

Glucose Levels during the First 24 Hours and Mortality among Critically Ill Adult Patients

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Introduction

Background

Research has shown that hypoglycemia [1] and hyperglycemia [2] are common occurrences among critically ill patients, with hypoglycemia being associated with increased mortality and hyperglycemia potentially increasing mortality several times over [3]. However, the association between glucose dysregulation and mortality may differ between diabetic and non-diabetic patients [4,5]. While diabetic patients may not experience an increased mortality rate with hyperglycemia, non-diabetic patients may be at risk of mortality with both hyperglycemia and hypoglycemia [5]. During the first 24 hours in the intensive care unit (ICU), patients may present with a range of glucose dysregulations, including hyperglycemia, hypoglycemia, both hyperglycemia and hypoglycemia, and normal glucose levels [6]. Therefore, it is essential to investigate the association between different glucose dysregulations and mortality rates among diabetic and non-diabetic critically ill patients."

Objective

The aim of this study is to investigate the impact of glucose dysregulation (hyperglycemia and/or hypoglycemia) on ICU and in-hospital mortality.

Methods

Patients from the Medical Information Mart for Intensive Care IV (MIMIC IV) database were included in the analysis. Glucose levels during the first 24 hours of ICU stays were used to classify patients into hypoglycemia, hyperglycemia, hypoglycemia & hyperglycemia, and normoglycemia groups. Propensity score matching was performed based on age, gender, race, Charlson Comorbidity Index (CCI), and Acute Physiology Score III (APSIII). Furthermore, separate analyses were conducted for patients with and without a diabetes diagnosis, respectively.

The groups were defined based on the glucose levels during the first 24 hours of ICU stay as follows (units in mg/dL):

- Hypoglycemia group: minimum glucose level < 70 and maximum glucose level <= 140
- Hyperglycemia group: minimum glucose level >= 70 and maximum glucose level > 140
- Hypoglycemia & hyperglycemia group: minimum glucose level < 70 and maximum glucose level > 140
- Normoglycemia group: minimum glucose level >= 70 and maximum glucose level <= 140

References

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Results and Discussions

Data were extracted from the MIMIC-IV database using five selection criteria (Figure 1):
(1) patients aged 18 years or older who were admitted to the ICU for the first time were selected;
(2) pregnant patients were excluded;
(3) patients with null blood glucose values were excluded;
(4) patients with an ICU admission count of >= 2 during one hospitalization were excluded;
(5) patients who were admitted to the ICU for less than 24 hours were excluded

