Journal of the ASEAN Federation of Endocrine Societies

ORIGINAL ARTICLE

Direct Medical Cost Analysis of Hyperglycemic Emergencies Among Patients with Diabetes Mellitus in a Tertiary Government Hospital in the Philippines

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Abstract

Background. There is limited published local data on the direct medical costs of hyperglycemic emergencies. This study aimed to analyze direct medical costs incurred during hospitalization for hyperglycemic emergencies from a healthcare payer perspective.

Methodology. This is a retrospective cohort study done in a tertiary government hospital in the Philippines. The primary outcome measure was the median cost and distribution of direct medical costs (in Philippine Pesos) incurred during hospitalization.

Results. Among 319 patients with cost data, the median direct medical cost was PhP 79,331.50 (USD 1,375.02; USD 1: PhP 57.69), representing approximately 22.5% of the average annual family income and 7.2 times the average annual healthcare expenditure per capita. HHS incurred the highest costs (PhP 143,902.77; USD 2,494.21) with diagnostic fees as the largest expense (PhP 41,507.00; USD 719.42). The total costs exceeded the coverage provided by PhilHealth, the national health insurance in the Philippines.

Socioeconomic disparities were evident, with lower-income patients incurring higher expenses due to delayed presentation and more severe illness.

Conclusion. This study highlights the substantial economic burden of hyperglycemic emergencies in a public tertiary hospital. As one of the first of its kind locally, the study informs policy efforts to reduce financial risk for vulnerable populations and optimize resource allocation for diabetes-related emergencies.

Key words: health expenditure, direct medical cost, hyperglycemic emergencies

INTRODUCTION

Diabetes mellitus (DM) remains a growing public health concern. As of 2022, the World Health Organization (WHO) estimated that approximately 830 million people are living with DM, with a rapid rise noted in low- and middle-income countries.[1] In the Philippines, the prevalence of DM has been increasing and is currently estimated at 7.5% according to the International Diabetes Federation.[2] Alongside this growing prevalence, hyperglycemic emergencies have become a significant cause of morbidity and mortality. A local study has reported a higher-than-expected mortality rate.[3]

Hyperglycemic emergencies are acute, severe, life-threatening emergencies in individuals with Type 1 (T1DM) and Type 2 Diabetes Mellitus (T2DM). Diabetic ketoacidosis (DKA) is characterized by hyperglycemia, ketonemia/ketonuria and metabolic acidosis. Hyperglycemic Hyperosmolar State (HHS), on the other hand, is marked by severe hyperglycemia, hyperosmolality and dehydration without any major ketosis or acidosis.[4] These emergencies require urgent medical attention and are commonly managed with adequate fluid resuscitation, insulin therapy, correction of electrolyte imbalances, and close monitoring of patients.[4,5]

eISSN 2308-118x (Online)
Printed in the Philippines

Received: June 29, 2025. Accepted: July 27, 2025.
Published online first: April 20, 2026.
https://doi.org/10.15605/jafes.041.01.5233

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Globally, the frequency of hyperglycemic emergencies is rising in both T1DM and T2DM populations.[4] In the Philippines, a 5% incidence rate for DKA and an 11% mortality rate have been reported.[3,6] These hyperglycemic emergencies impose a substantial clinical and financial burden, particularly in a resource-limited healthcare system. The global economic burden of diabetes is estimated at USD 1.31 trillion. Locally, the cost of managing T2DM varies considerably depending on the presence of complications, ranging from USD621 to USD3,226 annually per person with complications and USD127 to USD2,242 for those without.[7] However, specific data on the direct medical costs of hyperglycemic emergencies in the Philippines remain scarce.

In light of the Universal Health Care (UHC) Law, there is increasing demand from policymakers, healthcare payors and professional societies for reliable, context-specific cost data to inform reimbursement policies, optimize clinical resource allocation and support local guideline development. This study addresses this gap by evaluating the direct medical costs incurred during hospitalization for hyperglycemic emergencies among patients with diabetes mellitus in a tertiary government hospital in the Philippines. To provide clinical context to these costs, the study also examined key demographic, clinical and biochemical variables — including age, sex, diabetes type, comorbidities, identified etiologies (e.g., infection, non-adherence with medications), and biochemical markers such as pH, bicarbonate, anion gap, serum osmolality and glucose levels — as well as level of care received. These variables were selected based on existing literature demonstrating their association with disease severity, length of hospital stay and patient outcomes.[8]

OBJECTIVES

The main objective of this study is to analyze the direct medical costs incurred during hospital admissions of patients with DM treated for hyperglycemic emergencies (i.e., Diabetic Ketoacidosis or DKA, Hyperglycemic Hyperosmolar State or HHS, Diabetic Ketoacidosis-Hyperglycemic Hyperosmolar State Overlap or DKA-HHS, Euglycemic Diabetic Ketoacidosis).

Specifically, this study aims to:

1. Determine the median and distribution of direct medical costs incurred during hospital admissions of patients with DM treated for hyperglycemic emergencies.
2. Compare the median direct medical costs incurred across different socio-economic classifications.
3. Determine the association between selected factors – age, sex, etiology (i.e., infection, non-compliance with medications), presence of comorbidities, initial pH level, initial bicarbonate level, anion gap, type of diabetes, length of hospital stay) and direct medical costs among patients who had hyperglycemic emergencies.

METHODOLOGY

This paper was written following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. (Appendix B)

Study design

The researchers conducted a retrospective cohort study to evaluate the direct medical costs incurred by patients with diabetes mellitus admitted for hyperglycemic emergencies. This allowed assessment of cost accumulation during hospitalization and identification of factors associated with cost variation. The cost analysis was conducted from a healthcare payer perspective and was limited to direct medical costs, including diagnostics, medications, room charges and healthcare professional fees. Other categories of costs – indirect costs, out-of-pocket costs, administrative costs, long-term care costs, social costs, preventive care costs, legal and liability costs and behavioral health costs – were excluded. This focus on direct medical costs was a deliberate methodological choice reflecting the limited availability and reliability of non-medical cost data in the local setting. In the Philippine setting, where healthcare spending is largely out-of-pocket and the health system is fragmented, comprehensive tracking of indirect costs is challenging. Direct medical costs, routinely recorded in hospital billing and clinical records, provided the most feasible and consistent basis for analysis. Data were collected via retrospective review of medical records from January 1, 2017, to December 31, 2024.

Study setting

The study was conducted at East Avenue Medical Center, a tertiary government referral hospital in Quezon City. It is a 1,000-bed tertiary government hospital retained by the Department of Health in Quezon City. This facility serves as an apex referral center, offering medical services to a diverse patient population from multiple regions across the country, encompassing various socioeconomic backgrounds, the majority of which are indigents. The hospital has a well-established Department of Internal Medicine with dedicated subspecialty sections, including Endocrinology, which manages patients with diabetes mellitus and related complications. EAMC handles a high annual patient census, with diabetes consistently ranking among the leading causes of adult medical admissions.

Data gathering procedure

The researchers reviewed medical charts after obtaining permission from the Health Information Management Department of Medical Records and the Hospital Information System.

A review of databases from medical records from January 1, 2017, to December 31, 2024, was performed. The data-

base was searched using the following keywords: "DKA," "HHS," "DKA-HHS overlap," "diabetic ketoacidosis," "euglycemic DKA," and "hyperglycemic hyperosmolar state."

