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HBA1C & COMMUNITY-ACQUIRED PNEUMONIA: IMPACT ON SEVERITY, INFLAMMATION, HOSPITAL STAY & COMPLICATIONS

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ABSTRACT

Background: Community-acquired pneumonia (CAP) is a serious cause of hospitalisation and death, and is affected by the presence of underlying metabolic disorders. HbA1C is a reflection of glycemic control and could be used as a severity and prognosis marker in CAP patients.

Objective: To evaluate the association of HbA1c levels with pneumonia severity, inflammatory response, duration of hospital stay, and complications among patients with community-acquired pneumonia.

Methods: The study was conducted as a prospective observational study in a hospital setting over six months, involving 126 patients with CAP. Demographic data, clinical characteristics, HbA1c, inflammatory markers, radiological findings, duration of hospital stay, and complications were documented. Data was analyzed by SPSS 26. Any continuous variables were compared by suitable statistical tests, and associations between HbA1c and clinical outcome were tested using chi-square and correlation tests. P-values < 0.05 were regarded as being statistically significant.

Results: Among 126 patients, 54 (42.9%) had HbA1c levels ≥6.5%. Patients with elevated HbA1c showed significantly higher pneumonia severity, increased CRP levels (112.6 ± 45.8 vs. 68.5 ± 32.4 mg/L, $p<0.001$), higher WBC counts, and longer hospital stays (9.4 ± 3.5 vs. 6.2 ± 2.1 days, $p<0.001$).

Conclusion: There was an increased inflammatory burden with higher HbA1c levels, which were also associated with more severe CAP, longer hospital stay, and higher risk of complications. HbA1c could prove to be a quick, easy screening tool to identify patients at risk for pneumonia in the early stages.

KEYWORDS: HbA1C, community-acquired pneumonia, glycemic control, inflammation

INTRODUCTION

Community-acquired pneumonia (CAP) is still among the most prevalent diseases that necessitate hospitalization and continues to be a significant public health problem in the world.[1] An acute infection of the lung parenchyma that develops outside of the hospital setting is defined as an acute community-acquired pneumonia and is typically caused by Streptococcus pneumoniae, atypical organisms, and Haemophilus influenzae.[2] Vaccination programs, antimicrobial therapy, and supportive care have improved, but CAP continues to be a cause of considerable infectious disease-related mortality in the world.[3] Lower respiratory tract infections (LRTIs) are estimated to kill millions of individuals every year, and pneumonia is the leading cause of death among the elderly and those with underlying metabolic or immune-related disease.[4] It is possible to have a mild CAP that can be treated on an outpatient basis, but it can also be a severe CAP, requiring the use of an intensive care unit, mechanical ventilation, and sophisticated organ support.[5]

Important factors that have been documented to affect vulnerability to respiratory infection and clinical outcomes are diabetes mellitus and impaired glucose regulation.[6] Hyperglycemia affects innate and adaptive immunity in several ways: by decreasing neutrophil chemotaxis, phagocytosis, cytokine production, endothelial dysfunction, and oxidative stress.[7] The glycated hemoglobin (HbA1c) is a widely used marker that represents the mean blood glucose level for the past 2–3 months and is a measure of chronic glycemia, not fluctuations in blood glucose.[8] In addition to its use

for the diagnosis of diabetes, the level of HbA1c has now been considered as a potential prognosticator in acute diseases, including infections like CAP.[9]

Diabetes has significantly risen to become a global epidemic, placing ever-increasing numbers of people at risk from diabetes-related infections.[10] Diabetic patients are more likely to suffer from respiratory infections than their non-diabetic counterparts, and pneumonia is among the most common infections reported among diabetic patients.[9] High HbA1c levels have been linked to worse disease severity, higher inflammatory burden, longer hospital stays and higher risk of adverse outcomes in pneumonia patients in previous studies.[9, 11].

Clinically, the link between chronic glycemic status and outcomes of CAP is important because HbA1c is a readily accessible, inexpensive, and standard laboratory measurement. Early risk stratification of patients with elevated HbA1c, closer monitoring, optimized management strategies and improved allocation of healthcare resources may be possible for patients at high risk of severe disease. Although it is known that HbA1c levels are linked to the outcome of infection, little is known about the independent contribution of HbA1c to disease progression and recovery from CAP, particularly in the developing world, where pneumonia is a large contributor to hospital admissions.

Thus, this study was designed to investigate the relationship between the severity of community-acquired pneumonia, inflammatory markers, hospital stay, and complications with HbA1c. The study aims to generate evidence on whether HbA1c as a measure of chronic glycemic status is a useful predictor of clinical outcome and could help better manage patients presenting with CAP.

