Validation of Predicting Hyperglycemic Crisis Death Score: A Risk Stratification Tool for Appropriate Disposition of Hyperglycemic Crisis Patients from the Emergency Department

Akilan Elangovan, Srihari Cattamanchi, Abdul Razack Farook, Ramakrishnan Venkatakrishnan Trichur

Department of Emergency Medicine, Sri Ramachandra Medical College and Research Institute, Chennai, Tamil Nadu, India

Abstract

Context: Predicting hyperglycemic crisis death (PHD) score is a simple, rapid tool with six independent mortality predictors to calculate 30-day mortality and appropriately dispose patients to Intensive Care Unit (ICU) or ward. Aims: This study aimed at validating the efficiency of PHD score as a decision rule for prognosticating 30-day mortality and classifying hyperglycemic crisis patients for appropriate disposition from the emergency department (ED). Materials and Methods: This is a prospective, observational study done in the ED of a teaching hospital over 14 months. All patients aged >18 years and who met the criteria of hyperglycemic crisis were enrolled. Thirty-day mortality of six independent predictors was the primary end point. Using PHD, risk scores were calculated and patients were disposed as per physician’s clinical judgment. Finally, the treating physician’s decision and PHD score disposition were compared and the efficiency of PHD in predicting 30-day mortality was analyzed. Multiple logistic regression models were used for analysis. Receiver operating characteristic curve was drawn, and area under the curve along with sensitivity, specificity, positive predictive value, and negative predictive value was analyzed. \( P < 0.05 \) was considered statistically significant. Results: A total of 133 patients were included. On applying PHD score, 69, 39, and 25 patients were in the low-, intermediate-, and high-risk groups, respectively, with a mortality rate of 5.8%, 20.5%, and 56%, respectively. On comparing physician disposition with PHD score, an increasing mortality was noticed in ICU, and PHD showed equal weight in risk stratification and appropriate disposition of patients. Conclusion: In adult patients with hyperglycemic crisis, PHD score is validated as a straightforward, prompt tool for predicting 30-day mortality and aids in disposition. The mortality rate in the PHD score Model II was similar to the physician’s clinical decision.

Keywords: Hyperglycemic crisis, disposition, emergency department, diabetic ketoacidosis, hyperosmolar hyperglycemic state, predicting hyperglycemic death score, physician’s disposition

Introduction

Diabetes mellitus (DM) is the most common metabolic disorder and one of the top five chronic diseases consuming a significant proportion of our health-care expenditure.\(^1\) Emergency physicians face patients with diabetes under several circumstances that may need an evaluation and treatment of acute life-threatening complications such as hypoglycemia, or hyperglycemic crisis, and chronic complications such as nephropathy, neuropathy, retinopathy, and angiopathy. The hyperglycemic crisis is an endocrine emergency linked with uncontrolled DM which leads to major complications and enormous health costs. The hyperglycemic crisis presents a sequel of diabetic emergency as diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic state (HHS), or mixed syndrome (DKA and HHS) that may result in significant morbidity and death.\(^2\) Hyperglycemic crisis characteristically necessitates intense therapy with appropriate disposition.\(^3\)

In the emergency department (ED), treatment for DKA/HHS involves correction of hyperglycemia, dehydration, electrolyte imbalance, and identifying comorbid and frequent monitoring of patients strictly as per guidelines suggested by the American Diabetes Association (ADA).\(^3\)

Address for correspondence: Dr. Srihari Cattamanchi, Department of Emergency Medicine, Sri Ramachandra Medical College and Research Institute, Porur, Chennai - 600 116, Tamil Nadu, India. E-mail: srihari@cattamanchi.in

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How to cite this article: Elangovan A, Cattamanchi S, Farook AR, Trichur RV. Validation of predicting hyperglycemic crisis death score: A risk stratification tool for appropriate disposition of hyperglycemic crisis patients from the emergency department. J Emerg Trauma Shock 2018;11:104-10.

