Article

Blood Glucose and Neurological Status: Dual Predictors of Survival in Diabetic Emergency

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Abstract

Background: Acute diabetic emergencies, including diabetic ketoacidosis (DKA), hyperosmolar hyperglycaemic syndrome (HHS), and hypoglycaemia, require urgent medical intervention. These complications result from severe metabolic disturbances, often causing neurological impairment. Blood glucose levels measure metabolic derangement, while the Glasgow Coma Scale (GCS) indicates cerebral dysfunction.
Objectives: This study evaluates the prognostic significance of blood glucose levels and GCS in predicting survival rates among diabetic emergency patients, hypothesizing that these parameters are robust outcome indicators.
Methods: A retrospective cross-sectional study analysed medical records of 250 patients treated for diabetic emergencies at Dr. Soedono General Hospital Madiun (2017–2024). Blood glucose levels and GCS scores were assessed using chi-square tests ($p < 0.25$) and multivariate binomial logistic regression ($p < 0.05$) in SPSS version 21.
Results: Multivariate analysis identified GCS as the most critical survival predictor, with low GCS scores significantly correlating with mortality (OR = 0.002, 95% CI: 0.000–0.012, $p < 0.05$). Blood glucose levels >600 mg/dL were also associated with reduced survival rates (OR = 0.113, 95% CI: 0.074–4.304, $p < 0.05$). The model explained 72.1% of the variance in patient outcomes.
Conclusion: GCS and blood glucose levels are pivotal survival predictors in diabetic emergencies, with GCS being the predominant determinant. These findings highlight the importance of early neurological evaluation and glucose regulation in improving outcomes.

Implications of this paper in nursing and midwifery preventive care:

- **Early Neurological Assessment and Monitoring:** The study highlights the Glasgow Coma Scale (GCS) as a critical predictor of survival in diabetic emergencies. Nurses and midwives should prioritize early neurological assessment and continuous monitoring in emergency care settings to detect signs of deterioration promptly and initiate timely interventions.
- **Blood Glucose Management and Patient Education:** Severe hyperglycemia (blood glucose >600 mg/dL) significantly reduces survival rates in diabetic emergencies. Preventive strategies should focus on regular blood glucose monitoring, patient education on recognizing early symptoms of diabetic crises, and adherence to treatment regimens to minimize emergency complications.

Introduction

Diabetic emergencies, including diabetic ketoacidosis (DKA), hyperosmolar hyperglycaemic state (HHS), and hypoglycaemia, represent life-threatening conditions that require urgent medical intervention to prevent mortality and long-term complications [1]. These emergencies arise due to severe metabolic imbalances, which not only disrupt normal physiological functions but also significantly impact neurological status. Neurological dysfunction in diabetic emergencies often results from prolonged hyperglycaemia, cerebral edema, or hypoglycaemic-induced neuronal damage, leading to altered levels of consciousness and increased morbidity [2]. Therefore, understanding the relationship between metabolic disturbances and neurological status is critical in improving patient outcomes. Previous studies have established a strong association between severe hyperglycaemia and poor clinical outcomes, with blood glucose levels exceeding 600 mg/dL being a significant predictor of mortality in diabetic emergencies [3]. Similarly, neurological

impairment, as measured by GCS, has been shown to independently predict survival, with lower GCS scores correlating with an increased risk of death due to severe cerebral dysfunction and diminished recovery capacity [4]. The interplay between these two factors suggests that an integrated assessment of blood glucose levels and GCS can enhance prognostic accuracy and guide clinical decision-making in diabetic emergencies [5]. Despite advancements in emergency diabetes care, the prognostic role of combined metabolic and neurological assessments remains underexplored. While hyperglycaemia-induced metabolic stress exacerbates systemic complications, concomitant neurological deterioration may further reduce survival chances, necessitating an early and comprehensive evaluation of both parameters [6]. This study aims to investigate the dual predictive role of blood glucose levels and neurological status in determining survival outcomes among diabetic emergency patients. By establishing the significance of these variables, the findings may contribute to the development of more refined clinical protocols and predictive models, ultimately improving emergency management strategies for diabetes-related complications.

