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Original Research Article

Correlation between Blood Glucose Levels and Clinical Severity in COVID-19 Patients: Prognostic Importance

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Abstract:

Background: COVID-19, caused by SARS-CoV-2, presents a wide range of clinical severities, from mild symptoms to critical illness. Identifying prognostic markers is essential for effective patient management. Emerging evidence suggests that blood glucose levels may correlate with COVID-19 severity. This study examined the correlation between blood glucose levels and clinical severity in COVID-19 patients and evaluated its prognostic importance.

Methods: A cross-sectional study was carried out, involving 80 COVID-19 positive patients. Blood glucose levels were measured upon admission, and clinical severity was categorized as mild, moderate, severe, or critical. Data were examined using SPSS version 21.0.

Results: The study revealed a considerable positive correlation between blood glucose levels and clinical severity ($r = 0.65$, $p < 0.001$). Mean blood glucose levels were 110.4 ± 15.3 mg/dL for mild cases, 125.6 ± 18.7 mg/dL for moderate cases, 160.3 ± 22.1 mg/dL for severe cases, and 180.7 ± 25.4 mg/dL for critical cases. Hyperglycemia was prevalent in severe (50%) and critical (53.3%) cases, while hypoglycemia was rare (6.3%).

Conclusion: Increased COVID-19 clinical severity was substantially correlated with elevated blood glucose levels. In COVID-19 patients, blood glucose monitoring and management may enhance clinical results and lower the risk of serious consequences.

Recommendations: It is advised that more studies be done to investigate the processes underlying the correlation between COVID-19 severity and hyperglycemia. In order to enhance prognosis, healthcare providers should think about routinely monitoring and managing blood glucose levels in COVID-19 patients.

Keywords: COVID-19, Blood Glucose, Clinical Severity, Hyperglycemia, Prognostic Marker.

Introduction

The novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that caused the global outbreak of Coronavirus Disease 2019 (COVID-19) has presented healthcare systems with hitherto unheard-of obstacles. Globally, COVID-19 has caused millions of illnesses and a considerable number of deaths since it first surfaced in December 2019. Acute respiratory distress syndrome (ARDS), multi-organ failure, severe pneumonia, and even mortality are among the conditions that fall under the clinical spectrum of COVID-19 [1]. Finding prognostic markers that indicate the disease's severity is essential to enhancing patient care and results.

The severity of COVID-19 may be correlated with metabolic disturbances, such as changes in blood glucose (BG) levels, according to recent research. Even in individuals who had never been diagnosed with diabetes before, hyperglycemia has been found to be a frequent finding in COVID-19 patients [2]. The direct impact of the virus on pancreatic beta cells, the systemic inflammatory response, and the administration of glucocorticoids in the treatment of COVID-19 can all lead to elevated BG levels. These results imply that BG levels in COVID-19 patients may be a useful indicator of the prognosis and severity of the illness.

It has long been known that hyperglycemia is associated with poor outcomes in a number of infectious diseases, and research on its potential connection to COVID-19 is growing. Research has indicated that in COVID-19 patients, hyperglycemia is linked to a higher chance of hospitalisation, serious illness, and death [3]. Furthermore, better clinical outcomes have been associated with managing hyperglycemia in hospitalised COVID-19 patients, underscoring the significance of glycemic control in these patients [4].

Notwithstanding these discoveries, more thorough research is still required to precisely examine the relationship between BG levels and the clinical severity of COVID-19. Comprehending this correlation may yield significant insights for risk assessment and customised care of COVID-19 cases.

This study aimed to examine the correlation between blood glucose levels and clinical severity in COVID-19 patients, and to evaluate its prognostic importance.

Methodology

Study Design: A cross-sectional study.

Study Setting: The study took place at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, spanning from July 2020 to May 2021 after receiving approval from the Institutional Ethics Committee.

Participants: A total of 80 COVID-19 positive patients were included in the study. Participants were selected using a consecutive sampling method.

Inclusion Criteria: Comprised patients aged 18 years and older with confirmed COVID-19 infection via RT-PCR test.

Exclusion Criteria: Individuals with pre-existing conditions affecting glucose metabolism (e.g., diabetes mellitus), those on corticosteroid therapy and pregnant women were excluded from the study.

Sample size: To calculate the sample size for this study, the following formula was used for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

- n = sample size

- Z = Z-score corresponding to the desired level of confidence

- p = estimated proportion in the population

- E = margin of error

Bias: To minimize selection bias, patients were consecutively selected based on the inclusion and exclusion criteria. Information bias was reduced by using standardized data collection instruments and procedures.

Variables: The primary variables included BG levels and clinical severity of COVID-19. Clinical severity was categorized based on the World Health Organization's criteria into mild, moderate, severe, and critical.

Data Collection: Data was collected from patient medical records and laboratory results. BG levels were measured at the time of hospital admission. Clinical severity was assessed and documented by the attending physician.

Procedure: Upon admission, blood samples were taken to measure BG levels. Clinical severity was evaluated and recorded. Additional patient information, including demographics and medical history, was extracted from medical records.