Received: 07.01.17. Accepted: 28.11.17.
In the management of a hyperglycemic patient, it is crucial to comprehend the mortality risk of the patient on arrival to the ED and the most appropriate disposition for the patient after initial management in the ED.[2]

Notwithstanding the advances made in the health care, mortality in DKA and HHS patients remains conceivably a lethal and life-threatening sequel in hyperglycemic emergencies (HEs).[2,4-6] Mortality is related to six risk factors such as age (above 65 years),[7] level of consciousness on admission, the severity of acidosis, the degree of hyperosmolarity, the severity of azotemia, and nursing home care.[8] In the United States, 140,000 patients with DKA were hospitalized in 2009,[9,10] which accounts for 4%–9% of all hospital discharge summaries in persons with diabetes.[8,10,11] More than 20% of patients with DKA had previously undiagnosed diabetes.[9,12,13] Another 15% of admissions were of patients with multiple admissions for DKA.[9] Fatalities are rarely ascribed to the complications of hyperglycemic crisis, instead associated with concealed triggering sickness and its complication such as infection, poor drug compliance, and new-onset diabetes.[3]

However, there are inadequate information and decision rules on the acuteness of the disease to prognosticate mortality and estimate the requirement for admissions into intensive care in the treatment of HE in adults.[6] Consequently, timely identification of HE patients presents with possible benefits such as the early determination of patients of high-risk wanting critical care admission, excellent treatment at the earliest in the critical care, and optimizing resources in the health-care facility without jeopardizing the quality of therapy provided in the ward and Intensive Care Unit (ICU).[6]

For ED physicians to make an appropriate decision on the management of patients with the hyperglycemic crisis, many studies based on mortality predictors have proposed certain decision rules. MacIsaac et al.[1] demonstrated age as the only real prognosticator of death, whereas Chung et al.[4] utilized mental status as the prognostic agent. Six objective predictors of mortality made the Efstathiou et al.’s[5] model, but for only DKA, where some of the predictors were not easily or immediately obtained in the ED, rendering it useless as a first-line care model. Huang et al.[2] investigated 13 univariate independent predictors of mortality of HE and formed a predicting hyperglycemic death (PHD) score using six independent mortality predictors.

PHD score is useful for emergency physicians, as a prediction tool as it aids in stratifying mortality risk groups and making appropriate management decision in hyperglycemic crisis patients.[2] There are many univariate mortality predictors for patients with the hyperglycemic crisis, of which six predictors are made into consideration as a mortality and risk stratification score. The PHD score is a simplistic, prompt tool with six objective predictors of mortality such as hypotension, absent tachycardia, infection, anemia, cancer, and severe coma for prognosticating 30-day mortality, risk group classification, and admission of patients to either ward or ICU.[3]

The main goal of the study is to validate the efficacy of predicting hyperglycemic crisis death (PHD) score as a decision rule for prognosticating mortality within 30 days and classifying hyperglycemic crisis patients into mortality risk groups for appropriate dispositions after ED treatment for further management.

### Materials and Methods

#### Study setting and population

This study is a prospective, observational study of patients in hyperglycemic crisis registered in the ED to validate the efficacy of the PHD score. The study was conducted in the department of emergency medicine in a tertiary care university teaching hospital, with an annual input of patients of about 25,000–30,000. The study was conducted over 14 months from May 2014 to July 2015. All patients above 18 years of age presenting to ED and satisfying the case definition for hyperglycemic crisis were enrolled in the study. Patients who received treatment in other hospitals before visiting our ED for continuing inpatient care and patients with age <18 years were excluded from the study.

#### Methodology

All adult patients presenting to the ED are enrolled when they meet the hyperglycemic crisis criteria projected by the ADA for mild, moderate, and severe DKA and HHS.[14] A 30-day mortality of six independent predictors is used as the primary end point. The enrolled patients were divided into two groups as dead and still hospitalized. The treating physician’s disposition of the patients and 30-day mortality were recorded. In patients who died, risk factors for mortality were assessed and the PHD score (AHASCI-7) was used to calculate risk for these patients [Table 1].[2] Appropriate management decisions in the disposition of the patient (viz., treatment in ED, ward, or ICU) and the 30th day mortality of the six independent predictors were stratified based on the PHD risk score. Finally, after dividing patients into disposition and mortality risk groups, a comparative analysis of physician and PHD score disposition was done in adult

| Table 1: Predictive hyperglycemic disposition (Predicting hyperglycemic crisis death) (AHASCI-7) |
|---|---|
| **Description** | **Score** |
| Absent tachycardia (HR ≤ 100/min) | x1 |
| Hypotension (SBP < 90 mmHg) | x1 |
| Anemia (Hb < 10 g/dl) | x1 |
| Severe coma (GCS ≤ 8) | x1 |
| Cancer (yes/no) | x1 |
| Infection (yes/no) | x2 |
| HR: Heart rate, SBP: Systolic blood pressure, Hb: Hemoglobin, GCS: Glasgow Coma Scale, AHASCI-7: Absent tachycardia x 1, Hypotension x 1, Anemia x 1, Sensorium x 1, Cancer x 1, and Infection x 2 (Score is calculated using the six independent mortality predictors) |