Methods

This study employed a retrospective design with a cross-sectional approach, conducted at the Emergency Department (ED) of a Regional General Hospital (RSUD) in East Java, between July and September 2024. The study population comprised medical records of patients aged over 30 years with type 2 diabetes mellitus, who had been treated in the ED for hypoglycemia, hyperosmolar hyperglycemic state (HHS), or diabetic ketoacidosis (DKA) over the preceding eight years (2017–2024). Inclusion criteria were limited to patients diagnosed with type 2 diabetes mellitus, selected through a time sampling method within a predefined period to ensure a representative dataset. This approach captured variations in patient characteristics, disease severity, and treatment outcomes while minimizing selection bias. Patients with type 1 diabetes mellitus and gestational diabetes were excluded to maintain population homogeneity, as these conditions have distinct pathophysiologies and management strategies that could confound the analysis. Additionally, incomplete medical records were excluded to ensure data accuracy and reliability in assessing survival factors in diabetic emergency patients. Sampling was carried out using a time sampling method, resulting in a total of 250 patient medical records. These records were retrieved from the hospital's electronic medical record database following ethical approval (No. 400.14.5.4/23377/102.9/2024). Data collection was conducted through the integrated electronic medical record system managed by the Medical Record Unit. The key variables measured included blood glucose levels (mg/dL), neurological status assessed using the Glasgow Coma Scale (GCS), and survival rate. A trained medical records team ensured the accuracy of data entry and verification. Any incomplete or missing data were excluded from the analysis. Data analysis was performed using SPSS version 21 (IBM Corp., Armonk, NY, USA), with logistic binomial regression applied at a significance threshold of $p<0.05$ to identify factors significantly influencing patient survival rates.

Results

The trend in the incidence of diabetic emergency cases from 2017 to 2024 is illustrated in Figure 1, with data presented clearly to facilitate interpretation. Notable fluctuations in case numbers were observed across the years, which may correlate with advancements in diabetes management and changes in patient health status. In 2017 and 2018, the cases remained relatively stable at approximately 2.96% and 2.20%, respectively. However, a significant rise of 21.97% occurred in 2019, followed by a reduction in subsequent years, with cases dropping to 10.70% in 2020 and 8.40% in 2021. The decline in cases during this period may reflect improvements in diabetes management strategies. In 2022, a sharp decline to 2.29% was recorded, yet a dramatic increase was observed in 2023, reaching 35.82%. This surge may be linked to the escalating incidence of diabetic ketoacidosis (DKA) or hyperosmolar hyperglycaemic state (HHS), possibly due to deteriorating patient health or delays in seeking treatment. By 2024, the percentage of cases fell to 15.66%, though it remained higher than in the early years of the study period, suggesting that challenges in

diabetic emergency management persisted. Additionally, the Glasgow Coma Scale (GCS) was identified as a significant predictor of survival, with low GCS scores strongly associated with mortality (OR = 0.002, 95% CI: 0.000–0.012, $p < 0.05$). Blood glucose levels >600 mg/dl were also linked to reduced survival rates (OR=0.113, 95% CI: 0.074–4.304, $p<0.05$). The model accounted for 72.1% of the variance in patient outcomes. Given its crucial role in patient prognosis, further analysis was conducted to assess potential confounding factors, such as comorbidities and treatment variability, which could influence survival outcomes. Detailed percentages for each year are provided in Figure 1.