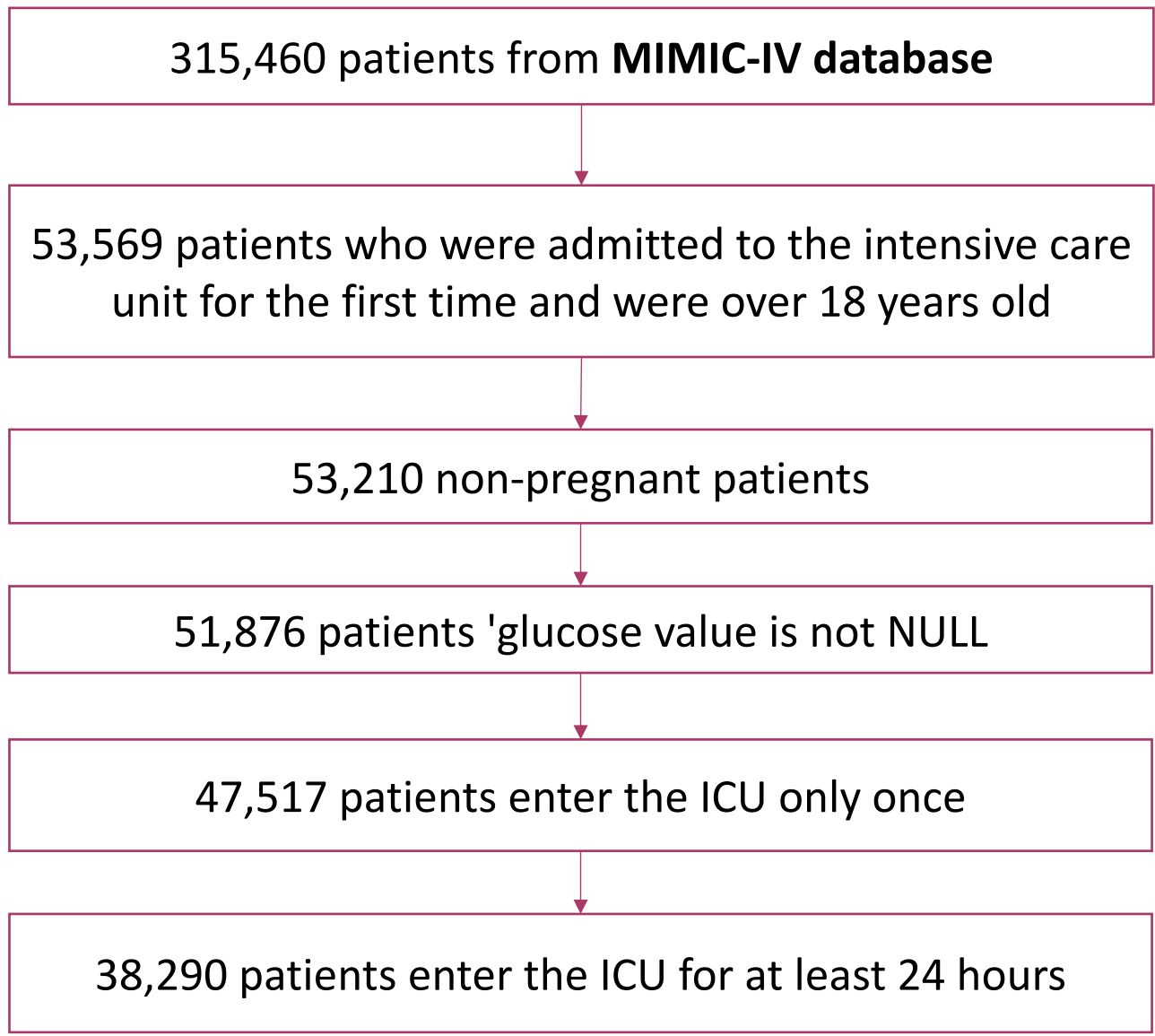


Figure 1. study attrition figure

Table 1. Characteristics of study population

	All patients	Nondiabetic patients	Diabetic patients
Total	38,290	26,628	11,662
Age (mean (SD))	65.02 (16.75)	63.87 (17.71)	67.66 (13.98)
Gender = M (%)	21,799 (56.9)	14,964 (56.2)	6,835 (58.6)
Race (%)			
Asian	1,086 (2.8)	722 (2.7)	364 (3.1)
Black	3,317 (8.7)	1,841 (6.9)	1,476 (12.7)
Other	8,114 (21.2)	5,634 (21.2)	2,480 (21.3)
White	25,773 (67.3)	18,431 (69.2)	7,342 (63.0)
CCI (mean (SD))	5.44 (2.93)	4.81 (2.76)	6.89 (2.77)
APSIII (mean (SD))	45.87 (23.18)	44.11 (22.94)	49.87 (23.22)
Minimum Glucose (mean (SD))	108.15 (33.51)	104.59 (26.70)	116.28 (44.32)
Maximum Glucose (mean (SD))	178.26 (80.98)	155.18 (58.37)	230.96 (98.77)
Mean Glucose (mean (SD))	138.94 (43.92)	127.02 (31.89)	166.16 (54.28)
ICU mortality = Yes (%)	2,821 (7.4)	1,911 (7.2)	910 (7.8)
In-hospital mortality = Yes (%)	3,591 (9.4)	2,451 (9.2)	1,140 (9.8)

Table 2. Associations between glucose levels and outcomes adjusted for age, gender and race (reference group: normoglycemia)

Overall population			
	Hypoglycemia	Hyperglycemia	Hypoglycemia & Hyperglycemia
ICU mortality	3.73 (3.03, 4.58) *	1.78 (1.62, 1.96) *	2.95 (2.49, 3.48) *
In-hospital mortality	3.41 (2.82, 4.11) *	1.57 (1.45, 1.71) *	2.40 (2.06, 2.80) *
Diabetic population			
	Hypoglycemia	Hyperglycemia	Hypoglycemia & Hyperglycemia
ICU mortality	4.18 (2.81, 6.18) *	1.23 (0.97, 1.58)	1.53 (1.11, 2.12) *
In-hospital mortality	3.56 (2.46, 5.12) *	1.16 (0.94, 1.45)	1.33 (0.99, 1.79)
Non-diabetic population			
	Hypoglycemia	Hyperglycemia	Hypoglycemia & Hyperglycemia
ICU mortality	3.20 (2.46, 4.10) *	1.95 (1.75, 2.17) *	4.37 (3.52, 5.39) *
In-hospital mortality	3.11 (2.47, 3.88) *	1.69 (1.54, 1.85) *	3.53 (2.88, 4.29) *

- In general, both hypo- and hyper-glycemia showed significant positive association with ICU and in-hospital mortality;
- For diabetic patients, hyperglycemia was not significantly associated with mortality increase, possibly masked by the higher baseline health risk for diabetic patients (as indicated by the CCI in Table 1.

Table 3. Associations between glucose levels and outcomes after propensity score matching (reference group: normoglycemia)

Overall population			
	Hypoglycemia	Hyperglycemia	Hypoglycemia & Hyperglycemia
ICU mortality	1.01 (0.77, 1.33)	1.40 (1.26, 1.56)	0.91 (0.74, 1.12)
In-hospital mortality	1.03 (0.80, 1.33)	1.25 (1.13, 1.37)	0.89 (0.73, 1.08)
Diabetic population			
	Hypoglycemia	Hyperglycemia	Hypoglycemia & Hyperglycemia
ICU mortality	1.18 (0.71, 1.98)	1.09 (0.78, 1.50)	0.94 (0.66, 1.33)
In-hospital mortality	1.16 (0.72, 1.88)	1.11 (0.84, 1.48)	0.83 (0.60, 1.13)
Non-diabetic population			
	Hypoglycemia	Hyperglycemia	Hypoglycemia & Hyperglycemia
ICU mortality	0.88 (0.62, 1.25)	1.54 (1.37, 1.73)	1.16 (0.87, 1.55)
In-hospital mortality	1.01 (0.74, 1.38)	1.36 (1.23, 1.50)	1.12 (0.86, 1.47)

- After propensity score matching the association between hypoglycemia and mortality vanished. A possible explanation is that hypoglycemia is an indication of poor baseline health, and when health risks are adjusted by propensity matching, the association disappeared;
- For non-diabetic patients, hyperglycemia is still significantly associated with increased mortality, indicating that hyperglycemia is an important clinical sign that needs extra attention in ICU care.

Conclusions

High blood sugar levels (hyperglycemia) are significantly associated with an increased risk of mortality in non-diabetic patients receiving critical care. On the other hand, low blood sugar levels (hypoglycemia) and the combination of low and high blood sugar levels (hypoglycemia & hyperglycemia) do not show a statistically significant association with mortality in these patients after propensity score matching. Overall, while hyperglycemia appears to be a significant risk factor for mortality in critically ill patients, the relationship between hypoglycemia and mortality is less clear and requires further investigation.