"Journal of Emergencies, Trauma, and Shock | Volume 11 | Issue 2 | April-June 2018"
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Data collection
Data collection was carried out by history taking from patient or patient’s attendees and accessing the patient’s inpatient file for required laboratory and radiological investigations. Details of admission investigations and other investigations relevant to the admission diagnosis and comorbidities were recorded. Patient details were collected in a preformatted questionnaire.

Statistical analysis
Data collected were entered in a spreadsheet (Microsoft Office Excel 2013; Microsoft Corporation, Redmond, WA), and the statistical analysis was done using statistical software SPSS (IBM SPSS Release 21.0.0; IBM SPSS Inc., Chicago, Illinois, USA). Categorical data were analyzed using descriptive statistics such as frequency and percentages and for continuous variables, the mean and standard deviation are used. For analyzing the regression model, the multiple logistic regression model was used. The receiver operating characteristic curves were drawn to find the area under the curve (AUC) to achieve the highest average sensitivity and specificity with positive predictive value and negative predictive value. To determine the significance in the categorical data, Chi-square test was done. \( P < 0.05 \) was considered statistically significant in all the statistical tools.

Ethics and consent
This study was approved by the institutional ethics committee. Informed consent was obtained from all the patients or their relatives who were enrolled in the study either in English or in the local language.

Results
A total of 133 patients in hyperglycemic crisis were included in the study [Figure 1]. A male-to-female ratio of 1:1.01 was observed, where 66 patients (49.6%) were male and 67 patients (50.4%) were female, of which 37 patients (27.8%) were found within the age group of 51–60 (51.2 ± 14.37) years. The most common comorbid illness was DM in 107 patients (80.5%), followed by coronary artery disease in 105 patients (78.9%) and hypertension in 76 patients (57.1%). The most common predisposing factors in our study group were poor drug compliance in 84 patients (63.2%) and infection in 78 patients (58.6%). The subgroup analysis showed that the most common hyperglycemic emergency was DKA in 88 patients (66.2%), followed by HHS in 37 patients (27.8%) and mixed syndrome in 8 patients (6%) [Table 2].

Based on the various clinical judgments by the admitting physician, low-risk patients (stable) were admitted in the ward and high-risk patients (unstable) who need to continue monitoring were admitted in the ICU. On clinical evaluation, 76 patients (57.1%) were in the low-risk group and disposed to the ward whereas 57 patients (42.9%) were in the high-risk group and disposed to the ICU. The mortality rate among the patients admitted in ward and ICU as per physician disposition was 5.3% (4/76) in the ward and 38.6% (22/57) in the ICU, which was statistically significant [Table 3].

Of the six variables, anemia, altered sensorium, cancer, and infection had significance \(( P < 0.05 )\) as predictors of mortality in the PHD score [Table 4]. The PHD scores (AHASCI-7) using the six variables were calculated ranging from 0 to 7 and were stratified into mortality risk and disposition groups. Patients

![Figure 1: Flow diagram comparing physician and PHD score disposition of patient and 30-day mortality. *DKA: Diabetic ketoacidosis, HHS: Hyperosmolar hyperglycemic state, and Mixed: Mixed syndrome which includes both DKA and HHS. †AHASCI-7 score is calculated using the six independent mortality predictors - Absent tachycardia \( \times 1 \), Hypotension \( \times 1 \), Anemia \( \times 1 \), Sensorium \( \times 1 \), Cancer \( \times 1 \), and Infection \( \times 2 \)](image-url)
Table 2: Descriptive in hyperglycemic crisis and its subgroups (diabetic ketoacidosis, hyperosmolar hyperglycemic state, and mixed)