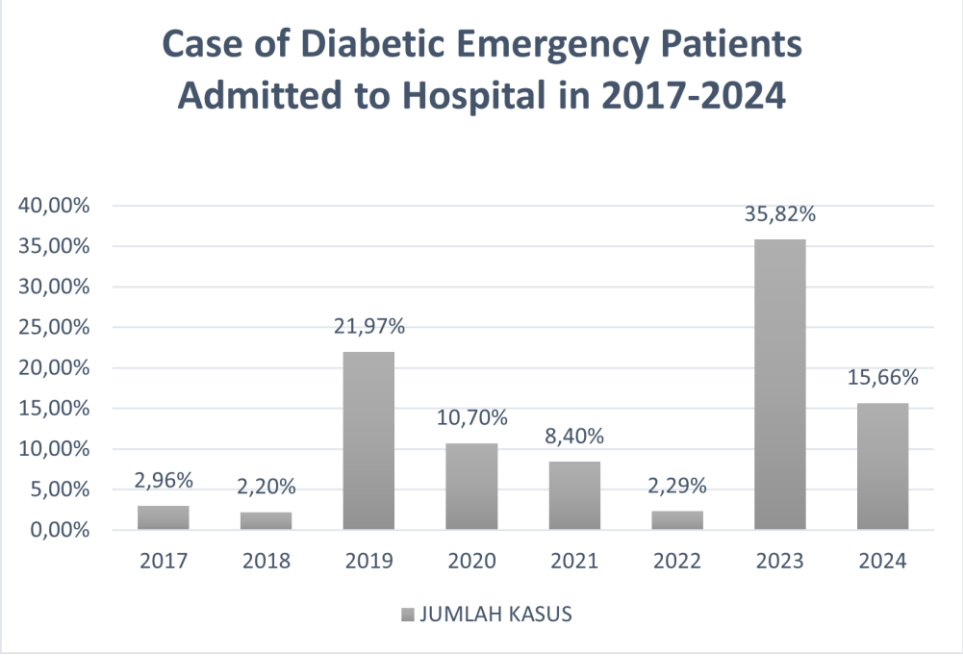

Figure 1: Diagram of diabetic emergency patient admissions (MRS) in the ED from 2017 – 2024

The characteristics of patients experiencing diabetic emergencies from 2017 to 2024 are summarized in Table 1. The majority of patients were elderly (71.3 %) and predominantly male (69.3 %). Blood glucose levels varied widely, with a substantial proportion experiencing severe hypoglycemia or extreme hyperglycemia. Neurological status, assessed using the Glasgow Coma Scale (GCS), showed a distribution across low, moderate, and high categories. In terms of survival, more than half of the patients survived, while a significant proportion did not. Further details on age distribution, gender, blood glucose levels, GCS scores, and survival rates are provided in Table 1

Table 1: Blood glucose levels and GCS of diabetic emergency patients 2017 – 2024

Characteristics		n = 250	%
Age	Adults (30 – 59 years)	115	28.7
	Elderly (>60 years)	135	71.3
Gender	Female	123	30.7
	Male	127	69.3
Blood Sugar Levels	<54 mg/dl	161	64.4
	>250 mg/dl	15	6.0
	>600mg/dl	74	29.6
GCS	Low (3 – 8)	99	39.6
	Moderate (9 – 12)	38	15.2
	High (13 – 15)	113	45.2
Survival Rate	Deceased	91	36.4
	Alive	159	63.6

The analysis exploring the relationship between blood glucose levels, neurological status, and patient survival rates in diabetic emergencies is detailed in Table 2. The bivariate analysis, conducted using the chi-square test with a significance threshold of $p < 0.25$, revealed that both blood glucose levels and neurological status were significantly associated with patient survival. Specifically, the categories of blood glucose levels—<54 mg/dL ($p<0.001$), >250 mg/dL ($p < 0.001$), and >600 mg/dL ($p=0.004$)—demonstrated significant associations at the bivariate level. Regarding neurological status, the low Glasgow Coma Scale (GCS) category exhibited a p-value of 0.113, while the moderate and high categories showed p-values of 0.098 and 0.580, respectively. In the multivariate analysis, conducted using binomial logistic regression with a significance level of $p < 0.05$, GCS ($p < 0.001$) emerged as a significant predictor of patient survival, whereas blood glucose levels did not exhibit a significant relationship ($p = 0.073$). The R Square value indicated that the model accounted for approximately 72.1% of the variance in the data. Multivariate analysis identified neurological status, as measured by the Glasgow Coma Scale (GCS), as the most influential factor affecting survival in patients with diabetic emergencies (OR = 0.002, 95% CI: 0.000–0.012, $p < 0.05$). Additionally, blood glucose levels >600 mg/dL were associated with reduced survival rates (OR = 0.113, 95% CI: 0.074–4.304, $p < 0.05$) (Table 2).

Table 2: Blood glucose and neurological status in survival diabetic emergency

	S.E.	Df	p	R Square	Chi-Square (p <0.25)	Multivariate (p <0.05)	95% CI Exp (B)
Blood Sugar Levels				0.028	0.073	0.113	0.002 (0.000–0.012)
<54 mg/dl	0.528	2	< 0.001				
>250 mg/dl	0.623	1	< 0.001				
>600mg/dl	1.038	1	0.004				
GCS				0.721	< 0.001*	< 0.001*	0.113 (0.074–4.304)
Low	0.842	2	0.113				
Moderate	0.840	1	0.098				
High	0.863	1	0.580				

***p<0.05**

These findings highlight the critical role of neurological status in predicting survival outcomes among diabetic emergency patients. The strong association between low GCS scores

and mortality suggests that impaired consciousness significantly increases the risk of poor prognosis (Table 2). This emphasizes the need for early neurological assessment in diabetic emergencies to guide clinical interventions. Although blood glucose levels were associated with survival in the bivariate analysis, their significance diminished in the multivariate model, indicating that other factors, such as neurological status, play a more dominant role.