Statistical Analysis

SPSS version 21.0 was used to analyse the data. The features of the patients were summarised using descriptive statistics. The Pearson's correlation coefficient was utilised to estimate the relationship between clinical severity and BG levels. Statistical significance was attained when the p-value was < 0.05.

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

A total of 80 patients were involved in the study. The mean age was 55.3 ± 12.4 years. There were 45 (56.3%) males and 35 (43.7%) females. Most of the patients had no significant past medical history affecting glucose metabolism.

Table 1: Patient Demographics

Characteristic	Value
Number of Patients	80
Mean Age (years)	55.3 ± 12.4
Gender	
- Male	45 (56.3%)
- Female	35 (43.7%)
Pre-existing Conditions	

- None	60 (75.0%)
- Hypertension	15 (18.8%)
- Cardiovascular Diseases	5 (6.3%)

Patients were categorized into 4 groups based on the clinical severity of COVID-19: mild (20 patients, 25%), moderate (25 patients, 31.3%), severe (20 patients, 25%), and critical (15 patients, 18.8%). Compared to individuals with mild and moderate illness, individuals with severe and critical COVID-19 had considerably higher mean BG levels.

Table 2: Blood Glucose Levels by Clinical Severity

Clinical Severity	Number of Patients	Mean Blood Glucose Level (mg/dL)
Mild	20	110.4 ± 15.3
Moderate	25	125.6 ± 18.7
Severe	20	160.3 ± 22.1
Critical	15	180.7 ± 25.4

BG levels and the clinical severity of COVID-19 were shown to be considerably positively correlated ($r = 0.65$, $p < 0.001$), according to a Pearson's correlation coefficient study.

Among the patients, 5 (6.3%) experienced hypoglycemia (BG < 70 mg/dL), and 25 (31.3%) experienced hyperglycemia (BG > 140 mg/dL) during their hospital stay. The occurrence of hyperglycemia was notably higher in the severe and critical groups.

Table 3: Frequency of Hypoglycemia and Hyperglycemia by Clinical Severity

Clinical Severity	Hypoglycemia (n, %)	Hyperglycemia (n, %)
Mild	1 (5.0%)	2 (10.0%)
Moderate	2 (8.0%)	5 (20.0%)
Severe	1 (5.0%)	10 (50.0%)
Critical	1 (6.7%)	8 (53.3%)

Discussion

In a sample of eighty individuals, the study looked into the relationship between BG levels and the clinical severity of COVID-19. According to the findings, there is a strong positive link ($r = 0.65$, $p < 0.001$) between higher BG levels and more severe clinical conditions. The mean BG levels of patients with severe and critical COVID-19 were significantly greater than those with mild and moderate disease.

Patients were stratified into four groups based on clinical severity: mild, moderate, severe, and critical. The mean BG levels were 110.4 ± 15.3 mg/dL for mild cases, 125.6 ± 18.7 mg/dL for moderate cases, 160.3 ± 22.1 mg/dL for severe cases, and 180.7 ± 25.4 mg/dL for critical cases. This gradation indicates a clear trend where higher BG levels correspond to greater disease severity.

The study also highlighted the prevalence of hyperglycemia and hypoglycemia among the participants. Hyperglycemia was significantly more common in individuals with severe and critical COVID-19, affecting 50% and 53.3% of these groups, respectively. In contrast, hypoglycemia was relatively rare, with only 6.3% of the total cohort experiencing low BG levels.

These results suggest that raised BG levels could serve as a prognostic marker for COVID-19 severity. The significant correlation implies that hyperglycemia might reflect an underlying metabolic disturbance associated with severe disease outcomes. Consequently, monitoring and managing BG levels in COVID-19 patients could be crucial in improving clinical outcomes and lowering the risk of complications.

Overall, the study underscores the importance of considering BG levels as part of the comprehensive management strategy for COVID-19 patients. This approach could help identify patients at higher risk for severe disease and facilitate timely interventions to mitigate adverse outcomes.

The correlation between BG levels and the clinical severity of COVID-19 has been thoroughly studied in recent research, which emphasises the prognostic significance of hyperglycemia in predicting outcomes in COVID-19 patients. According to a review covering 14,502 patients, high fasting blood glucose (FBG) levels at admission are an independent predictor of poor COVID-19 prognosis, which includes higher severity and mortality. The incidence of severe COVID-19 rose by 33% for every 1 mmol/L raise in FBG [5].

Elevated BG levels at admission were a major independent risk factor for the development of severe cases and in-hospital death, according to a study of 2,041 hospitalised patients in Wuhan. Even in people without a history of diabetes, this connection persisted [6]. Elevated FBG levels, independent of diabetes history, were revealed to be a prognostic factor for clinical sequelae and one-year all-cause death in hospitalised COVID-19 patients in a study [7].