| Descriptive features | Hyperglycemic crisis (n=133) | Subgroup DKA (n=88) | Subgroup HHS (n=37) | Subgroup Mixed* (n=8) |
|----------------------|-----------------------------|---------------------|---------------------|----------------------|
|                      | Mean | SD    | Mean | SD    | Mean | SD    | Mean | SD    | Mean | SD    |
| Age (years)          | 51.15 | 14.37 | 49.97 | 13.74 | 53.72 | 15.48 | 52.12 | 15.98 |
| Glucose (mg/dl)      | 541.23 | 185.02 | 497.58 | 176.15 | 638.24 | 148.98 | 572.63 | 266.21 |
| pH                   | 7.22 | 0.16 | 7.16 | 0.13 | 7.38 | 0.10 | 7.15 | 0.06 |
| Na⁺ (mmol/L)         | 133.65 | 7.78 | 132.61 | 7.03 | 143.03 | 7.10 | 148 | 3.93 |
| K⁺ (mmol/L)          | 4.27 | 1.09 | 4.40 | 1.16 | 4.15 | 0.81 | 3.39 | 1.0 |
| HCO₃⁻ (mmol/L)       | 15.20 | 10.48 | 12.67 | 11.53 | 21.78 | 3.23 | 12.50 | 6.72 |
| Lactate (mmol/L)     | 4.72 | 2.05 | 5.26 | 1.83 | 3.04 | 1.13 | 6.46 | 2.97 |
| Serum osmolality (mOsm/kg) | 296.45 | 16.13 | 292.88 | 13.98 | 321.07 | 14.08 | 328.18 | 11.49 |
| Anion gap (mmol/L)   | 18.84 | 7.89 | 21.38 | 7.12 | 11.46 | 3.69 | 25.13 | 7.62 |
| Anemia (<10 g/dl)    | 11.89 | 2.32 | 11.85 | 2.37 | 11.99 | 2.18 | 11.85 | 2.52 |
| GCS <8               | 12.63 | 2.86 | 12.69 | 2.88 | 12.35 | 2.96 | 13.25 | 2.31 |
| Absent tachycardia (pulse <100/min) | 100.97 | 20.02 | 100.59 | 19.83 | 98.75 | 19.69 | 115.37 | 20.26 |
| SBP (mmHg)           | 117.40 | 24.36 | 115.79 | 19.86 | 124.05 | 28.71 | 116.25 | 15.97 |
| Hospital stay        | 7.35 | 8.27 | 6.72 | 8.98 | 9.14 | 6.75 | 6.13 | 5.57 |

*Mixed syndrome (both DKA and HHS). DKA: Diabetic ketoacidosis, HHS: Hyperosmolar hyperglycemic state, pH: Potential of hydrogen, GCS: Glasgow Coma Scale, SBP: Systolic blood pressure, SD: Standard deviation

Table 3: Comparison of physician disposition and predicting hyperglycemic crisis death scores for predicting 30-day mortality in hyperglycemic crisis patients

|                        | Accuracy (%) | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | AUC | SE† | Asymptotic significance* | Asymptotic 95% CI |
|------------------------|--------------|----------------|-----------------|---------|---------|-----|-----|---------------------------|------------------|
| Physician disposition  |              |                |                 |         |         |     |     |                           |                  |
| PHD Score              |              |                |                 |         |         |     |     |                           |                  |
| Low-risk group         | 36           | 15.4           | 39.3            | 6       | 65.6    | 0.357 | 0.049 | 0.004†                     | 0.262            |
| Intermediate-risk group| 51            | 31             | 71              | 20.5    | 80.9    | 0.507 | 0.055 | 0.902                     | 0.398            |
| High-risk group        | 75           | 53.8           | 89.7            | 56      | 88.9    | 0.724 | 0.064 | 0.000†                     | 0.600            |
| PHD score Model I      | 72           | 54             | 90              | 56      | 89      | 0.718 | 0.063 | 0.001†                     | 0.594            |
| PHD score Model II     | 73           | 85             | 61              | 34.4    | 94.2    | 0.727 | 0.052 | 0.000†                     | 0.626            |

†SE (under the nonparametric assumption), *Asymptotic significance (null hypothesis: True area=0.5), ‡Statistically significant as P<0.05. PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under the curve, SE: Standard error, CI: Confidence interval, PHD: Predicting hyperglycemic crisis death

with a score of 0–2 were in the low-risk group, with a score of 3 were in the intermediate-risk group, and with a score of 4–7 were in the high-risk mortality group [Figure 2]. Once the mortality risk groups were categorized, patients in the low-risk group were treated in the ED or admitted to the ward, in the intermediate-risk group were admitted to a ward or an ICU, and in the high-risk group were admitted to an ICU [Table 5]. The risk stratification of the three mortality risk groups by PHD score from our study for low-risk group was 5.8% (4/69), for intermediate-risk group was 20.5% (8/39), and high-risk group was 56% (14/25) [Table 3].