The following data were collected from medical records and recorded into the data abstraction form. Each patient received a unique identifier code. Demographics included age and sex. Clinical profile included type of DM (T1DM, T2DM, and others), duration of DM prior to onset of hyperglycemic emergency (in years), duration of symptoms (e.g., nausea, vomiting, abdominal pain, decreased sensorium) prior to presentation, vital signs (e.g., blood pressure, heart rate, respiratory rate, temperature), comorbidities (e.g., hypertension, pulmonary tuberculosis, autoimmune disorders, bronchial asthma, pregnancy), etiology (e.g., infection, non-compliance to medications), capillary blood glucose, random blood sugar, ketonuria, arterial blood gas (pH, pCO_2, HCO_3), anion gap, electrolytes (sodium, potassium, chloride), effective osmolality, level of care received (ward, ICU, ER) and type of hyperglycemic emergency (mild DKA, moderate DKA, severe DKA, HHS, DKA-HHS, Euglycemic DKA). Outcomes related to the patient included length of hospital stay, complications (e.g., hypoglycemia, hypokalemia, normal anion gap metabolic acidosis, thrombosis, cerebral edema, osmotic demyelination syndrome, acute kidney injury), and in-hospital mortality. Direct medical costs were extracted from medical and billing records and entered into a standardized data collection form. The cost components included medication expenses (e.g., intravenous fluids, electrolyte replacements, antibiotics, pressors, anti-diabetic medications), diagnostic fees, room charges and healthcare professional fees. These categories were selected based on their consistent availability and documentation in the patient records and were considered core components of inpatient care costs. However, some direct expenses not itemized or routinely documented may not have been fully captured. Consequently, the reported figures may underestimate the actual medical expenses incurred during hospitalization. The algorithm of the methodology is shown in Figure 1.

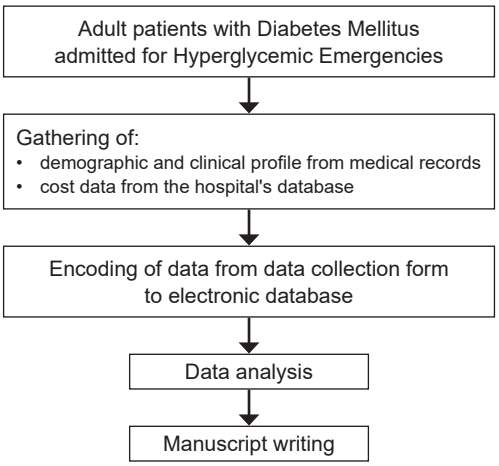

Figure 1. Algorithm of methodology.

Study participants

Adult patients who were clinically assessed to have hyperglycemic emergencies at East Avenue Medical Center from January 1, 2017, to December 31, 2024. The study period was selected based on the availability of accessible medical and billing records, with 2017 being the earliest year for which relevant data could be reliably retrieved.

Inclusion and exclusion criteria

The following individuals were included in the study: patients aged 18 years and above, diagnosed with DKA, HHS, DKA-HHS, or Euglycemic DKA, and admitted as service or private patients. Those with unavailable medical records were excluded.

Bias

Potential sources of bias included: selection bias due to incomplete or missing medical records and information bias related to inconsistencies in clinical documentation across the study period. To minimize bias in this study, the researchers utilized predefined inclusion and exclusion criteria to ensure objective patient selection and used a standardized data abstraction form to guide chart review.

Study outcome

The study's primary outcome of interest was the median cost and distribution of direct medical costs (in Philippine Peso) incurred during hospital admissions of patients with DM treated for hyperglycemic emergencies.

Sampling design

The researchers utilized a total enumeration technique. The study included all charts that met the inclusion and exclusion criteria.

Sample size

The sample size was computed using G*Power version 3.1. A minimum sample size of 395 was needed to achieve 80% power with a 5% level of significance in a multiple linear regression analysis with eight predictor variables of interest to detect a significant predictor of cost with a small effect size (Cohen's $f^2 = 0.02$). To ensure sufficient power for both objectives, a sample size of at least 395 participants was targeted for this study.

Data analysis

The data analysis involved descriptive statistics to summarize patient characteristics and direct medical costs of patients with diabetes mellitus treated for hyperglycemic emergencies seen at East Avenue Medical Center from January 1, 2017, to December 31, 2024. These were described across different types of hyperglycemic emergencies

and medical social service classifications. Box plots were generated to aid visual comparison between groups.

A generalized linear model with a gamma distribution and log-link function was used to analyze the relationship between total cost and the predictor variables of interest, adjusting for year of admission to account for inflation, policy changes, and the COVID-19 pandemic period. Length of hospital stay was log-transformed to address skewness, and influential data points were removed to improve model fit. The model was fitted using maximum likelihood estimation.

Data analysis was performed using Stata 17. The normality of distribution of numerical variables was checked using the Shapiro-Wilk test of normality. Missing values were neither replaced nor imputed. The generalized linear model excluded participants with missing data for total costs. Residual diagnostic plots were generated to check the fit of the generalized linear model. Statistical significance was set at $p < 0.05$.

In this retrospective cohort study, the researchers have opted not to perform sensitivity analyses. The primary focus is on the main outcomes as assessed by the predefined methodologies.

Ethical considerations

This study was approved by the EAMC institutional ethical review board (EAMC IERB 2024-150). The researchers adhered to ethical considerations and principles defined by relevant guidelines, including the Declaration of Helsinki, International Conference on Harmonization – Good Clinical Practice (ICH-GCP), National Ethical Guidelines for Research Involving Human Participants 2022, and the Data Privacy Act 2012.

RESULTS

A total of 377 patients with hyperglycemic emergencies were included in the analysis, as shown in Figure 2.

The demographics and clinical profiles of the study participants are presented in Table 1. Among the 377 patients, the majority presented with DKA, accounting for 69.5% of cases, with 38 classified as mild, 50 as moderate, and 174 as severe. This was followed by DKA-HHS overlap (19.4%) and HHS (10.9%). One case of euglycemic DKA was recorded. The median age of the cohort was 50 years (IQR: 24 years), with a male predominance (56.2%). Patients with HHS had the highest median age (65 years, IQR: 12 years), whereas DKA patients were generally younger (47 years, IQR: 23 years). T2DM was the most common diabetes type (83.6%), with all HHS patients diagnosed with T2DM. T1DM was more common in the DKA group (21.73%).

The median duration of diabetes was two years (IQR: 7 years), with patients experiencing symptoms for a median

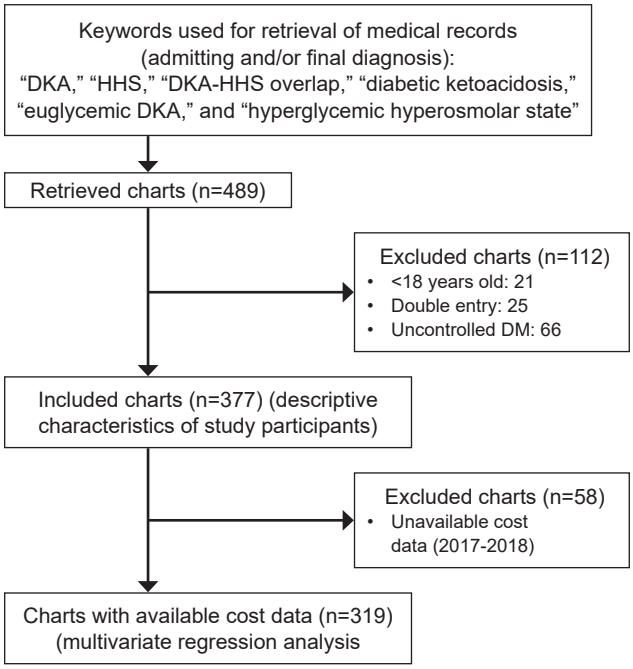

Figure 2. Participants flow diagram.

of three days (IQR: 6 days) before presenting to the hospital. The most common comorbidities were hypertension (37.7%) and pulmonary tuberculosis (16.2%). Infections (66.3%) and medication non-compliance (41.1%) were the most common precipitating factors.

On presentation, the median systolic and diastolic blood pressures were 120 mmHg (IQR: 30 mmHg) and 70 mmHg (IQR: 20 mmHg), respectively. Patients with HHS had higher median blood pressures compared to other groups. Random blood sugar was highest in DKA-HHS overlap (median: 702 mg/dL, IQR: 316 mg/dL) and lowest in DKA (median: 462 mg/dL, IQR: 258 mg/dL), consistent with the typical presentations of these conditions. The median glycosylated hemoglobin level was 12.7% (IQR: 4.18%), indicating poor glycemic control across all subgroups.

