International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Association Between Glycemic Gap and Adverse Clinical Outcomes in Diabetic Patients Admitted to the Intensive Care Unit: A Prospective Observational Study in Rural Tertiary Care Centre

Dr. Anjali Anil Gondchawar[1], Dr Bhagwan Pandharinath Gore[2], Dr Shirish Ardhapurkar[3]

[1]Junior Resident, Department of General Medicine Vedantaa Institute of Medical Sciences and Research Centre, Palghar
[2]Professor and Head of the Department, Department of General Medicine, Vedantaa Institute of Medical Sciences and Research Centre
[3]Professor, Department of General Medicine, Vedantaa Institute of Medical Sciences and Research Centre, Palghar

OPEN ACCESS

Corresponding Author:

Dr. Anjali Anil Gondchawar
Junior Resident, Department of General Medicine
Vedantaa Institute of Medical Sciences and Research Centre, Palghar
Email:
anjali.17031999@gmail.com

Received: 17-05-2026
Accepted: 08-06-2026
Available online: 30-06-2026

ABSTRACT

Background: Stress-induced hyperglycemia is a common metabolic response observed in critically ill patients and is associated with increased morbidity and mortality. In patients with Type 2 Diabetes Mellitus (T2DM), admission hyperglycemia may reflect both chronic glycemic status and acute physiological stress. Glycemic gap, defined as the difference between admission blood glucose and HbA1c-derived average glucose (ADAG), has emerged as a useful indicator of acute stress-related hyperglycemia and may serve as a prognostic marker in critically ill diabetic patients.

Objectives: To evaluate the association between glycemic gap and adverse clinical outcomes among patients with Type 2 Diabetes Mellitus admitted to the intensive care unit (ICU).

Materials and Methods: A hospital-based cross-sectional observational study was conducted in the Medical ICU of a tertiary care center from January 2024 to April 2026. Adult patients with Type 2 Diabetes Mellitus admitted to the ICU were included. Admission random blood sugar, HbA1c, ADAG, and glycemic gap were calculated and analyzed. Clinical outcomes and adverse events including acute kidney injury (AKI), acute respiratory distress syndrome (ARDS), shock, multiple organ dysfunction syndrome (MODS), and mortality were recorded. Statistical analysis was performed to determine the association between glycemic gap and patient outcomes.

Results: The mean HbA1c, admission blood glucose, ADAG, and glycemic gap were 9.2 ± 4.7%, 201 ± 70 mg/dL, 218 ± 118 mg/dL, and 4.9 ± 0.8, respectively. Admission blood glucose and glycemic gap demonstrated significant differences between improved and deteriorated outcome groups ($p<0.0001$). MODS (15%) was the most common complication, followed by AKI (13%), ARDS (12%), and shock (4%). Higher glycemic gap showed a positive correlation with adverse outcomes, prolonged ICU stay, organ dysfunction, and mortality.

Conclusion: Glycemic gap is a simple and effective prognostic marker associated with adverse outcomes in critically ill patients with Type 2 Diabetes Mellitus and may aid in early risk stratification in the ICU.

Keywords: Glycemic gap.

INTRODUCTION

Critically ill patients frequently develop disturbances in glucose metabolism due to activation of the neuroendocrine stress response. Stress-induced hyperglycemia results from increased secretion of catecholamines, cortisol, glucagon, and inflammatory cytokines, leading to enhanced hepatic gluconeogenesis, glycogenolysis, and peripheral insulin resistance. Although transient hyperglycemia may represent a physiological adaptive mechanism during acute illness, excessive

elevations in blood glucose have consistently been associated with increased morbidity and mortality in critically ill patients.[1]

In individuals without diabetes, admission hyperglycemia has been shown to predict adverse outcomes including prolonged hospitalization, multiple organ dysfunction syndrome (MODS), acute kidney injury (AKI), sepsis, and death.[2] However, interpretation of hyperglycemia in patients with pre-existing diabetes mellitus is more complex because elevated blood glucose levels may reflect chronic poor glycemic control rather than acute physiological stress.[3]