For validating the efficacy of PHD score in disposing the patients correctly, PHD score was compared with the physician judgment which comprises of ward (low risk) and ICU (high risk) disposition. Hence, for our convenience and easy comparison, in score Model I, we have categorized the PHD score into low (low + intermediate)- and high-risk groups. Hence, 108 patients (81.2%) can be considered low risk and disposed to ward and 25 patients (18.8%) can be regarded as high risk and disposed to ICU [Table 5]. The mortality rate in the score Model I was 11.1% of the ward patients (12/108) and 56% of the ICU patients (14/25), with P<0.001 [Table 3].

In score Model II, we modified disposition for our convenience and easy comparison with physician disposition group and we have categorized the PHD score into low- and high (intermediate + high)-risk groups. Sixty-nine patients were considered to be at low risk and disposed to ward (51.9%) and 64 patients were considered to be at high risk and disposed to ICU (48.1%) [Table 5]. The mortality rate in the score Model II was 5.8% (4/69) for patients admitted to the ward...
Table 4: Six independent mortality predictors (AHASCI-7) in the predicting hyperglycemic crisis death score

| PHD score-AHASCI | β* | SE | Wald | df | Significant | Exp (B)* | 95% CI for EXP (B) |
|------------------|----|----|------|----|-------------|---------|-------------------|
| Absent tachycardia | 0.160 | 0.501 | 0.103 | 1 | 0.749 | 1.174 | 0.440 - 3.133 |
| Hypotension | 0.199 | 1.288 | 0.024 | 1 | 0.080 | 1.220 | 0.098 - 15.246 |
| Anemia | −1.780 | 0.570 | 9.764 | 1 | 0.002** | 0.169 | 0.055 - 0.515 |
| Sensorium | −1.930 | 0.594 | 10.539 | 1 | 0.001** | 0.145 | 0.045 - 0.466 |
| Cancer | −1.564 | 0.886 | 3.117 | 1 | 0.000** | 0.209 | 0.037 - 1.188 |
| Infection | −1.237 | 0.597 | 4.294 | 1 | 0.038** | 0.290 | 0.090 - 0.935 |
| Constant | 3.098 | 0.641 | 23.384 | 1 | | | |

*β: Values for the logistic regression equation for predicting the dependent variable from the independent variable. Significant: Asymptotic significance, Exp (B): These are the odds ratios for the predictors. They are the exponentiation of the coefficients, **Statistically significant as P<0.05. SE: Standard error, Wald: Wald’s χ² value, CI: Confidence interval, PHD: Predicting hyperglycemic crisis death, AHASCI-7: Absent tachycardia x 1, Hypotension x 1, Anaemia x 1, Sensorium x 1, Cancer x 1, and Infection x 2 (Score is calculated using the six independent mortality predictors), df: Degrees of freedom

Table 5: The differences between predicting hyperglycemic crisis death score Model I and Model II

| PHD score | PHD score | PHD score Model I | PHD score Model II |
|-----------|-----------|-------------------|-------------------|
| Risk group | Disposition | Mortality | Risk group | Disposition | Mortality | Risk group | Disposition | Mortality |
| Score 0-2 | Low risk | ED/ward 69 (51.8%) | 4 (5.8%) | Low risk | Ward 108 (81.2%) | 12 (11.1%) | Low risk | Ward 69 (51.8%) | 4 (5.8%) |
| Score 3 | Intermediate risk | Ward/ICU 39 (29.3%) | 8 (20.5%) | Intermediate risk | ICU 25 (18.7%) | 14 (56%) | Intermediate risk | ICU 25 (18.7%) | 14 (56%) |
| Score 4-7 | High risk | ICU 25 (18.7%) | 14 (56%) | High risk | ICU 25 (18.7%) | 14 (56%) | High risk | ICU 64 (48.1%) | 22 (34.4%) |