Patients with DKA had the lowest pH values (7.16, IQR: 0.29), while those with DKA-HHS overlap had the highest anion gap (28.7 mmol/L, IQR: 10.6 mmol/L), consistent with metabolic acidosis. The lowest bicarbonate levels were seen in DKA cases (HCO_3: 5.7 mmol/L, IQR: 7.2 mmol/L). Effective osmolality was highest in HHS patients (324 mOsm/kg, IQR: 30 mOsm/kg), confirming the hyperosmolar state characteristic of the condition. These findings support the diagnosis of each hyperglycemic emergency classification.

Most patients were managed in the emergency room (39.3%), while 24.9% were immediately transferred and managed in the intensive care unit (ICU). ICU admission was most frequent among patients with DKA-HHS overlap (31.5%). The median time to recovery was two days (IQR: 1 day) across all groups.

The most common in-hospital complications included acute kidney injury (48.0%), hypokalemia (36.7%) and hypoglycemia (26.8%). The incidence of acute kidney injury was highest among DKA-HHS overlap patients (69.9%), which may have contributed to the high mortality rate in this subgroup.

The overall in-hospital mortality rate was 35.0%, with the highest mortality observed in the DKA-HHS group (57.5%), followed by HHS (43.9%) and DKA (27.5%). The median length of hospital stay was seven days (IQR: 11 days), with prolonged hospitalization noted in patients with HHS (9 days, IQR: 12 days).

Table 1. Descriptive characteristics of study participants with diabetes mellitus treated for hyperglycemic emergencies seen at East Avenue Medical Center (n = 377)

Variables	Over all (n=377)	DKA (n=262)	HHS (n=41)	DKA-HHS (n=73)	Euglycemic DKA (n=1)
Age (years), median (IQR)	50 (24)	47 (23)	65 (12)	55 (22)	37
Sex, n (%)					
Male	212 (56.23%)	144 (54.96%)	20 (48.78%)	47 (64.38%)	1
Female	165 (43.77%)	118 (45.04%)	21 (51.22%)	26 (35.62%)	0
Type of diabetes mellitus, n (%)					
Type 1 DM	62 (16.4%)	56 (21.37%)	0	6 (8.22%)	0
Type 2 DM	315 (83.55%)	206 (78.63%)	41 (100.00%)	67 (91.78%)	1
Others	0	0	0	0	0
Duration of diabetes (years), median (IQR)	2 (7)	3 (8)	3 (7)	1 (6)	6
Duration of symptoms (days), median (IQR)	3 (6)	3 (6)	6 (8)	3 (6)	2
Comorbidities, n (%)					
Hypertension	142 (37.67%)	79 (30.15%)	27 (65.85%)	36 (49.32%)	0
Pulmonary tuberculosis	61 (16.18%)	44 (16.79%)	7 (17.07%)	10 (13.70%)	0
Autoimmune disorder	0	0	0	0	0
Bronchial asthma	14 (3.71%)	13 (4.96%)	0	1 (1.37%)	0
Pregnancy	3 (0.80%)	2 (0.76%)	0	1 (1.37%)	0
Etiology, n (%)					
Infection	250 (66.31%)	171 (65.27%)	29 (70.73%)	49 (67.12%)	1
Non-compliance to medications	155 (41.11%)	106 (40.46%)	18 (43.90%)	31 (42.47%)	0
Others	67 (17.77%)	45 (17.18%)	10 (24.39%)	12 (16.44%)	0
Systolic blood pressure (mmHg), median (IQR)	120 (30)	120 (30)	120 (40)	110 (30)	100
Diastolic blood pressure (mmHg), median (IQR)	70 (20)	70 (10)	80 (20)	70 (20)	60
Heart rate (bpm), median (IQR)	103 (23)	103 (22)	98 (22)	109 (22)	74
Respiratory rate (bpm), median (IQR)	22 (6)	22 (6)	20 (3)	23 (6)	20
Temperature (°C), median (IQR)	36.8 (0.4)	36.7 (0.4)	36.8 (0.4)	36.8 (0.4)	37.2
Capillary blood glucose (mg/dL), median (IQR)	452 (251.5)	403 (236)	563 (159)	600 (154)	178
Random blood sugar (mg/dL), median (IQR)	511 (336)	462 (258)	608 (365)	702.5 (316)	195
Ketonuria (+), median (IQR)	2 (1.5)	2 (2)	0 (0)	1 (1.75)	2
pH (mmol/L), median (IQR)	7.194 (0.286)	7.164 (0.299)	7.400 (0.083)	7.170 (0.262)	7.284
pCO2 (mmol/L), median (IQR)	18.1 (12.9)	16.1 (10.6)	28.6 (9.0)	21.0 (12.7)	21.5
HCO3 (mmol/L), median (IQR)	7.0 (9.2)	5.7 (7.2)	17.9 (7.0)	7.9 (7.3)	10
Anion gap (mmol/L), median (IQR)	26.6 (8.4)	27.0 (7.6)	19.9 (8.9)	28.7 (10.6)	21.8
Sodium (mmol/L), median (IQR)	135.70 (10.31)	133.40 (8.40)	148.00 (16.40)	146.57 (18.40)	136.2
Potassium (mmol/L), median (IQR)	4.33 (1.24)	4.40 (1.22)	4.06 (1.16)	4.21 (1.29)	3.54
Chloride (mmol/L), median (IQR)	101.0 (11.3)	99.6 (9.2)	110.3 (20.2)	109.3 (19.1)	104.4
Glycosylated hemoglobin (%), median (IQR)	12.70 (4.18)	12.66 (3.80)	10.80 (4.94)	14.30 (5.18)	13.8
Effective osmolality (mmol/L), median (IQR)	300 (27)	294 (17)	327 (32)	324 (30)	283
Time to recovery (days), median (IQR)	2 (1)	1 (1)	2 (1)	2 (2)	1
Level of care received, n (%)					
Emergency room	148 (39.26%)	95 (36.26%)	15 (36.59%)	38 (52.05%)	0
Ward	135 (35.81%)	106 (40.46%)	17 (41.46%)	12 (16.44%)	0
Intensive care unit	94 (24.93%)	61 (23.28%)	9 (21.95%)	23 (31.51%)	1
In-hospital complications, n (%)					
Hypoglycemia	101 (26.79%)	65 (24.81%)	16 (39.02%)	20 (27.40%)	0
Hypokalemia	139 (36.87%)	101 (38.55%)	15 (36.59%)	23 (31.51%)	0
Normal anion gap metabolic acidosis	1 (0.27%)	0	1 (2.44%)	0	0
Thrombosis	1 (0.27%)	0	0	1 (1.37%)	0
Cerebral edema	1 (0.27%)	1 (0.38%)	0	0	0
Osmotic demyelination syndrome	0	0	0	0	0
Acute kidney injury	181 (48.01%)	114 (43.51%)	16 (39.02%)	51 (69.86%)	0
Length of hospital stay (days), median (IQR)	7 (11)	8 (10)	9 (12)	5 (10)	6
In-hospital mortality, n (%)	132 (35.01%)	72 (27.48%)	18 (43.90%)	42 (57.53%)	0

The direct medical costs incurred during hospital admissions for hyperglycemic emergencies varied across the different clinical groups, as summarized in Table 2. Out of the 377 patients, cost data were available for only 319 patients due to the unavailability of cost data from 2017-2018. The overall median total cost was PhP 79,331.50 (IQR: 103,027.27). Among the subgroups, patients with HHS had the highest median total cost of PhP 143,902.77 (IQR: 184,655.35), followed by DKA cases at PhP 78,230.81 (IQR: 90,883.92) and DKA-HHS overlap cases at PhP 74,167.55 (IQR: 74,915.82). The single case of euglycemic DKA incurred a total cost of PhP 39,947.20.

The median medication costs were highest in HHS patients (PhP 13,209.46, IQR: 31,700.83), followed by DKA-HHS (PhP 7,361.34, IQR: 16,117.46), and lowest in DKA cases (PhP 5,460.74, IQR: 13,675.99). The costs of IV fluids and antibiotics were notably higher in HHS cases than in isolated DKA cases and DKA-HHS overlap cases. Patients with HHS had the highest antibiotic costs (PhP 2,105.87, IQR: 6,690.03), while the lowest was recorded in DKA patients (PhP 490.19, IQR: 4,646.51).

