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Admission Glucose Level Predicts In-hospital Mortality in Patients with Acute Pulmonary Embolism Who Were Treated with Thrombolytic Therapy

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Abstract
Background Elevated admission serum glucose level is associated with unfavourable clinical outcomes in various clinical conditions. The aim of this study was to investigate the relationship between admission glucose levels and in-hospital and long-term adverse clinical outcomes in patients with pulmonary embolism (PE) treated with thrombolytic therapy.
Methods A total of 183 consecutive confirmed acute PE patients (98 female and 85 male; mean age 61.9 ± 15.7 years) who were treated with thrombolytic therapy enrolled in this study. The study population was categorised into four quartiles according to admission serum glucose levels (group I: glucose ≤115 mg/dl; group II: glucose >115–141 mg/dl; group III: glucose >141–195 mg/dl; and group IV: glucose ≥196 mg/dl).
Results In-hospital mortality was significantly higher in group IV (28.8 %) compared to group III (15.2 %), group II (6.6 %), and group I (2.1 %) ($p < 0.001$). In multivariate analysis, admission glucose level (OR 1.013, 95 % CI 1.004–1.021, $p = 0.004$) and admission anaemia (OR 0.602, 95 % CI 0.380–0.955, $p = 0.03$) were independent predictors of in-hospital mortality. The mean follow-up period was 34 months. During long-term follow-up, all-cause mortality, recurrent PE, major and minor bleeding were similar among the four groups.
Conclusion Admission glucose level is a simple, inexpensive, easily available, and effective laboratory parameter for predicting in-hospital mortality in patients with PE.

Keywords Pulmonary embolism · Glucose · Thrombolytic therapy · Mortality · Clinical outcomes

Introduction

Elevated admission serum glucose level is associated with unfavourable clinical outcomes in various clinical conditions, such as myocardial infarction, stroke, and heart failure (HF) [1–7]. The relationship between elevated serum glucose levels and the clinical outcomes of acute illnesses is important, due to the considerable benefits and risks of glycemic control [8]. Acute pulmonary embolism (PE), the third most common cardiovascular disease, is characterised by high morbidity and mortality. The presence of shock or persistent arterial hypotension is described as high-risk PE, and the mortality rate of this condition is greater than 30 % [9–13]. Previous studies have reported that acute and chronic hyperglycaemia is related to increased coagulation factors, impaired fibrinolysis, and higher risk of venous thromboembolism [14, 15]. The association between admission glucose levels and in-hospital and long-term clinical outcomes in PE patients who were treated with thrombolytic agents has not yet been evaluated. Hence, the aim of this study was to investigate the relationships between admission glucose levels and in-hospital and long-term adverse clinical outcomes in patients with PE.

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Methods

This retrospective study included 183 consecutive confirmed acute PE patients (37 high and 146 intermediate-high risk, 98 female; mean age 61.9 ± 15.7 years) admitted to Dr. Siyami Ersek Cardiovascular and Thoracic Surgery Research and Training Hospital between January 2007 and February 2015. All of the patients were treated with thrombolytic agents, either tissue plasminogen activator (t-PA, 148 patients) or streptokinase (35 patients). Pulmonary multi-slice computed tomography (CT) angiography (SOM-ATOM Sensation 64; Siemens, Erlangen, Germany) was performed to diagnose PE.

The study population was categorised into four quartiles according to admission serum glucose levels (group I: glucose ≤115 mg/dl; group II: glucose >115–141 mg/dl; group III: glucose >141–195 mg/dl; and group IV: glucose ≥196 mg/dl). The study protocol was approved by the Ethics Committee of the authors' hospital.

Analysis of Patient Data

The patients' demographic parameters and clinical history of risk factors [age, sex, chronic lung disease (CLD), prior PE or deep venous thrombosis (DVT), hypertension (HT), diabetes mellitus (DM), HF, malignancy, immobilisation, and renal insufficiency] were obtained from their medical records.

Pulmonary CT angiography and echocardiographic data were also obtained from the patients' records, and localisation of thrombosis in the pulmonary arteries was noted. Transthoracic echocardiography was performed using a Vivid 7 system (GE Vingmed Ultrasound AS, Horten). Pulmonary arterial peak systolic pressure was calculated using the simplified Bernoulli equation [16].

Blood values obtained from venous blood samples at admission were recorded from the medical reports. Haemoglobin, white blood cell (WBC), neutrophil, and platelet counts were measured as part of the automated complete blood count, using a Coulter LH 780 Hematology Analyzer (Beckman Coulter Ireland, Inc., Galway, Ireland). Glucose and other biochemical measurements were performed using Siemens Healthcare Diagnostic Products kits and calibrators (Marburg, Germany).

t-PA was administered as a 10 mg bolus, followed by a 90 mg intravenous infusion over a period of two hours. Streptokinase was given as 250,000 IU in 30 min plus 100,000 IU/h for a period of 12 or 24 h. Intravenous unfractionated heparin infusion or subcutaneous low-molecular-weight heparin was administered after the thrombolytic therapy.