PHD: Predicting hyperglycemic crisis death, ICU: Intensive Care Unit

Discussion

In practice, patient’s quality of life not only depends on early identification and treatment of diseases, but also depends on the appropriate disposition of a patient after weighing in the safety of the patient, medical resources available, and the cost of receiving treatment in the ED. PHD score would help ED physicians to improve standardization in practice. As we realize from our results, the physician had admitted 76 high-risk patients in the ICU comparative to only 69 high-risk patients admitted to the ICU as per PHD score disposition. Ultimately, both the disposition types have an equal mortality rate of 22 patients. PHD score is a risk stratification and a disposition tool that only guides the physician in easy decision-making for appropriate disposition to the ward or ICU and not a management tool that interferes with the ED physician in making clinical judgment based on experience in treating patients with hyperglycemia.

Efstathiou et al. in their study projected a risk stratification prediction model for hyperglycemic crises patients which include six clinical and laboratory variables as independent predictors of mortality (P < 0.05) available on the 1st day of hospital admission. Hamburger et al., Javor et al., and Kitabchi et al. suggested that outside the ICU, mild-to-moderate DKA can efficiently be managed, and in a step-down ICU, patients with severe but uncomplicated DKA can be administered after the initial critical hours of therapy. Gershengorn et al. in their study reported that based on the patient’s condition, the severity of the disease, and availability of local resources, the decision to manage DKA patients in

Figure 2: PHD score mortality risk stratification and their disposition with AHASCI-7* score. *AHASCI-7 score is calculated using the six independent mortality predictors - Absent tachycardia × 1, Hypotension × 1, Anaemia × 1, Sensorium × 1, Cancer × 1, and Infection × 2

and 34.4% (22/64) for patients admitted to the ICU, with P = 0.001 [Table 3].

From the 30-day mortality analysis of the 26 patients who died, 16 were male, 15 patients (57.7%) were diagnosed as DKA, 8 patients (30.8%) were diagnosed as HHS, 9 patients (34.6%) were ≥65 years old, 13 patients (50%) had bradycardia (heart rate <100/min), 6 patients (23.1%) had hypotension (systolic blood pressure <90 mmHg), 10/26 patients (38.5%) had anemia (hemoglobin <10 g/dl), 9 patients (34.6%) had Glasgow Coma Scale (<8), 5 patients (19.2%) had cancer, 21 patients (80.8%) had infection being the highest, and 9 patients died within 7 days of admission.
the ward or an ICU was made. Savage et al.\[19\] and Wolfsdorf et al.\[20\] reported in their study that they saved time, resources, and hospitalization cost up to 30% which led to better outcomes as they had a predefined local guideline for a referral to either ward or an ICU.

Our study tries to support the above evidence that the PHD score is an easy score to remember and may facilitate standardization in practice. PHD score may aid in a more objective risk stratification and help emergency and ICU physicians decide on the appropriate disposition of patients after initial ED management. In comparison to Huang et al.\[2\] among six independent mortality predictors, anemia, altered sensorium, cancer, and infection were statistically significant with $P = <0.05$ [Table 4].

From the subgroup analysis, DKA was seen predominantly in 66.2%, HHS was observed in 27.8%, and only 6% had mixed syndrome. From the 30-day mortality analysis of 26 patients who died, three were new-onset DM and 23 were known DM. The mortality rates among subgroups were 17% for DKA, 21.6% for HHS, and 37.3% for mixed group. The mortality rates were significantly high among HHS and mixed groups. This pattern has been seen in several studies done earlier in other countries and in different populations.\[2,21-23\]

On applying the PHD score to the study sample of 133 patients, 69 patients were in low-risk, 39 patients were at intermediate-risk, and 25 patients were in the high-risk group. Moreover, the mortality rate among the three risk groups of PHD score was 5.8% in a low-risk group, 20.5% in an intermediate-risk group, and 56% in high-risk group.

On comparing physician disposition with PHD score Model I and Model II disposition, we found that low-risk patients admitted to the ward were 81.2% in Model I disposition, 51.9% in Model II disposition, and 57.1% in physician disposition. On the other hand, high-risk patients admitted to the ICU were 18.8% in PHD score Model I disposition, 48.1% in PHD score Model II disposition, and 42.9% in physician disposition. Hence, PHD score Model II disposition was almost equal to physician’s disposition in ward and ICU.