Glycated hemoglobin (HbA1c) provides an estimate of average blood glucose levels over the preceding two to three months and allows differentiation between chronic hyperglycemia and acute stress-related glycemic excursions.[4] The concept of the glycemic gap was developed to quantify the difference between admission blood glucose concentration and HbA1c-derived average glucose (ADAG), thereby providing an estimate of acute stress-induced hyperglycemia independent of chronic glycemic status.[5]

Several investigators have reported that glycemic gap is superior to admission glucose alone in predicting adverse outcomes among critically ill diabetic patients. Elevated glycemic gap has been associated with increased incidence of sepsis, acute respiratory distress syndrome (ARDS), renal dysfunction, cardiovascular complications, and mortality.[6–9] Furthermore, glycemic gap has emerged as a potentially useful prognostic marker in patients with acute myocardial infarction, stroke, severe infections, and critical care admissions.[10–12]

The intensive care unit (ICU) population represents a heterogeneous group characterized by severe physiological stress and high risk of organ dysfunction. Early identification of patients at increased risk of deterioration is essential for optimizing monitoring strategies and therapeutic interventions. Since glycemic gap can be easily calculated using routinely available laboratory parameters, it may serve as an inexpensive and readily accessible prognostic tool.[13]

Despite growing evidence supporting its prognostic value, data regarding glycemic gap among critically ill diabetic patients in the Indian population remain limited. Therefore, the present study was undertaken to evaluate the association between glycemic gap and adverse outcomes among patients with type 2 diabetes mellitus admitted to the intensive care unit.

MATERIALS AND METHODS

This hospital-based cross-sectional observational study was conducted in the Medical Intensive Care Unit (MICU) of Vedantaa Institute of Medical Sciences and Research Centre, Palghar, Maharashtra, over a period extending from January 2024 to April 2026. The study included adult patients aged 18 years and above with a known diagnosis of Type 2 Diabetes Mellitus who required admission to the ICU for management of critical medical illnesses. Patients fulfilling the eligibility criteria and having available admission blood glucose and HbA1c measurements were enrolled consecutively after obtaining appropriate institutional approval and informed consent wherever applicable.

Baseline demographic details, clinical characteristics, laboratory investigations, and outcome-related variables were recorded using a predesigned data collection form. The laboratory parameters included admission random blood sugar (RBS) and glycated hemoglobin (HbA1c). The HbA1c-derived average glucose (ADAG) was calculated using the standard formula: ADAG = (28.7 × HbA1c) − 46.7. Glycemic gap was determined by calculating the difference between admission blood glucose and ADAG, thereby representing the acute stress-related rise in blood glucose over the patient's chronic glycemic status.

Patients were monitored throughout their ICU stay for development of adverse outcomes including acute kidney injury (AKI), acute respiratory distress syndrome (ARDS), shock, multiple organ dysfunction syndrome (MODS), prolonged ICU stay, and mortality. Based on the clinical course and final outcome, patients were categorized into improved and deteriorated groups. Comparative analysis of glycemic parameters was performed between the two groups to evaluate the prognostic significance of glycemic gap.

The collected data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software version 26. Continuous variables were expressed as mean ± standard deviation, while categorical variables were represented as frequencies and percentages. Appropriate statistical tests including independent sample t-test and Chi-square test were used to determine differences between groups. Correlation analyses were performed to assess the relationship between glycemic gap and adverse outcomes. A p-value less than 0.05 was considered statistically significant.