Diagnostic fees contributed significantly to the overall costs, with HHS patients incurring the highest median diagnostic expenses (PhP 74,250.86, IQR: 82,221.00), followed by DKA (PhP 41,898.50, IQR: 45,962.50) and DKA-HHS overlap cases (PhP 34,112.50, IQR: 47,235.00). Laboratory expenses accounted for a substantial portion of the diagnostic fees, with HHS patients paying a median of PhP 43,494.50 (IQR: 64,835.61), compared to PhP 27,955.00 (IQR: 39,552.00) in the overall cohort.

Room charges also varied across the subgroups, with the highest median cost recorded in HHS cases (PhP 8,400.00, IQR: 8,760.00). The costs for healthcare professional fees were highest among HHS cases, with a median of PhP 8,400.00 (IQR: 8,760.00).

The final model explained 18% of the deviance in total cost (AIC = 24.88, BIC = -1566.66). Model diagnostics indicated adequate fit with no evidence of systematic residual patterns (Appendix A). Log-transformed length of hospital stay showed a strong positive association with total cost (β = 0.5612, 95%CI [0.5170, 0.6053], p <0.001). This indicates that a 1% increase in length of hospital stay is associated with a 0.01% increase in expected median total cost. Age was positively associated with total cost (β = 0.0080, 95% CI [0.0036, 0.0124], p <0.001), with each additional year corresponding to a 0.80% increase in expected total cost. The presence of infection was a significant factor (β = 0.1571, 95% CI [0.0288, 0.2854, p = 0.016), as these patients had 17% higher expected median total cost than those without infection. Non-compliance with medication was also significant (β = -0.2096, 95% CI [-0.3251, -0.0940, p = 0.009) as non-compliant patients had 19% lower expected median total cost than those with other precipitating causes. Initial pH level was negatively associated with total cost (β = -0.7737, 95% CI [-1.1620, -0.3853], p <0.001), with each additional unit corresponding to a 53.87% decrease in expected total cost. Anion gap was negatively associated with total cost (β = -0.0130, 95% CI [-0.0213, -0.0047], p = 0.002), with each additional mmol/L corresponding to a 1.29% decrease in expected total cost. Table 3 shows the patient-related clinical predictors of direct medical costs incurred during hospital admissions of patients with diabetes mellitus treated for hyperglycemic emergencies.

Table 4 presents the comparison of direct medical costs incurred during hospital admissions for diabetic ketoacidosis (DKA) across different socioeconomic classifications. The median total costs varied significantly among the different socio-economic classes, with the highest costs observed in Class D (PhP 94,024.65, IQR: 114,872.00) and the lowest in Class A (PhP 40,449.56, IQR: 7,084.32).

Medication costs were also highest among Class B patients (PhP 9,938.47, IQR: 17,933.90), whereas Class A patients

Table 2. Summary of direct medical costs (in PhP) incurred during hospital admissions of patients with diabetes mellitus treated for hyperglycemic emergencies (n = 319)

Direct medical costs	Over all (n=319)	DKA (n=214)	HHS (n=40)	DKA-HHS (n=64)	Euglycemic DKA (n=1)
Total costs, median (IQR)	79,331.50 (103,027.27)	78,230.81 (90,883.92)	143,902.77 (184,655.35)	74,167.55 (74,915.82)	39,947.20
Medications cost, median (IQR)	6,572.17 (15,699.18)	5,460.74 (13,675.99)	13,209.46 (31,700.83)	7,361.34 (16.117.46)	2,682.18
IV fluids	792.05 (1,315.69)	770.32 (1,143.09)	1,497.63 (1.490.71)	705.17 (1,171.30)	997.22
Electrolyte replacement	403.00 (1,122.13)	444.87 (1,198.28)	245.78 (887.48)	370.80 (1,041.08)	520.00
Antibiotics	657.21 (4,584.37)	490.19 (4,646.51)	2,105.87 (6.690.03)	939.20 (3,758.50)	248.95
Pressors	0 (175.52)	0 (109.70)	0 (670.02)	103.40 (2,573.94)	0.00
Anti-diabetic medications	288.96 (351.25)	288.96 (368.52)	288.93 (380.60)	244.00 (159.12)	239.10
Others	9,555.14 (19,007.80)	8,173.99 (15,652.32)	16,493.83 (39,020.71)	13,478.55 (17,951.43)	5,185.02
Diagnostic fees (PhP), median (IQR)	41,507.00 (51,689.00)	41,898.50 (45,962.50)	74,250.86 (82,221.00)	34,112.50 (47,235.00)	15,340.00
Imaging	4,662.50 (6,990.50)	1,570.00 (5,117.50)	6,352.50 (7,602.50)	4,937.50 (7,222.50)	365.00
Laboratory	27,955.00 (39,552.00)	27,951.50 (36,577.00)	43,494.50 (64,835.61)	21,883.50 (35,495.00)	8,575.00
Arterial blood gas	8,400.00 (9,600.00)	9,600.00 (10,800.00)	6,000.00 (10,576.00)	6,600.00 (8,400.00)	6,000.00
Others	400.00 (400.00)	400.00 (400.00)	400.00 (3,600.00)	400.00 (400.00)	400.00
Room charges (PhP), median (IQR)	8,400.00 (20,000.00)	8,350.00 (18,000.00)	13,100.00 (23,650.00)	6,750.00 (20,700.00)	12,000.00
Healthcare professional (PhP), median (IQR)	4,740.00 (6,840.00)	4,740.00 (3,750.00)	8,400.00 (8,760.00)	4,740.00 (8,400.00)	4,740.00
Other costs, median (IQR)	9,555.14 (19,007.80)	8,173.99 (15,652.32)	16,493.83 (39,020.71)	13,478.55 (17,951.43)	5,185.02

incurred the least (PhP 1,879.99, IQR: 6,228.45). Diagnostic fees followed a similar trend, with Class D having the highest median cost (PhP 48,979.00, IQR: 45,723.00) and Class A the lowest (PhP 20,859.00, IQR: 8,008.29).

Room charges and healthcare professional fees also varied across socio-economic classes, with Class B patients incurring the highest room charges (PhP 12,300.00, IQR: 18,400.00), while Class C2 had the lowest (PhP 6,300.00, IQR: 17,350.00). Median healthcare professional fees remained relatively stable across all classes, ranging from PhP 4,545.00 to PhP 5,000.00.

Table 5 presents the comparison of direct medical costs incurred during hospital admissions for hyperosmolar hyperglycemic state (HHS) across different socio-economic classifications. The highest total costs were observed among Class B patients, with a median expenditure of PhP 192,289.90 (IQR: 210,735.30). The lowest median total cost was reported in Class C2 (PhP 33,062.67, IQR: 3,196.05).

Medication costs also varied among the groups, with Class B patients incurring the highest median expense (PhP 27,531.91, IQR: 47,365.02), while Class C2 had the lowest (PhP 615.70, IQR: 6,986.11). Diagnostic fees were highest in Class D (PhP 86,870.80, IQR: 60,423.50) and lowest in Class C2 (PhP 19,578.00, IQR: 6,396.00).

Room charges were highest for Class B (PhP 13,200.00, IQR: 22,000.00) and lowest for Class C2 (PhP 400.00, IQR: 2,600.00). Healthcare professional fees were relatively similar across most socio-economic classes, with a median range of PhP 1,560.00 to PhP 9,600.00, except for Class C1, which had a slightly higher median of PhP 9,135.00 (IQR: 11,745.00).

Table 6 presents the comparison of direct medical costs incurred during hospital admissions for diabetic ketoacidosis-hyperosmolar hyperglycemic state (DKA-HHS) across different socio-economic classifications. The highest median total costs were observed in Class B patients at PhP 121,036.70 (IQR: 74,033.64). The lowest total cost was seen in Class C1 (PhP 63,274.71, IQR: 65,184.36).