MATERIALS AND METHODS

A prospective observational study in a hospital setting was performed in patients with community-acquired pneumonia (CAP). The study was conducted in Medical/Pulmonology Department of HMC Hospital. The study duration was six months, from Jan 2025 to December 2025. Patients with clinical and radiological findings of community-acquired pneumonia were recruited and followed during their hospital stay to assess the relationship between severity of pneumonia, inflammatory response, hospital stay duration, and complications with HbA1c concentrations.

The OpenEpi online Sample Size Calculator was used to determine the sample size. This calculation an expected prevalence of 30% of all pneumonia inpatients would have poor glycemic control, an 8% margin of error, and a 95% confidence interval, the minimum sample size was calculated to be 126 participants.[12] Patients were recruited with non-probability consecutive sampling until the desired sample size was reached.

Patients diagnosed with community-acquired pneumonia who fulfilled the inclusion criteria were included in the study. A structured data collection proforma was used to obtain data on the demographic, clinical presentation, comorbid conditions, HbA1c levels, inflammatory markers, radiological features, severity indicators, duration of hospital stay, and complications.

A non-probability consecutive sampling technique was used for selecting patients. All patients who came to the hospital with clinical and radiological findings of CAP during the study period were assessed for inclusion. Consenting and meeting the a priori defined eligibility criteria were sequentially enrolled until the desired sample size was met. This was done to ensure systematic recruitment of available CAP patients and to minimize study population selection bias.

The study included patients diagnosed with CAP, based on clinical symptoms, physical examination, and radiological findings of lung infection. All adult patients, ≥18 years of age, both males and females, were recruited. Patients who needed hospitalization because of the severity of pneumonia were included, and those who were willing to participate in the study. Eligible for analysis were participants who had HbA1c measurements available and full clinical and laboratory information.

Informed consent was obtained, and data were gathered from patients with a community-acquired pneumonia (CAP) diagnosis. Demographic variables such as age, gender, BMI, smoking status, and pertinent clinical history were collected on a structured data recording proforma. Details of underlying conditions like diabetes mellitus, hypertension, chronic kidney disease, and cardiovascular disease were recorded.

Fever, respiratory rate, oxygen saturation, blood pressure, and respiratory symptoms were noted at admission. Severity of pneumonia was determined based on the conventional clinical criteria and the pneumonia severity scoring systems. Hospital records were used to obtain laboratory investigations such as complete blood count, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), renal function tests, and blood glucose levels. Long-term glycemic status was evaluated by HbA1c, which was measured by laboratory methods standardized by the laboratory.

Radiological characteristics, obtained by chest X-ray or computed tomography (CT) scan, were noted for the diagnosis of pneumonia and to assess the extent of lung involvement. Patients were followed up during their hospital stay, and clinical outcomes such as hospital stay, intensive care unit (ICU) admission, mechanical ventilation, septic complications, and other pneumonia-related complications were recorded. All gathered data was entered in a secure database to be statistically evaluated.

The data collected were analyzed with SPSS version 26.0. All continuous variables were expressed as mean ± SD (standard deviation) or median (IQR) based on the distribution of the data. Categorical data, such as gender, presence

of diabetes, severity categories, and complications, were expressed by frequencies and percentages. Appropriate statistical tests were used to determine the correlation of HbA1c with the severity of pneumonia, inflammatory response, hospital stay, and complications. Independent sample t-test or Mann–Whitney U test was used for comparison of continuous variables between two groups, and chi-square test or Fisher's exact test was used for categorical variables. The relationship between HbA1c level and inflammatory markers or length of hospitalization was assessed using correlation analysis. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 126 patients with community-acquired pneumonia were included in the study. This study population was largely male, and over half of the participants were 60 years or older. The most prevalent comorbidity identified was hypertension, followed by diabetes mellitus, with chronic kidney disease and cardiovascular disease being less prevalent. Multiple risk factors were present in the study population, as about one-third of the participants had a history of smoking (Table 1).

Long-term glycemic status was assessed, and it was found that many patients had abnormal HbA1c levels, the largest being in the diabetic range. HbA1c levels in the overall mean level showed that the glycemic control was relatively poor in hospitalized CAP patients, reflecting the high prevalence of metabolic dysfunction among the CAP patients (Table 2).

There was a significant correlation between HbA1c status and the severity of pneumonia. HbA1c level was more likely to be elevated among patients with moderate to severe pneumonia than among patients with lower HbA1c levels, who were more likely to have mild pneumonia. The results indicate that there was a relationship between poor long-term glycemic control and a more severe clinical presentation of CAP (Table 3).

Patients with elevated HbA1C had significantly increased inflammatory markers. Poor glycemic control was associated with increased inflammatory burden, indicative of increased systemic immune activation and potentially more aggressive disease process. The results are congruent with the hypothesis that chronic hyperglycemia could enhance the inflammatory response to acute respiratory infections (Table 4).