On comparing the 30-day mortality group of physician disposition with PHD score Model I and Model II disposition, results showed that in score Model I disposition, the death rate in the ward was 46.2% and in ICU was 53.8% which were almost equal. Whereas in PHD score Model II disposition and physician disposition, the death rate in the ward was 15.4% and in ICU was 84.6%, the same in both the groups. Hence, PHD score Model II disposition was almost equal to physician’s disposition in both, showing an increasing mortality risk in the ICU.

Both physician’s disposition and PHD score Model II disposition had a high sensitivity of 85%, whereas the specificity was 67% for physician’s disposition and 61% for PHD score Model II. However, PHD score model I disposition had a high specificity of 90% but a low sensitivity of 54%. All the three had statistically highly significant $P$ values.

In Huang et al.\[5\] study, the PHD score was divided into three mortality risk groups, high risk of 59.5% (22/37, 95% confidence interval [CI]: 42.2%–74.8%), intermediate risk of 24.5% (13/51, 95% CI: 14.8%–39.9%), and low risk of 0% mortality (0/242, 95% CI: 0–0.02). The PHD score had a high predictive power with AUC at 0.925 and 95% CI from 0.870 to 0.979.\[24\] Marinac and Mesa et al.\[24\] reported that one-third of DKA patients did not require ICU admission and treatment based on their admission criterion. The average ICU stay was significantly longer in those with severe DKA, although the total hospital stay did not differ by the severity of illness score. Alourfi and Homsi\[25\] showed a mortality rate of 11.3% which was significantly higher in the ICU than in the ward ($P \leq 0.05$). The complication in the ICU was (41.6%) more when compared to in the ward (14%) ($P = 0.001$).\[21\]

**Limitations**

This study is a high-risk prediction tool, and it is important not to forget that the interaction between the patient and the physician, personal intentions of the patient, and necessities along with expert clinical decision-making and careful amalgamation of scientific data play a crucial role in providing critical medical care instead of prognostic estimates. This study was conducted in a single center. Therefore, results from this study may not be generalizable, and a multicenter validation study is required. The sample size may not be broad enough to have results with a significant statistical power. Similar validation research projects with larger sample sizes are needed to prove the efficacy of the PHD score. An overlap may be seen amidst the three hyperglycemic crisis types; however, as we are studying with the hyperglycemic crisis in its entirety, our study results are not affected by the overlap. Larger, multicentric trials are needed, but also a trial that compares PHD with physician intuition is needed. Does this implementation have a clinical impact?