Medication costs were highest in Class B (PhP 21,266.39, IQR: 36,278.45) and lowest in Class C3 (PhP 4,985.14, IQR: 30,316.22). Diagnostic fees followed a similar trend, with Class B incurring the highest costs (PhP 32,930.50, IQR: 38,895.25), while Class C2 had the lowest (PhP 30,428.00, IQR: 65,876.27).

Room charges were highest in Class B (PhP 10,500.00, IQR: 14,800.00) and lowest in Class C2 (PhP 800.00, IQR: 17,100.00). Healthcare professional fees were highest in Class B (PhP 9,600.00, IQR: 2,880.00) and lowest in Class C3 (PhP 1,560.00, IQR: 7,200.00).

Figures 3A and 3B illustrate the total hospitalization costs (in PhP ×1,000) for patients admitted with diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic state (HHS), and combined DKA-HHS, stratified by socio-economic classification. Figure 3A includes all observations,

Table 3. Patient-related clinical predictors of direct medical costs incurred during hospital admissions of patients with diabetes mellitus treated for hyperglycemic emergencies (n = 300)

Predictor variable	Coefficient (β)	Std. err.	95% CI	*p*-value
Age	0.0080	0.0022	0.0036, 0.0124	0.000
Female sex	-0.0319	0.0507	-0.1313, 0.0675	0.529
Infection	0.1571	0.0655	0.0288, 0.2854	0.016
Non-compliance	-0.2096	0.0590	-0.3251, -0.0940	0.000
Presence of any comorbidity	0.0460	0.0366	-0.0257, 0.1178	0.208
Initial pH level	-0.7737	0.1982	-1.1620, -0.3853	0.000
Initial bicarbonate level	0.0039	0.0073	-0.0104, 0.0182	0.593
Anion gap	-0.0130	0.0042	-0.0213, -0.0047	0.002
Type 2 diabetes	-0.0612	0.0944	-0.2462, 0.1238	0.517
Length of hospital stay	0.5612	0.0225	0.5170, 0.6053	0.000

Note: The model was adjusted for year of admission.

Table 4. Comparison of direct medical costs (in PHP) incurred during hospital admissions of patients with diabetes mellitus treated for DKA across different socio-economic classification (n = 214)

Direct medical costs	Class A (n=5)	Class B (n=26)	Class C1 (n=48)	Class C2 (n=43)	Class C3 (n=48)	Class D (n=92)
Total costs, median (IQR)	40,449.56 (7,084.32)	84,942.48 (72,771.93)	83,958.97 (75,436.46)	66,710.88 (79,568.38)	69,082.95 (78,608.75)	94,024.65 (114,872.20)
Medications cost, median (IQR)	1,879.99 (6,228.45)	9,938.47 (17,639.30)	6,055.02 (14,242.77)	4,333.29 (9,320.59)	5,507.23 (11,660.99)	4,795.59 (18,605.74)
Diagnostic fees, median (IQR)	20,859.00 (8,008.29)	40,221.00 (36,386.00)	45,404.00 (46,525.50)	34,414.13 (44,250.25)	41,496.50 (30,775.19)	48,979.00 (45,723.00)
Room charges, median (IQR)	10,000.00 (12,100.00)	12,300.00 (18,400.00)	10,400.00 (18,100.00)	6,300.00 (17,350.00)	8,100.00 (18,100.00)	7,750.00 (19,600.00)
Healthcare professional, median (IQR)	5,000.00 (1,622.00)	4,740.00 (1,662.00)	4,740.00 (3,642.00)	4,545.00 (4,776.00)	4,740.00 (3,540.00)	4,740.00 (4,590.00)

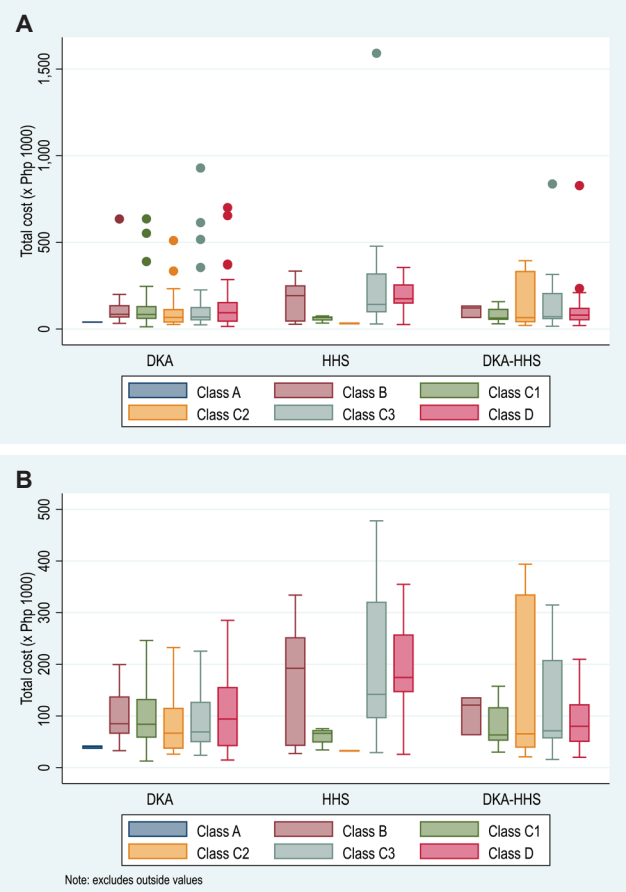

Figure 3. Box plots of total costs by hyperglycemic emergency across different socioeconomic classification **(A)**. Blow-out box plot by excluding outside values **(B)** for better visualization of the distribution.

including outliers, while Figure 3B presents the same data with outliers excluded to emphasize the distribution of typical costs.

Across all clinical categories, Class A patients—those classified as fully paying—incurred the lowest and most uniform costs. In contrast, patients from lower socioeconomic classes, particularly Classes C3 and D, exhibited greater cost variability, with several high-cost outliers observed in the HHS and DKA groups. The most extreme outlier, seen in a Class C3 patient with HHS, exceeded PhP 1.5 million in total costs (Figure 3A). When these outliers are excluded (Figure 3B), the data more clearly demonstrate that median costs were generally higher for Classes B, C3, and D compared to Classes C1 and C2.

Among the three clinical presentations, HHS was associated with the highest median and upper-quartile costs, followed by DKA-HHS and DKA. These findings suggest that both disease severity and socioeconomic classification significantly influence hospitalization costs. The wide cost variability among subsidized patients raises important considerations for resource allocation, especially in public healthcare settings aiming to deliver equitable care.

Post hoc power analysis

A simulation-based power analysis to estimate the minimum detectable effect size (β) for a Generalized Linear Model (GLM) with a Gamma distribution and log link, using approximately 300 eligible participants from the census. The outcome variable was total hospital cost,

Table 5. Comparison of direct medical costs (in PHP) incurred during hospital admissions of patients with diabetes mellitus treated for HHS across different socio-economic classification (n = 40)

Direct medical costs	Class A (n=0)	Class B (n=12)	Class C1 (n=4)	Class C2 (n=3)	Class C3 (n=9)	Class D (n=13)
Total costs, median (IQR)	-	192,289.90 (210,735.30)	66,487.14 (24,609.41)	33,062.67 (3,196.05)	141,926.20 (225,912.00)	174,541.00 (112,120.60)
Medications cost, median (IQR)	-	27,531.91 (47,365.02)	4,156.52 (4,769.56)	615.70 (6,986.11)	12,976.45 (33,724.16)	18,076.28 (30,920.38)
Diagnostic fees, median (IQR)	-	78,618.00 (98,657.75)	28,183.11 (13,131.61)	19,578.00 (6,396.00)	82,148.00 (81,733.50)	86,870.00 (60,423.50)
Room charges, median (IQR)	-	13,200.00 (22,000.00)	3,600.00 (6,200.00)	400.00 (2,600.00)	22,600.00 (21,600.00)	18,000.00 (17,900.00)
Healthcare professional, median (IQR)	-	9,600.00 (15,300.00)	9,135.00 (11,745.00)	1,560.00 (4,590.00)	5,790.00 (5,220.00)	9,600.00 (1,550.00)

