfavorable outcomes like death, admission to the intensive care unit, and extended hospital stays.

Comparison between Diabetic and Non-Diabetic Groups

People with diabetes showed a greater frequency of severe disease, complications, and unfavourable outcomes as compared to people without the disease. Patients with diabetes had lengthier average hospital stays than those without the disease. The diabetes group also had a higher need for intensive care unit admission and mechanical ventilation. However, a small

subset of non-diabetic individuals with stress hyperglycemia at admission also had a significant risk of severe pneumonia and delayed recovery, indicating that hyperglycemia alone may have a negative impact on the severity of the disease regardless of diabetes (Table 3).

Table 3: Comparison of outcomes between diabetic and non-diabetic patients

Outcome parameter	Diabetic (n = 23)	Non-diabetic (n = 17)	p-value
ICU admission, n (%)	7 (30.4%)	3 (17.6%)	0.32
Mechanical ventilation, n (%)	5 (21.7%)	1 (5.9%)	0.18
Mean hospital stay (days) $\pm$ SD	9.1 $\pm$ 3.4	7.0 $\pm$ 3.1	0.03*
Mortality, n (%)	4 (17.4%)	2 (11.8%)	0.62

Independent t-test and Chi-square test applied as appropriate. $p < 0.05$ considered statistically significant.

DISCUSSION

The findings of this study demonstrated that elevated admission blood glucose levels were significantly associated with poor clinical outcomes in patients hospitalized with community-acquired pneumonia. Patients who presented with hyperglycemia had higher rates of intensive care unit admission, mechanical ventilation, longer duration of hospital stay, and greater mortality when compared to patients with normal glucose levels. This correlation was seen in both those with and without diabetes, indicating that hyperglycemia is a significant predictor of community-acquired pneumonia rather than just having diabetes.

The current study's findings are in line with a number of other studies that have been published. Even after controlling for comorbidities and disease severity, hyperglycemia at the time of hospital admission was independently linked to an increased risk of intensive care unit admission and 30-day mortality, according to Cheng et al.'s (2020) extensive multicenter retrospective study in China involving over 3300 patients [2]. Similarly, Jensen et al. (2017) found that elevated blood glucose was a strong predictor of severe outcomes in a Danish cohort study of 1318 patients, especially among non-diabetic patients [4]. This suggests that stress-induced hyperglycemia reflects the systemic inflammatory response and correlates with the severity of the disease. Further highlighting the detrimental role of uncontrolled blood glucose in pneumonia outcomes, Ali et al. (2019) showed that diabetic patients with community-acquired pneumonia in Egypt had considerably longer hospital stays, a greater need for oxygen supplementation, and higher mortality rates than non-diabetic patients [6].

A study from Turkey by Hashemi et al. (2023) compared clinical, laboratory, and outcome parameters between diabetic and non-diabetic patients with

community-acquired pneumonia and reported that the diabetic group experienced longer hospitalization, higher pneumonia severity scores, and more frequent intensive care admissions [5]. The present study observed a similar pattern in which diabetic patients had poorer outcomes, though even non-diabetic patients with stress hyperglycemia showed increased morbidity and mortality. In contrast, Bhattacharya et al. (2013) did not find a significant association between admission glucose and short-term outcomes in older adults with pneumonia, suggesting that age and comorbidities may modify the prognostic impact of hyperglycemia [7]. Such variations among studies may be attributed to differences in patient demographics, definitions of hyperglycemia, and glycemic control thresholds used across populations.

Evidence from meta-analyses has reinforced that acute hyperglycemia at hospital admission is a more reliable predictor of poor outcomes than the mere presence of diabetes. In-hospital hyperglycemia, but not diabetes per se, was linked to significantly increased mortality and critical care unit admissions among persons treated with community-acquired pneumonia, according to a 2022 systematic review and meta-analysis by Barmanray et al. [8]. Similarly, acute dysglycemia in non-diabetic patients was a strong predictor of 28-day and 90-day mortality in a prospective multicenter cohort study conducted in Germany, Switzerland, and Austria. This suggests that hyperglycemia may identify patients at higher risk of death even in the absence of pre-existing diabetes [1].

The pathophysiological mechanisms linking hyperglycemia and poor outcomes in pneumonia are multifactorial. Hyperglycemia impairs the innate immune system by inhibiting neutrophil chemotaxis, phagocytosis, and intracellular bacterial killing, thereby increasing susceptibility to infection and delaying recovery. It also promotes an exaggerated inflammatory

response, endothelial dysfunction, and oxidative stress, all of which contribute to alveolar damage and impaired gas exchange. Schuetz et al. (2014) demonstrated that hyperglycemia in patients with community-acquired pneumonia was associated with higher levels of inflammatory markers such as C-reactive protein, procalcitonin, and pro-adrenomedullin, confirming that dysregulated glucose metabolism amplifies systemic inflammation and contributes to disease severity [9]. Chronic hyperglycemia, as seen in diabetes, further aggravates endothelial injury and impairs pulmonary defense mechanisms, while stress-induced hyperglycemia in non-diabetic individuals reflects a maladaptive metabolic response to acute illness. According to prior clinical research, patient outcomes in acute infections may be enhanced by maintaining glucose control by insulin therapy or structured glycemic management methods. However, especially in critically ill patients, the danger of hypoglycemia must be weighed against aggressive glycemic control.

This study has some limitations that must be acknowledged. The retrospective nature and relatively small sample size may limit the ability to establish causal relationships or generalize the findings. The study also did not include dynamic glucose monitoring or long-term outcomes such as 30-day or 90-day mortality. Despite these limitations, the findings align well with global data emphasizing the adverse prognostic impact of hyperglycemia in pneumonia.

CONCLUSION

This study concluded that higher admission blood glucose levels were substantially linked to worse clinical outcomes in patients with community-acquired pneumonia, such as increased mortality, longer hospital stays, higher rates of intensive care unit admission, and the need for mechanical ventilation. These results were in line with several international research that cumulatively show that hyperglycemia is an independent predictor of illness severity and a poor prognosis, regardless of whether it is pre-existing owing to diabetes or stress-induced in non-diabetic individuals. The findings underscore the necessity of early detection and effective glycemic management as a crucial component of clinical care to enhance outcomes and minimize complications, as well as the significance of routine glucose monitoring in all patients admitted with pneumonia.

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