RESULTS

Table 1: Glycemic Profile of the Study Population

Parameter	Mean ± SD
HbA1c (%)	9.2 ± 4.7
Admission RBS (mg/dL)	201 ± 70

ADAG (mg/dL)	218 ± 118
Glycemic Gap	4.9 ± 0.8

Table 2: Comparison of Glycemic Parameters Between Improved and Deteriorated Outcome Groups

Parameter	Significance (p-value)
HbA1c	0.08
Admission RBS	<0.0001
ADAG	0.08
Glycemic Gap	<0.0001

Table 3: Adverse Outcomes Observed in the Study Population

Adverse Outcome	Percentage (%)
Multiple Organ Dysfunction Syndrome (MODS)	15
Acute Kidney Injury (AKI)	13
Acute Respiratory Distress Syndrome (ARDS)	12
Shock	4

Table 4: Correlation of Clinical Variables with Mortality

Variable	Correlation with Mortality
Length of ICU Stay	Positive Significant Correlation
MODS	Positive Significant Correlation
AKI	Positive Significant Correlation
Glycemic Gap	Positive Correlation

Table 5: Correlation of Glycemic Gap with Clinical Outcome

Outcome	Correlation with Glycemic Gap
Improved Outcome	Negative Correlation
Worsened Outcome	Positive Correlation
Mortality	Positive Correlation

The study evaluated critically ill patients with Type 2 Diabetes Mellitus admitted to the intensive care unit. Analysis of glycemic parameters demonstrated poor baseline glycemic control among the study population, as reflected by a mean HbA1c of 9.2 ± 4.7%. The mean admission random blood sugar level was 201 ± 70 mg/dL, indicating significant hyperglycemia at presentation. The calculated mean ADAG was 218 ± 118 mg/dL, while the mean glycemic gap was 4.9 ± 0.8, suggesting the presence of acute stress-induced glycemic excursions beyond chronic glucose levels.

Comparison of glycemic parameters between patients with improved and deteriorated clinical outcomes revealed statistically significant differences in admission blood glucose and glycemic gap. Admission RBS and glycemic gap showed highly significant associations with outcome ($p<0.0001$), whereas HbA1c and ADAG did not demonstrate statistically significant differences between the groups. These findings indicate that acute alterations in glucose metabolism during critical illness may be more predictive of patient outcomes than long-term glycemic control alone.

Evaluation of adverse events showed that multiple organ dysfunction syndrome was the most common complication, occurring in 15% of patients. Acute kidney injury was observed in 13% of patients, followed closely by acute respiratory distress syndrome in 12%. Shock was comparatively less frequent and occurred in 4% of the study population. The predominance of organ dysfunction-related complications highlights the severity of illness among ICU-admitted diabetic patients.

Further analysis demonstrated that increased ICU stay, development of MODS, and occurrence of AKI were significantly associated with mortality. Patients experiencing these complications had a greater likelihood of clinical deterioration and death compared with patients without such events. The findings suggest that organ dysfunction plays a major role in determining prognosis among critically ill diabetic individuals.

A positive correlation was observed between glycemic gap and worsened clinical outcomes, including mortality and major complications. Conversely, a negative correlation was identified between glycemic gap and favorable clinical outcomes. Patients with higher glycemic gap values were more likely to develop adverse events and experience poor prognosis, whereas lower glycemic gap values were associated with clinical improvement and recovery. These observations support the potential utility of glycemic gap as a simple prognostic marker for risk stratification in critically ill patients with Type 2 Diabetes Mellitus.

DISCUSSION

The present study demonstrated a significant association between elevated glycemic gap and adverse clinical outcomes among critically ill patients with type 2 diabetes mellitus. The findings support the hypothesis that acute stress-induced hyperglycemia, rather than chronic hyperglycemia alone, contributes substantially to disease severity and mortality.