Table 6. Comparison of direct medical costs (in PHP) incurred during hospital admissions of patients with diabetes mellitus treated for DKA-HHS across different socio-economic classification (n = 64)

Direct medical costs	Class A (n=0)	Class B (n=6)	Class C1 (n=13)	Class C2 (n=12)	Class C3 (n=11)	Class D (n=31)
Total costs, median (IQR)	-	121,036.70 (74,033.64)	63,274.71 (65,184.36)	65,364.28 (297,187.50)	71,214.21 (152,352.00)	80,036.89 (73,248.77)
Medications cost, median (IQR)	-	21,266.39 (36,278.45)	8,005.78 (11,403.74)	10,869.26 (48,548.39)	4,985.14 (30,316.22)	7,959.07 (11,661.35)
Diagnostic fees, median (IQR)	-	32,930.50 (38,895.25)	30,253.50 (33,462.50)	30,428.00 (65,876.27)	35,126.00 (56,574.50)	42,423.86 (49,882.00)
Room charges, median (IQR)	-	10,500.00 (14,800.00)	4,000.00 (16,800.00)	800.00 (17,100.00)	8,800.00 (37,800.00)	9,400.00 (24,600.00)
Healthcare professional, median (IQR)	-	9,600.00 (2,880.00)	5,790.00 (8,040.00)	4,740.00 (11,280.00)	1,560.00 (7,200.00)	4,740.00 (7,200.00)

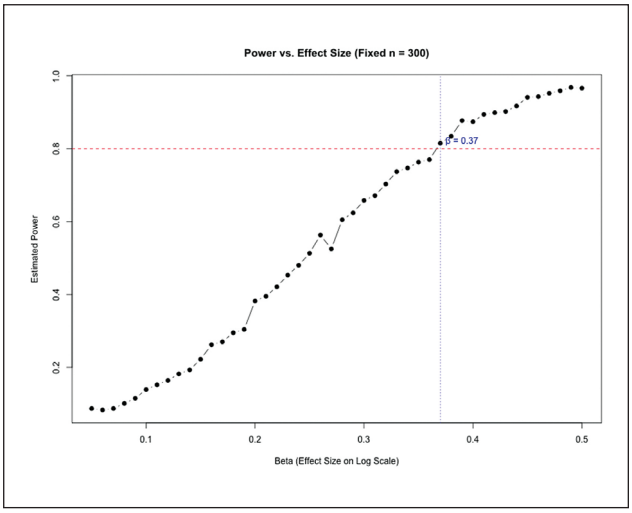

Figure 4. Power analysis of the approximately 300 eligible participants from the census.

modeled as Gamma-distributed with an assumed shape parameter of 1 (Figure 4).

The model included the following covariates of interest: age, sex, infection, non-compliance, comorbidity, pH, bicarbonate, anion gap, type 2 diabetes, length of hospital stay, and confounder: year of admission.

Using simulation (1,000 iterations per tested effect size), the β was varied, and the statistical power to detect it at a significance level of $\alpha = 0.05$ was recorded. The minimum detectable β with at least 80% power was estimated to be $\beta = 0.37$ on the log scale, corresponding to a relative increase of exp(β) = 45 % increase in total cost associated with a particular variable of interest while controlling the other factors constant.

DISCUSSION

This study evaluated the direct medical costs incurred during hospital admissions for hyperglycemic emergencies among patients with diabetes mellitus in a tertiary government hospital in the Philippines. Specifically, the study aimed to estimate the median cost of hospitalization, examine variations across socio-economic classifications, and identify clinical and biochemical factors associated with increased healthcare expenditures.

DKA was the most common hyperglycemic emergency in this cohort, accounting for nearly 70% of admissions. This finding is consistent with recent international reports noting the predominance of DKA over HHS, particularly in low- and middle-income countries. However, the incidence of DKA-HHS overlap was notably higher than reported in global literature and local studies conducted in private tertiary hospitals.[3,4] The variation in case distribution may reflect the role of the study institution as an apex hospital, receiving complex and severe cases from surrounding provinces and underserved communities.

HHS is classically seen in older patients with long -standing type 2 diabetes, yet in our cohort, DKA (69.5%) was far more common than HHS (10.9%) despite 83.6% having T2DM. This apparent paradox likely reflects a sizeable subgroup of adults with T2DM who manifest an insulin-deficient, ketosis-prone phenotype; the relatively short median diabetes duration (3 years) and the younger age of the DKA group (median 47 years versus 65 years for HHS) are consistent with this pattern.[9]

In this study, most DKA cases were severe (n = 174). This means that the majority of patients with DKA needed intensive care. ICU admission was mainly recommended for these severe DKA cases, as well as for patients with HHS and those with overlapping features of both conditions.

Infection (66.31%), including community-acquired pneumonia, hospital-acquired pneumonia, urinary tract infection and non-compliance with medication (41.11%), were identified as the predominant causes of hyperglycemic emergency, aligning with global data. Other precipitating causes include cerebrovascular disease, acute pancreatitis and upper gastrointestinal bleeding. The in-hospital mortality rate observed in this study (35.01%) aligns with global trends reported in low- and middle-income countries.[4] In this study, in-hospital mortality rates for DKA-HHS overlap at 57.53%, surpassing global trends of 3.6% in Nigeria, 5.3% in Japan, 8% in the United States, and 25% in Jamaica. This likely indicates systemic challenges such as delayed access to care, limited ICU resources, and elevated rates of acute kidney injury (48.01%), which is a recognized predictor of mortality.[10]

The median direct medical cost per admission for a hyperglycemic emergency was PhP 79,331.50 (USD 1,375.02), representing a substantial financial burden in the context of current household income and health expenditure patterns in the Philippines. To contextualize this burden, the 2023 estimated average annual family income was PhP 353,230 (USD 6,122.39),[11] meaning the median hospitalization represents approximately 22.5% of the estimated average annual family income. This figure far exceeds the average annual health expenditure per capita, estimated at PhP 11,083.00 (USD 192.10)[12] in 2023, suggesting that such emergencies can impose a strain on the health spending of families, particularly among lower-income groups.

To enable international comparisons, the median direct medical cost was converted using the 2023 World Bank Purchasing Power Parity (PPP) conversion factor for the Philippines (PhP 19.26 = International USD 1), resulting in an adjusted cost of approximately International (Int'l) USD 4,120. When adjusted for PPP to allow for valid cross-country comparisons, this cost is markedly higher than that reported in other low- and middle-income settings. For example, the direct medical cost per admission in Thailand was reported at USD 1,096.17,[13] which translates to **Int'l USD 1,045** using Thailand's PPP of 10.49. Similarly, in South Africa, a cost of USD 288.98[14] corresponds to **Int'l USD**

750 using a PPP of 3.85. These comparisons suggest that, relative to purchasing power, managing hyperglycemic emergencies in the Philippines imposes a heavier financial burden on both patients and the health system.[15]

This burden becomes even more significant when considered in the context of local income and health financing. Locally, the financial coverage provided by the national health insurance program, PhilHealth, remains limited. As of the latest schedule, PhilHealth provides a case rate of PhP 30,810.00 for diabetes mellitus with coma or ketosis (ICD code E10.1), covering only 38.8% of the observed median hospitalization cost. This leaves an average out-of-pocket expense of PhP 48,521.50, which constitutes roughly 13.7% of a household's annual income – far exceeding the World Health Organization's threshold for catastrophic health expenditure (10%).

The highest costs incurred by HHS amounted to PhP 143,902.77 (USD 2,493.21), likely attributable to extended ICU stays, complicated fluid and electrolyte management, and increased resource utilization associated with higher mortality rates. Diagnostic fees represented the most significant cost component (PhP 41,507.00, USD 719.42), primarily due to the necessity for regular laboratory monitoring (e.g., arterial blood gas analysis, electrolyte panel, random blood sugar). The cost incurred by DKA (PhP 78,230.81, USD 1,355.94) was lower than that for HHS, yet remained substantial. Euglycemic DKA resulted in the lowest costs (PhP 39,947.20, USD 692.39); however, the limited sample size (n = 1) restricts generalizability. This study reports lower direct medical costs per DKA admission than US-based studies, costing USD 1,343.70 (IQR: USD 1,561.04) versus USD 21,215.00 to USD 36,600. A UK-based study estimated the cost of DKA admission to be £2,064.00 (USD 2,568.54).[4] These discrepancies likely reflect differences in healthcare system structures, unit pricing, and availability of subsidized care. As this study was conducted in a public tertiary referral hospital with substantial government subsidies, the costs captured here represent a fraction of the actual economic burden. They are not directly comparable to costs in private or unsubsidized settings.