Patients with higher HbA1c levels had significantly poorer clinical outcomes. The high-HbA1c group had a higher rate of intensive care unit admission, mechanical ventilation, sepsis, and pneumonia complications. While there was a higher number of deaths among those with higher HbA1c levels, this difference was not statistically significant. In general, poor glycemic control was correlated with a more complicated course of the disease (Table 5).

Patients with higher HbA1c were significantly more likely to be hospitalized for longer, suggesting a longer recovery period and further health care use. This discovery further corroborates the detrimental effect of sub-optimal long-term glycemic control on disease progression and treatment outcomes in CAP patients (Table 6).

The correlation analysis revealed significant positive correlations between the level of HbA1c and the important measures of disease burden, such as inflammatory markers, severity of pneumonia, and hospital stay. The results of this analysis indicate that a higher HbA1c was consistently linked to poorer clinical and laboratory outcomes and further support the prognostic value of HbA1c in patients with community-acquired pneumonia (CAP) (Table 7).

Table 1. Demographic and Clinical Characteristics of Study Participants (n=126)

Variables	Frequency (n)	Percentage (%)
Age (years)		
Mean age ± SD	58.4 ± 14.2	
Age ≥60 years	68	54.0
Age <60 years	58	46.0
Gender		
Male	76	60.3
Female	50	39.7
Comorbidities		
Diabetes mellitus	54	42.9
Hypertension	61	48.4
Chronic kidney disease	12	9.5
Cardiovascular disease	18	14.3
Smoking history	39	31.0

Table 2. Distribution of HbA1c Levels Among Patients with Community-Acquired Pneumonia

HbA1c Category	Frequency (n)	Percentage (%)
<5.7% (Normal)	32	25.4
5.7–6.4% (Prediabetes range)	40	31.7

≥6.5% (Diabetes range)	54	42.9
Mean HbA1c (%)	6.8 ± 1.4	

Table 3. Association Between HbA1c Levels and Pneumonia Severity

Pneumonia Severity	HbA1c <6.5% (n=72)	HbA1c ≥6.5% (n=54)	p-value
Mild pneumonia	38 (52.8%)	12 (22.2%)	
Moderate pneumonia	26 (36.1%)	25 (46.3%)	
Severe pneumonia	8 (11.1%)	17 (31.5%)	
Total	72	54	0.002

Table 4. Comparison of Inflammatory Markers According to HbA1c Status

Laboratory Parameter	HbA1c <6.5% (n=72) Mean ± SD	HbA1c ≥6.5% (n=54) Mean ± SD	p-value
CRP (mg/L)	68.5 ± 32.4	112.6 ± 45.8	<0.001
WBC count (×10⁹/L)	11.2 ± 3.1	13.8 ± 4.2	0.001
ESR (mm/hr)	42.6 ± 18.5	61.4 ± 25.3	<0.001
Random blood glucose (mg/dL)	142.5 ± 35.7	218.4 ± 56.2	<0.001

Table 5. Association Between HbA1c Level and Clinical Outcomes

Clinical Outcome	HbA1c <6.5% (n=72)	HbA1c ≥6.5% (n=54)	p-value
ICU admission	7 (9.7%)	15 (27.8%)	0.009
Mechanical ventilation	3 (4.2%)	10 (18.5%)	0.012
Sepsis development	8 (11.1%)	16 (29.6%)	0.015
Pneumonia-related complications	12 (16.7%)	22 (40.7%)	0.003
Mortality	3 (4.2%)	7 (13.0%)	0.08

Table 6. Relationship Between HbA1c Level and Duration of Hospital Stay

HbA1c Category	Mean Hospital Stay (days) ± SD	p-value
HbA1c <6.5%	6.2 ± 2.1	
HbA1c ≥6.5%	9.4 ± 3.5	<0.001

Table 7. Correlation of HbA1c with Severity and Inflammatory Parameters

Variable	Correlation coefficient (r)	p-value
HbA1c vs CRP	0.48	<0.001
HbA1c vs WBC count	0.35	<0.001
HbA1c vs Hospital stay duration	0.42	<0.001
HbA1c vs pneumonia severity score	0.46	<0.001

DISCUSSION

The present study findings indicate that higher levels of HbA1c were significantly linked with the severity of CAP, increased inflammatory markers, longer hospital stays, and increased rates of complications. The proportion of patients with severe pneumonia, intensive care admission, mechanical ventilation, and septic complications was higher in patients with HbA1c ≥6.5% than in those with HbA1c <6.5%. Additionally, HbA1c was correlated with positive values of CRP, white blood cell count, ESR, pneumonia severity score, and duration of hospitalization, indicating that poor long-term glycemic control may be associated with an over-strong inflammatory response and poor clinical outcomes.