Discussion

The findings of this study suggest that neurological status, as assessed by the Glasgow Coma Scale (GCS), serves as the primary predictor of survival in patients experiencing diabetic emergencies. This is consistent with previous studies that have demonstrated a strong correlation between GCS scores and patient outcomes in acute metabolic conditions [7,4,8]. Additionally, blood glucose levels play a significant role, particularly when exceeding 600 mg/dL, which has been previously linked to increased mortality in hyperglycaemic crises. These findings emphasize the critical importance of prompt and continuous neurological assessment in the management of patients within the emergency department (ED) [9,10]. Patients exhibiting low GCS scores face an exceptionally high risk of mortality, aligning with previous research that identifies severe neurological impairment as a key determinant of adverse outcomes in diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state (HHS)[10,11]. This underscores the need for early intervention strategies aimed at stabilizing the patient's neurological condition to improve survival rates [12,13]. Moreover, both extreme hyperglycaemia and hypoglycaemia necessitate particularly careful attention [14]. Severe hyperglycaemia (above 600 mg/dL) has been strongly associated with a heightened risk of mortality, while hypoglycaemia (below 54 mg/dL) also presents substantial potential for serious complications, corroborating earlier studies that emphasize the dangers of extreme blood glucose fluctuations [15,16]. Consequently, close monitoring of blood glucose levels from the point of initial triage in the ED is essential to enhancing patient survival. These findings carry significant implications for the formulation of more comprehensive ED protocols, which should incorporate a combined evaluation of blood glucose levels and neurological status as a key component of the early triage process for diabetic emergency patients [17,18]. By adopting this approach, healthcare providers can allocate resources more effectively to those patients at the greatest risk, thereby improving clinical outcomes [19,20]. From a preventive standpoint, public health education plays a pivotal role in reducing the incidence of diabetic emergencies. This initiative involves educating patients and their families on effective home blood glucose management, early identification of complications such as DKA or HHS, and reinforcing the significance of regular health check-ups [21]. Community-based preventive programs that encourage healthy lifestyles, including balanced diets and regular physical activity, also play a crucial role in preventing acute complications [22]. This study provides valuable insights into the critical role of GCS in predicting survival in diabetic emergencies, reinforcing its importance in clinical decision-making. The integration of blood glucose levels as an additional predictor further enhances the study's applicability to emergency care settings. However, there are limitations to consider. As a retrospective study conducted at a single institution, the findings may not be generalizable to other settings or populations. Additionally, the lack of longitudinal data prevents an assessment of long-term outcomes post-emergency treatment. Furthermore, while GCS and blood glucose levels are highlighted, other potential confounding factors influencing survival rates, such as comorbidities and treatment variations, warrant further investigation. Future research should be conducted with a larger population and a broader range of care conditions to validate these findings and aid in the development of risk prediction algorithms. By doing so, these results not only offer fresh insights into the management of diabetic emergencies but also provide a foundation for the creation of more effective preventive measures, ultimately enhancing the quality of life for diabetic patients.

Conclusion

This study highlights the Glasgow Coma Scale (GCS) as the primary predictor of survival in

diabetic emergencies, with blood glucose levels also playing a significant role. Patients with low GCS scores are at an exceptionally high risk of mortality, emphasizing the importance of early neurological assessment and intervention in emergency care. The integration of both GCS and blood glucose levels in triage protocols can enhance patient outcomes by facilitating timely and appropriate medical interventions. Additionally, public health education on blood glucose management and early recognition of complications is essential in reducing the incidence of diabetic emergencies. Future studies should expand on these findings by incorporating larger sample sizes and exploring long-term patient outcomes to develop more precise risk prediction models.

Ethical Consideration

This research has received approval from the Research Ethics Committee of Dr. Soedono General Madiun Hospital with ethics number: 400.14.5.4/233377/102.9/2024.

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Conflict of interest

The authors hereby declare that there are no potential conflicts of interest concerning the research, authorship, or publication of this article.

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Authors' contributions

1.Lintang Arum Nikentari contributed to conceptualization, methodology, data collection, and manuscript writing. Heri Kristianto supervised the study, performed data analysis, reviewed the manuscript, and handled correspondence. Laily Yuliatun conducted the literature review, statistical analysis, and manuscript editing and contributed to data interpretation, validation, and final manuscript approval.

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