The median length of hospitalization for DKA was comparable to that of HHS, with durations of 8 and 9 days, respectively. However, room charges for DKA patients were significantly lower. This discrepancy may be attributed to the relatively lower mortality rate among DKA cases (27.5%) compared to HHS (43.9%) and overlap cases (57.5%). The reduced mortality rate in DKA patients was supported by a shorter median time to resolution of DKA — 1 day (IQR: 17) — versus 2 days (IQR: 21.5) observed in other groups. This equates to an earlier transition from intensive care to regular ward settings. Additionally, most patients in this cohort belonged to classes D and E, which may have contributed to extended hospitalization due to the time required for processing the discharge procedure, such that patients would seek further government help for financial aid. These findings are corroborated by the results of the final analytical model, which identified length of stay as a primary cost driver, with longer hospitalizations associated with increased total costs.

Socioeconomic stratification demonstrated disparities in healthcare expenses. In cases of DKA, patients classified as Class D (lower income) experienced greater costs (PhP 94,024.65) compared to Class A (PhP 40,449.56), likely attributable to delayed presentation necessitating more advanced interventions. In contrast, HHS costs were highest in Class B (PhP 192,289.90), indicating that middle-income groups may encounter obstacles to preventive care, resulting in significant decompensation of glycemic control and subsequent admission for such emergencies. Published studies on inequities in care costs associated with hyperglycemic emergencies are limited.

The final model used in this study accounted for 18% of the deviance in total direct medical costs for hyperglycemic emergencies, indicating modest explanatory power. Nonetheless, the model diagnostics demonstrated an adequate fit with no significant residual trends, supporting the validity of the identified associations.

In the analysis, length of hospital stay (LOS) emerged as the most significant driver of cost. The log-transformed length of hospital stay was used to account for the skewed distribution of LOS data and to model its association with median total costs. The median LOS in the cohort was 7 days, which served as the baseline reference point for interpretation. This means that the predicted costs are calculated relative to a patient with a 7-day stay. For example, an increase to 8 days (approximately 14.3% longer than the median) corresponds to an estimated 0.143% increase in total cost, while a stay of 10 days (43% longer) would be associated with approximately a 0.43% increase in costs. The estimated 0.143% per additional day was derived from the regression coefficient ($\beta = 0.5612$), indicating that each 1% increase in LOS results in a 0.01% increase in total cost. Since a one-day increase (from 7 to 8 days) represents approximately a 14.3% increase ($1/7 \times 100\%$), we multiply 14.3% by 0.01% to arrive at the 0.143% increase in total cost per additional day. This finding is consistent with prior studies, which consistently highlight prolonged hospitalization as a major determinant of cost in diabetes care due to higher utilization of intensive care and procedures. Efficient inpatient protocols—such as early recognition of metabolic stabilization, prompt transition to subcutaneous insulin, and timely discharge planning—may offer meaningful opportunities to reduce unnecessary expenditure.[16]

Age was also positively associated with total cost with each additional year of age corresponds to a 0.80% increase in expected total cost. Using the median age of 50 years as a reference point, this translates to meaningful cost variations across the age spectrum: a 60-year-old patient would incur approximately 8% higher costs compared to the median, while a 70-year-old would face roughly 16% higher costs.

This finding aligns with established healthcare economics literature and the recent published article by the American Diabetes Association last 2023.[17]

Infection as a precipitating factor was associated with a 17% increase in expected costs. This likely reflects the additive burden of managing concurrent infectious processes requiring more diagnostics, intravenous antibiotics, and potentially longer hospitalizations.[18]

Non-compliance with medications was associated with a 16% reduction in total costs. In our study, patients with DKA precipitated by non-compliance exhibited a lower mortality rate (32.9%) and a shorter median time to resolution (1 day vs. 2 days) compared to the compliant group. Despite experiencing a higher proportion of in-hospital complications (81.2% vs. 73.8%), both groups had a similar median hospital stay of 7 days. Notably, the lower costs linked to non-compliance may be explained by these faster resolution times and lower mortality rates, aligning with findings from other studies that indicate lower per-admission costs in non-compliance-related DKA episodes. However, they may contribute significantly to the overall economic burden due to their higher frequency.[19]

Initial pH level was negatively associated with total cost, with each additional unit corresponding to a 53.87% decrease in expected total cost. Higher initial pH can be seen in patients presenting with higher pH values around 7.5—more commonly observed in hyperosmolar hyperglycemic state (HHS) and DKA-HHS overlap cases—would demonstrate substantially lower total costs. This counterintuitive inverse relationship can be primarily attributed to the paradoxically higher early mortality rates observed in HHS and overlap presentations in this study, where severe hyperosmolarity and metabolic derangements lead to rapid clinical deterioration and early demise, thereby truncating the opportunity for prolonged intensive care utilization and cumulative cost accumulation.

Lastly, a small but statistically significant inverse relationship was observed between anion gap and total hospital cost, with each 1 mmol/L increase in anion gap associated with a 1.29% decrease in expected cost. Higher anion gaps are commonly used to classify the severity of DKA, with larger gaps indicating more severe metabolic disturbances.[4] At first glance, this counterintuitive finding may suggest that patients with more severe DKA — reflected by higher anion gaps — incur lower healthcare costs, potentially due to rapid deterioration leading to earlier mortality and shorter hospital stays. However, further analysis is needed to clarify whether this relationship is driven by mortality or other factors associated with disease severity.

Limitations of the study

This study has several limitations. Its retrospective design inherently limits the accuracy and completeness of the data, as it relied on how thoroughly physicians and other healthcare personnel documented a patient's clinical status and direct medical costs in the medical records. Some medical charts contained incomplete data, which may have affected data quality.

Notably, only 319 out of the initially planned 395 charts contained complete cost data and were included in the final analysis. While a post hoc GLM/Gamma simulation power analysis was conducted to estimate statistical power given the reduced sample size, this shortfall may have limited the study's ability to detect smaller effect sizes and increased the risk of type II error. It also raises the potential for selection bias, as missing cost data could be associated with patient characteristics or clinical outcomes not captured in the analysis.

Subgroup analyses were not performed in this study, which may have further limited the exploration of heterogeneity within the patient population. Further studies should consider incorporating subgroup analyses to understand differential cost drivers better.

This study was conducted at EAMC, a tertiary government hospital in the Philippines, primarily serving lower-to middle-income patients. As a result, the findings may be more applicable to public hospital settings and populations with limited healthcare access rather than private hospital settings or high-income populations. In addition, since the data were collected from a single institution, the results may not fully reflect cost variations in other hospitals, particularly private hospitals or rural healthcare settings.

The study only assessed direct medical costs from a healthcare payer perspective within the Philippine healthcare system. Since healthcare financing, insurance systems, and hospital financial structures vary across different countries, cost estimates in this study may not be directly related to other countries with different healthcare systems from those in the Philippines. However, the identified predictors of cost are likely relevant across different healthcare systems.

Since there is a relatively lower proportion of HHS compared to DKA in this study, in regions where HHS is more prevalent, or where care differs significantly, cost distributions and predictors may differ. Additionally, mortality and in-hospital complication rates are higher, suggesting more severe disease at presentation, limiting the applicability of the cost estimates in this study to settings where good glycemic control and good patient compliance are observed.

Lastly, the findings in this study may be more applicable to low-and middle-income countries where resource constraints and government-subsidized hospitalization significantly impact hospitalization costs.