Significant variations in BG levels were observed between the various phases of the disease in a study that correlated BG levels with CT-based staging of COVID-19. The clinical importance of BG monitoring in controlling the severity of COVID-19 was highlighted by this study [8]. Studies revealed a correlation between elevated pre-infection glucose levels and heightened chances of severe COVID-19 consequences. Pre-infection glucose levels and disease severity were found to be correlated in a J-shaped manner in diabetic patients [9]. According to a study, in diabetic individuals, hyperglycemia upon admission and BG decline were highly significant indicators of severe COVID-19. Strict glucose management is necessary because patients with poorly managed BG had considerably worse results [10].

Another study found a J-shaped relationship between non-diabetic individuals' FBG levels and the severity of COVID-19, indicating that both hypo- and hyperglycemia are linked to worse clinical outcomes [11]. When compared to patients with bacterial or co-occurring infections, people with COVID-19 had higher FBG levels, which was linked to worse clinical outcomes. According to the study, COVID-19 patients are more susceptible to high BG levels, which can result in more serious problems [12].

Conclusion

The clinical seriousness of COVID-19 was observed to significantly positively correlate with BG levels in this investigation. The mean BG levels of individuals with severe and critical COVID-19 were significantly greater than those with mild and moderate disease. These results imply that high BG levels may function as a predictor of COVID-19 severity. For COVID-19 patients, controlling and monitoring BG levels may be essential to enhancing therapeutic results and lowering the risk of serious consequences.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

Recommendation: It is advised that more studies be done to investigate the processes underlying the correlation between COVID-19 severity and hyperglycemia. In order to enhance prognosis, healthcare providers should think about routinely monitoring and managing blood glucose levels in COVID-19 patients.

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List of Abbreviations:

ARDS - Acute Respiratory Distress Syndrome

BG - Blood Glucose

COVID-19 - Coronavirus Disease 2019

FBG - Fasting Blood Glucose

RT-PCR - Reverse Transcription Polymerase Chain Reaction

SARS-CoV-2 - Severe Acute Respiratory Syndrome Coronavirus 2

WHO - World Health Organization

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References

1. Lemos S, Solari PN. John Hopkins Got Incidence Rate Wrong: a Close Look at John Hopkins University's Web-Based Interactive Dashboard for Real-Time Tracking of COVID-19. Available at SSRN 4122259. 2021 Dec 5.
2. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. jama. 2020 Apr 7;323(13):1239-42.
3. Wang S, Ma P, Zhang S, Song S, Wang Z, Ma Y, Xu J, Wu F, Duan L, Yin Z, Luo H. Fasting blood glucose at admission is an independent predictor for 28-day mortality in patients with COVID-19 without previous diagnosis of diabetes: a multi-centre retrospective study. Diabetologia. 2020 Oct;63(10):2102-11.
4. Zhu L, She ZG, Cheng X, Qin JJ, Zhang XJ, Cai J, Lei F, Wang H, Xie J, Wang W, Li H. Association of blood glucose control and outcomes in patients with COVID-19 and pre-existing type 2 diabetes. Cell metabolism. 2020 Jun 2;31(6):1068-77.
5. Lazarus G, Audrey J, Wangsaputra VK, Tamara A, Tahapary D. High admission blood glucose independently predicts poor prognosis in COVID-19 patients: A systematic review and dose-response meta-analysis. Diabetes Res Clin Pract. 2020;171:108561.

6. Wu J, Huang J, Zhu G, Wang Q, Lv Q, Huang Y, et al. Elevation of blood glucose level predicts worse outcomes in hospitalized patients with COVID-19: a retrospective cohort study. BMJ Open Diabetes Res Care. 2020;8:e 001 476.
7. Chai C, Chen K, Li S, Cheng G, Wang W, Wang H, et al. Effect of elevated fasting blood glucose level on the 1-year mortality and sequelae in hospitalized COVID-19 patients: A bidirectional cohort study. J Med Virol. 2022; 94:3240-3250.
8. Xu C, Ruan X, Chen XQ, Huang QL, Zhao ZY, Ru L. CT-based staging and prognosis of novel coronavirus (COVID-19) pneumonia: correlation with blood glucose levels. Eur Rev Med Pharmacol Sci. 2020; 24:13056-13061.
9. Shauly-Aharonov M, Shafrir A, Paltiel O, Calderon-Margalit R, Safadi R, Bicher R, et al. Both high and low pre-infection glucose levels associated with increased risk for severe COVID-19: New insights from a population-based study. PLoS ONE. 2021;16:e0254847.
10. Xiao F, Zhou Y, Zhang M, Chen D, Peng S, Tang H, et al. Hyperglycemia and blood glucose deterioration are risk factors for severe COVID-19 with diabetes: A two-center cohort study. J Med Virol. 2021; 94:1967-1975.
11. Zhu B, Jin SW, Wu LP, Hu C, Wang Z, Bu L, et al. J-shaped association between fasting blood glucose levels and COVID-19 severity in patients without diabetes. Diabetes Res Clin Pract. 2020; 168:108381.
12. Wang W, Chai Z, Cooper M, Zimmet P, Guo H, Ding J, et al. Elevated Fasting Blood Glucose Levels Are Associated with Worse Clinical Outcomes in COVID-19 Patients Than in Pneumonia Patients with Bacterial Infections. Pathogens. 2022; 11:902.