**Conclusion**

The PHD score, created by six independent mortality predictors, is a straightforward, prompt tool, facilitating standardization of management of hyperglycemic crisis patients in ED practice. PHD score contributes to a more objective risk stratification, helping ED physician decide on appropriate disposition for hyperglycemic crisis patients after ED treatment, devoid of compromise on the quality of medical care provided in the ICU and ward, purely based on the balance of the safety of the patient, medical resources available, and cost. Our results show that Model II of the PHD score correlates with the physician’s judgment and was accurately able to predict which patients needed intensive care and who could be managed in a ward setting. This score will aid the emergency physician in the appropriate disposition of a patient presenting with hyperglycemia without the need for referral to a physician before admission. Despite our results being statistically significant, a larger study should be performed in multiple centers to verify if the scores can accurately predict mortality or survival.
Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES
1. Cydulka RK, Maloney GE Jr. Diabetes mellitus and disorders of glucose haemostasis. In: Marx JA, Hockberger R, Walls R, editors. Rosen’s Emergency Medicine – Concepts and Clinical Practice. 8th ed., Vol. 2. Philadelphia: Mosby; 2013. p. 1652-66.
2. Huang CC, Kuo SC, Chien TW, Lin HJ, Guo HR, Chen WL, et al. Predicting the hyperglycemic crisis death (PHD) score: A new decision rule for emergency and critical care. Am J Emerg Med 2013;31:830-4.
3. American Diabetes Association. Hyperglycemic crises in patients with diabetes mellitus. Diabetes Care 2001;24:154-61.
4. Chung ST, Perue GG, Johnson A, Younger N, Hoo CS, Pascoe RW, et al. Predictors of hyperglycemic crises and their associated mortality in Jamaica. Diabetes Res Clin Pract 2006;73:184-90.
5. MacIsaac RJ, Lee LY, McNeil KJ, Tsalamandris C, Jerums G. Influence of age on the presentation and outcome of acidic and hyperosmolar diabetic emergencies. Intern Med J 2002;32:379-85.
6. Efstathiou SP, Tsiakou AG, Tsioulos DI, Zacharos ID, Mitromaras AG, Mastorantonakis SE, et al. A mortality prediction model in diabetic ketoacidosis. Clin Endocrinol (Oxf) 2002;57:595-601.
7. Wang J, Williams DE, Narayan KM, Geiss LS. Declining death rates from hyperglycemic crisis among adults with diabetes, U.S 1985-2002. Diabetes Care 2006;29:18-22.
8. Kreisberg R. Diabetic ketoacidosis. In: Rifkin H, Porte D, editors. Diabetes Mellitus: Theory and Practice. 4th ed. New York: Elsevier Science; 1990. p. 591-603.
9. Faich GA, Fishbein HA, Ellis SE. The epidemiology of diabetic acidosis: A population-based study. Am J Epidemiol 1983;117:551-8.
10. Centers for Disease Control and Prevention, Diabetes Public Health Resource. Available from: http://www.cdc.gov/diabetes/statistics/hospitalization_national.htm. [last accessed on 2016 Sep 06].
11. Kitabchi AE, Umpierrez GE, Murphy MB, Barrett EJ, Kreisberg RA, Malone JI, et al. Management of hyperglycemic crises in patients with diabetes. Diabetes Care 2001;24:131-53.
12. White NH. Diabetic ketoacidosis in children. Endocrinol Metab Clin North Am 2000;29:657-82.
13. Maldonado MR, Chong ER, Oehl MA, Balasubramanyam A. Economic impact of diabetic ketoacidosis in a multiethnic indigent population: Analysis of costs based on the precipitating cause. Diabetes Care 2003;26:1265-9.
14. Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic crises in adult patients with diabetes. Diabetes Care 2009;32:1335-43.
15. Hamburger S, Barjenbruch P, Soffer A. Treatment of diabetic ketoacidosis by internists and family physicians: A comparative study. J Fam Pract 1982;14:719-22.
16. Javor KA, Kotsanos JG, McDonald RC, Baron AD, Kesterson JG, Tierney WM, et al. Diabetic ketoacidosis charges relative to medical charges of adult patients with type I diabetes. Diabetes Care 1997;20:349-54.
17. Kitabchi AE, Wall BM. Management of diabetic ketoacidosis. Am Fam Physician 1999;60:455-64.
18. Lord GM, Scott J, Pusey CD, Rees AJ, Walport MJ, Davies KA, et al. Diabetes and rhabdomyolysis. A rare complication of a common disease. BMJ 1993;307:1126-8.
19. Savage MW, Dhatariya KK, Kilvert A, Rayman G, Rees JA, Courtney CH, et al. Joint British Diabetes Societies guideline for the management of diabetic ketoacidosis. Diabet Med 2011;28:508-15.
20. Wolfsdorf J, Craig ME, Daneman D, Dunger D, Edge J, Lee WR, et al. International Society for Pediatric and Adolescent Diabetes. ISPAD clinical practice consensus guidelines 2006-2007. Diabetic ketoacidosis. Pediatr Diabetes 2007;8:28-43.
21. Ogbera AO, Awobusuyi J, Unachukwu C, Fasanmade O. Clinical features, predictive factors and outcome of hyperglycemic emergencies in a developing country. BMC Endocr Disord 2009:9-9.
22. Deese TA, Eshete TC, Gudina EK. Predictors and treatment outcome of hyperglycemic emergencies at Jimma University Specialized Hospital, Southwest Ethiopia. BMC Res Notes 2015;8:553.
23. Ezeani Iu, Eregie A, Ogedengbe O. Treatment outcome and prognostic indices in patients with hyperglycemic emergencies. Diabetes Metab Syndr Obes 2013;6:303-7.
24. Marinac JS, Mesa L. Using a severity of illness scoring system to assess intensive care unit admissions for diabetic ketoacidosis. Crit Care Med 2000;28:2238-41.
25. Aloufi Z, Homsi H. Precipitating factors, outcomes, and recurrence of diabetic ketoacidosis at a university hospital in Damascus. Avicenna J Med 2015;5:11-5.