CONCLUSION AND RECOMMENDATIONS

This study presents one of the first local estimates of direct medical costs associated with hyperglycemic emergencies in a Philippine public tertiary hospital, revealing a substantial financial burden on patients, particularly among lower-income groups. Key cost drivers included longer hospital stays and infections. In contrast, lower costs were associated with female sex, non-compliance with medications and higher anion gap—possibly reflecting differences in disease severity or early mortality. Despite study design and limitations, it offers relevant insights for health system planners and policy makers.

Future research should expand to multicenter settings, incorporate subgroup and sensitivity analysis, and explore cost variations based on DKA severity, level of care, and socioeconomic classification.

Statement of Authorship
All authors certified fulfillment of ICMJE authorship criteria.

CRediT Author Statement
JPA: Conceptualization, Methodology, Validation, Investigation, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration; **AILD:** Conceptualization, Methodology, Software, Validation, Data curation, Writing – original draft preparation, Writing – review and editing, Visualization; **MRP:** Conceptualization, Methodology, Resources, Writing – original draft preparation, Writing – review and editing; **EQV:** Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft preparation, Writing – review and editing, Visualization, **CT:** Conceptualization, Methodology, Validation, Resources, Writing – original draft preparation, Writing – review and editing Supervision, Project administration.

Data Availability Statement
Datasets generated and analyzed are included in the published article.

Author Disclosure
JPA, AILD, MRP, and CT declare no conflict of interest. EQV is a biostatistician and peer reviewer for JAFES and receives compensation from the same institution.

Funding Source
None.

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APPENDICES

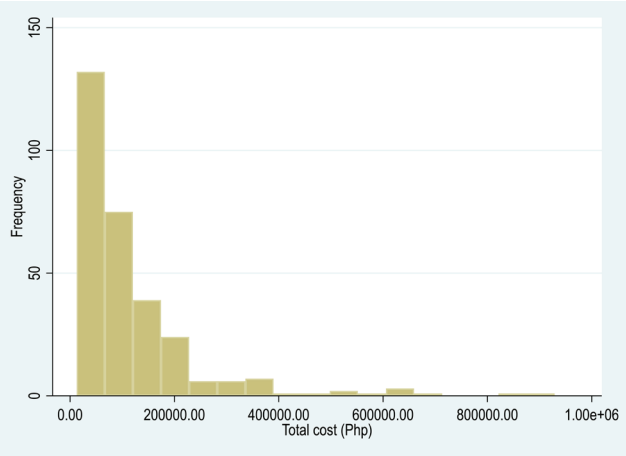

Figure A1. The histogram of the dependent variable total cost showing gamma distribution.

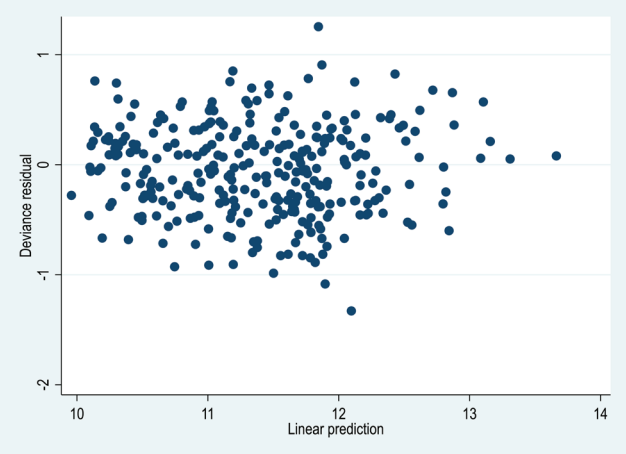

Figure A2. Deviance residual versus linear prediction plot shows random scatter indicating validity of the log link function.

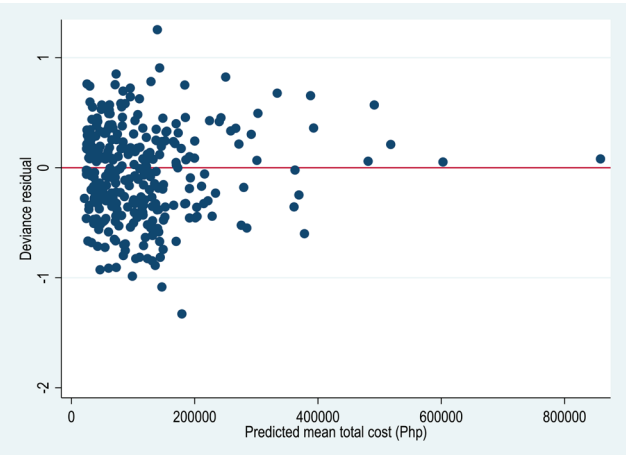

Figure A3. Deviance residual versus predicted plot shows random scattering around zero indicating homoskedasticity.

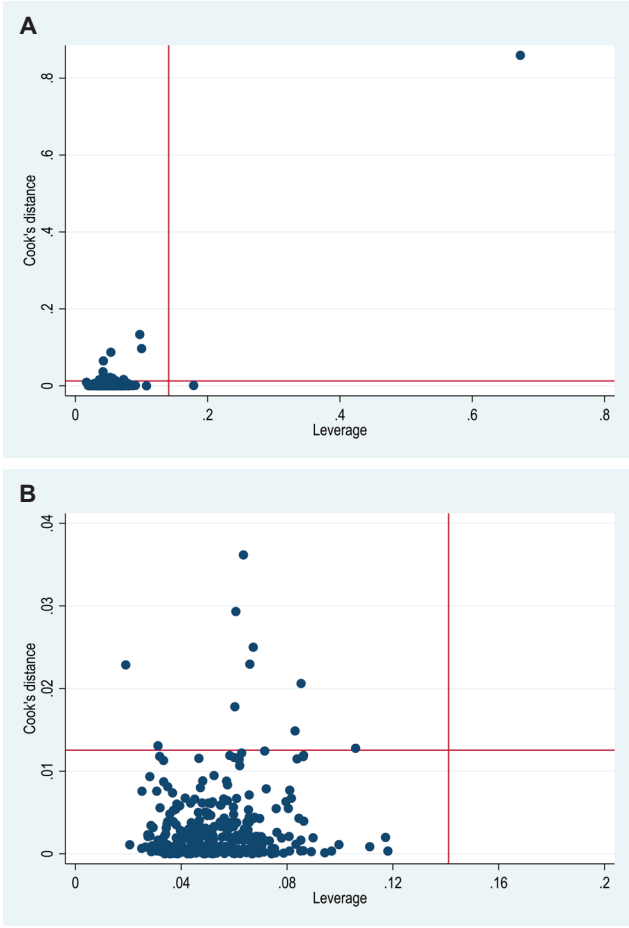

Figure A4. Cook's distance versus leverage plot showing before **(A, n=319)** and after **(B, n=300)** removing influential points.

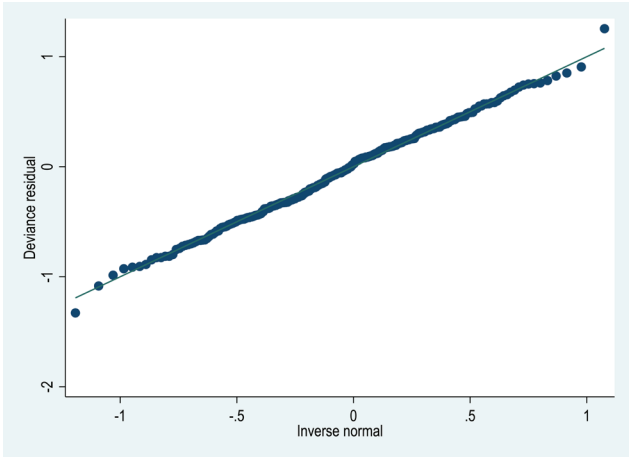

Figure A5. Normal Q-Q plot of deviance residual indicating normal distribution.

Appendix B. STROBE Statement—Checklist of items that should be included in reports of cohort studies

	Item No.	Recommendation	Page No.
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	
		(c) Explain how missing data were addressed	
		(d) If applicable, explain how loss to follow-up was addressed	
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	10
		(c) Consider use of a flow diagram	10
Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (e.g., average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	12
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19
Generalisability	21	Discuss the generalisability (external validity) of the study results	24
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	25

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.