This was consistent with the findings of Huang et al. (2021), who assessed the clinical features and the mortality risk of diabetic people with diabetes with severe community-acquired pneumonia (CAP).[13] The authors stressed that impaired glucose regulation can negatively affect immunity and make people more susceptible to having a serious experience with pneumonia.[13] In line with this, Feldman et al. (2025) showed that the presence of comorbidities, especially metabolic disorders, was linked with the short- and long-term outcome of the CAP, further supporting the importance of metabolic status in the progression of CAP.[14]

Our finding of elevated HbA1c with higher inflammatory activity was similar to the study by Dungu et al. (2023), which studied diabetes status and increased insulin resistance with CRP in CAP patients. They found that metabolic abnormalities affected inflammatory responses during pneumonia, suggesting that these abnormalities may lead to a

greater inflammatory state systemically.[15] Hyperglycemia can further activate inflammatory pathways by promoting oxidative stress, endothelial dysfunction, and cytokine activation, increasing tissue injury in the lungs, and slowing recovery.

These findings were also confirmed by Olsen et al. (2022), who measured glycemic variability in hospitalized CAP patients and noted the association between glycemic variability and clinical outcomes, such as increased hospital stays.[16] These results indicate that chronic dysglycemia (as determined by HbA1c) may offer further predictive value beyond its use in measuring acute dysglycemia.

This current work also showed increased admission to the ICU and respiratory complications in individuals with higher HbA1c levels. Cincilevičiūtė et al. (2021) found that host defense and general physiological reserve were some of the risk factors associated with complicated courses of CAP.[17] Moreover, Zhao et al. (2025) identified clinical markers like respiratory rate and other physiological markers as predictors of the prognosis of CAP, highlighting the importance of early recognition of high-risk patients to help guide management decisions.[18]

The predictive value of adverse outcomes for HbA1c has also been noted in other severe pneumonia states. A more severe COVID-19 pneumonia was linked to higher HbA1c levels and increased mortality, indicating a potential link between chronic hyperglycemia and poorer host response and physiological adaptation in cases of acute respiratory infections.[19] These findings corroborate the general notion of a connection between glycemic status and outcomes of infection, but COVID-19 pneumonia is not necessarily bacterial CAP.

The capacity of HbA1C to predict outcomes in CAP has been further explored recently. A large retrospective study evaluating the HGI in severe CAP patients showed a correlation between abnormal glycation patterns and the risk of death, thus further supporting the importance of HbA1c-related measures in assisting in the identification of those at risk for closer monitoring.[20] Furthermore, research exploring host-response and inflammatory biomarkers in CAP has shown that over-activation of inflammatory pathways is closely associated with severity and prognosis, including S100A9 and other inflammatory markers.

Acute stress hyperglycemia, treatment-related glycemic changes, and preexisting conditions have been proposed to affect the association between glycemic markers and pneumonia outcomes; however, some studies have suggested this. In conclusion, the level of HbA1c should not be used alone to predict, but should be included in a broader picture of clinical assessment that also includes severity scores, inflammatory markers, and patient characteristics.

The results of the present study provide additional evidence, showing that HbA1c, a blood marker of glycemic control that is easily obtained and inexpensive, can be used to identify CAP patients with a high risk of adverse events, including severe disease, inflammatory complications, and prolonged hospitalization. However, HbA1c is not a reliable indicator of acute glucose levels, which can vary during infection and may offer a chance for early risk stratification. Larger multicenter trials are recommended to confirm HbA1c as a prognostic factor for CAP.

Limitations

The present study was limited in several ways that should be noted in the interpretation of the results. Firstly, the study was performed at a single hospital, and the sample size was fairly small, potentially limiting the applicability of the findings to other hospital populations and health care environments. Second, it cannot be ruled out that factors that could affect the accuracy of the HbA1c, including anemia, recent blood transfusion, and hemoglobin disorders, were not thoroughly tested. Third, the observational study design precludes the ability to draw a definitive causal association between higher HbA1c and poorer outcomes with pneumonia. Furthermore, treatment methods, reactions to the antibiotics, and other underlying comorbidities may have contributed to the clinical outcome after adjusting for the other variables in the statistical analysis. More multicenter, larger population, and longer follow-up studies are suggested to confirm the prognostic value of HbA1c for CAP.

CONCLUSION

The results of the present study showed that the severity of CAP was significantly associated with the HbA1c level, inflammatory response, hospital stay, and complication rates. Patients with poor glycemic control had a higher risk for admission into the intensive care unit, requirement for respiratory support, and adverse clinical outcomes. The results indicate that HbA1c could be used as a simple, valuable, and prognostic marker for early risk stratification for CAP patients, where the clinician can better monitor and manage, or identify high-risk patients.

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