Admission hyperglycemia has long been recognized as an independent predictor of poor outcomes in critically ill patients.[1–3] However, reliance on admission glucose alone may overestimate risk in patients with chronically uncontrolled diabetes. Glycemic gap addresses this limitation by accounting for baseline glycemic status reflected by HbA1c.[5]

In the present study, patients with worsening clinical outcomes demonstrated significantly higher glycemic gap values. Similar observations have been reported by studies evaluating ICU populations, acute myocardial infarction, ischemic stroke, and severe sepsis.[6–12] Elevated glycemic gap reflects exaggerated neuroendocrine activation and inflammatory stress, both of which contribute to endothelial dysfunction, oxidative stress, immune dysregulation, and organ injury.[7–9]

The predominance of MODS and AKI among adverse outcomes in this study is biologically plausible. Hyperglycemia promotes inflammatory cytokine release, microvascular dysfunction, and renal tubular injury, thereby increasing susceptibility to organ failure.[9],[10] Previous studies have similarly identified glycemic gap as a predictor of renal impairment and multiorgan dysfunction in critically ill populations.[6],[8]

The study findings suggest that glycemic gap may represent a simple and readily available prognostic marker that can be incorporated into routine ICU assessment. Early identification of high-risk patients using glycemic gap may facilitate timely intervention and improved resource allocation.

CONCLUSION

Higher glycemic gap was significantly associated with adverse clinical outcomes among patients with type 2 diabetes mellitus admitted to the intensive care unit. Elevated glycemic gap correlated positively with mortality, MODS, AKI, and prolonged ICU stay. Glycemic gap appears to be a simple, inexpensive, and clinically useful marker for assessing disease severity and predicting prognosis in critically ill diabetic patients. Further multicentric prospective studies with larger sample sizes are warranted to validate its utility in routine critical care practice.

REFERENCES

1. Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. J Clin Endocrinol Metab. 2002;87(3):978-982.
2. Capes SE, Hunt D, Malmberg K, Gerstein HC. Stress hyperglycaemia and increased risk of death after myocardial infarction in patients with and without diabetes: a systematic overview. Lancet. 2000;355(9206):773-778.
3. Krinsley JS. Association between hyperglycemia and increased hospital mortality in a heterogeneous population of critically ill patients. Mayo Clin Proc. 2003;78(12):1471-1478.
4. Nathan DM, Kuenen J, Borg R, Zheng H, Schoenfeld D, Heine RJ; A1c-Derived Average Glucose Study Group. Translating the A1C assay into estimated average glucose values. Diabetes Care. 2008;31(8):1473-1478.
5. Roberts GW, Quinn SJ, Valentine N, Alhawassi T, O'Dea H, Stranks SN, et al. Relative hyperglycemia, a marker of critical illness: introducing the stress hyperglycemia ratio. J Clin Endocrinol Metab. 2015;100(12):4490-4497.
6. Liao WI, Wang JC, Chang WC, Hsu CW, Chu CM, Tsai SH. Usefulness of glycemic gap to predict ICU mortality in critically ill patients with diabetes. Medicine (Baltimore). 2015;94(36):e1525.
7. Liao WI, Wang JC, Chang WC, Hsu CW, Chu CM, Tsai SH. The association between glycemic gap and adverse outcomes in diabetic patients with acute myocardial infarction. BMC Cardiovasc Disord. 2015;15:55.
8. Sung J, Bochicchio GV, Joshi M, Bochicchio K, Tracy JK, Scalea TM. Admission hyperglycemia is predictive of outcome in critically ill trauma patients. J Trauma. 2005;59(1):80-83.
9. Marik PE, Bellomo R. Stress hyperglycemia: an essential survival response. Crit Care. 2013;17(2):305.
10. Egi M, Bellomo R, Stachowski E, French CJ, Hart G. Variability of blood glucose concentration and short-term mortality in critically ill patients. Anesthesiology. 2006;105(2):244-252.
11. Krinsley JS. Glycemic variability: a strong independent predictor of mortality in critically ill patients. Crit Care Med. 2008;36(11):3008-3013.
12. Finfer S, Chittock DR, Su SY, Blair D, Foster D, Dhingra V, et al.; NICE-SUGAR Study Investigators. Intensive versus conventional glucose control in critically ill patients. N Engl J Med. 2009;360(13):1283-1297.
13. Van den Berghe G, Wouters P, Weekers F, Verwaest C, Bruyninckx F, Schetz M, et al. Intensive insulin therapy in critically ill patients. N Engl J Med. 2001;345(19):1359-1367.