Definitions

Patients with shock or hypotension were classified as being high risk regardless of their calculated pulmonary embolism severity index (PESI) score or cardiac biomarkers. Patients who were hemodynamically stable in PESI class III–V and who had both signs of RV dysfunction by echocardiography or CT angiography and elevated cardiac biomarkers in the circulation was defined as intermediate-high risk [9]. In-hospital mortality was defined as death from any cause during hospitalisation. HT was described as a history of HT for more than 1 year requiring initiation of antihypertensive therapy. DM was defined according to the usage of insulin or antidiabetic agents in the patient's medical history or a fasting glucose level >126 mg/dl. HF was defined as having the typical symptoms (breathlessness, fatigue, ankle swelling) and signs (elevated jugular venous pressure, pulmonary crackles) of abnormal cardiac function [17]. Shock was defined as systolic pressure <90 mmHg or a systolic pressure drop ≥40 mmHg for >15 min without new-onset arrhythmia, hypovolaemia, or sepsis [9]. Major bleeding was defined as a decline in haemoglobin level of 20 g/l or a transfusion requiring two or more units of red cells. Anaemia was defined as a baseline haemoglobin concentration <13 mg/dl in men and <12 mg/dl in women. Altered mental status was defined as signs of disorientation, lethargy, stupor, or coma. Syncope was defined as a transient, self-limited loss of consciousness due to transient global cerebral hypoperfusion, characterised by rapid onset, short duration, and spontaneous complete recovery [18].

Follow-Up

All follow-up data were obtained from hospital records or by interviewing (directly or by telephone) patients, their families, or their personal physicians. The primary endpoint was death. Recurrent pulmonary embolism, major and minor bleeding, use of fresh frozen plasma (FFP), and history of international normalised ratio >5 were noted.

Statistical Analysis

Quantitative variables were expressed as mean value ± standard deviation, and qualitative variables were expressed as percentage (%). Comparisons of parametric values between groups were performed with a one-way ANOVA and post hoc Tukey's test. Categorical variables were compared with a likelihood ratio χ^2 test or Fisher's exact test. Admission glucose levels were grouped according to quartile. Correlations between variables were analysed with Pearson's or Spearman's correlation tests. A backward stepwise multivariate logistic regression analysis that

included variables with $p < 0.1$ was performed to identify independent predictors of in-hospital mortality. Age, female gender, history of cancer, CLD, HF, systolic blood pressure <100 mmHg, heart rate ≥110 beat/min, $SO_2 < 90$ %, admission anaemia, admission creatinine >1.5 mg/dl, admission troponin >0.1 ng/ml, and admission glucose level were included in the model. The cumulative survival curves for mortality were constructed using the Kaplan–Meier method, with differences assessed using the log-rank test. p values < 0.05 were considered statistically significant. All statistical tests were carried out using SPSS version 15.0 (SPSS Inc., Chicago, IL).

Results

Baseline Characteristics

The baseline demographic and clinical data of the patients are summarised in Table 1. The mean age of the study population was 61.9 ± 15.7 years, 98 female, 37 patients were high and 147 patients were intermediate-high risk. Predisposing factors, such as HT, CLD, HF, history of DVT or PE, travel history, immobilisation for more than 3 days, and history of cancer, were similar among the four quartiles. DM rate was higher in group IV compared with group I, II, and III (53.3 vs. 28.2, 15.5, and 14.9 %, respectively; $p < 0.001$). Admission systolic pressure, heart rate, O_2 saturation, syncope, chest pain, dyspnoea, lower limb oedema, and electrocardiography findings were similar among the four groups.

Laboratory and Echocardiography Findings

Table 2 lists the patients' laboratory data. Patients in group IV had a higher creatinine level (1.37 ± 0.7 mg/dl) than patients in group III (1.23 ± 0.5 mg/dl), group II (1.11 ± 0.6 mg/dl), and group I (1.02 ± 0.3 mg/dl) ($p = 0.02$ for all). D-dimer, troponin, haemoglobin, and creatinine kinase isoenzyme MB levels and WBC counts were similar among the four groups. The patients' echocardiographic parameters are shown in Table 3. Left ventricular ejection fraction, tricuspid annular plane systolic excursion, and left and right ventricular diameters were not statistically different among the groups.

In-Hospital and Long-Term Outcomes

Table 4 and Figure 1 present the in-hospital clinical outcomes and in-hospital mortality of the study population. In-hospital mortality was significantly higher in group IV (28.8 %) compared to group III (15.2 %), group II (6.6 %), and group I (2.1 %) ($p < 0.001$). Multivariate analysis showed that admission glucose level [odds ratio (OR) 1.013, 95 % confidence interval (CI) 1.004–1.021, $p = 0.004$] and admission anaemia (OR 0.602, 95 % CI 0.380–0.955, $p = 0.03$) were independent predictors of in-hospital mortality. Patients in group IV also had a higher incidence of inotropic drug usage, shock, and mechanic ventilation. Rates of major bleeding, intracranial haemorrhage, and use of FFP were similar among the groups. The mean follow-up period was 34 months. During long-term follow-up, all-cause mortality, recurrent PE, major and minor bleeding, use of FFP, and history of international normalised ratio >5 were not statistically different among the four groups. An admission glucose level of 161 mg/dl was identified as an effective cut-off point for in-hospital mortality rate (area under curve = 0.761; 95 % CI 0.662–0.860; $p < 0.001$), with a sensitivity of 66.7 % and specificity of 66.7 %.

Discussion

In this single-centre study, we demonstrated that admission glucose level was associated with in-hospital mortality, inotropic drug usage, and cardiogenic shock, but that it was not a predictor of mortality during long-term follow-up.

The relationship between admission serum glucose level and adverse clinical outcomes in different clinical conditions, such as myocardial infarction, stroke, and HF, is well known [1–7]. Timóteo et al. [1] investigated 2099 patients with acute coronary syndrome (ACS), and they reported that glucose level on admission ≥160 mg/dl was an independent predictor of in-hospital and long-term mortality. Ergelen et al. [2] examined 2482 ST elevation myocardial infarction (STEMI) patients who underwent primary angioplasty, and they found that patients without DM whose admission glucose level was >200 mg/dl had the highest risk of in-hospital mortality. In a different study, Petursson et al. [4] evaluated 1957 patients, and they reported that admission hyperglycaemia without DM was a strong predictor of 30-day and long-term mortality in ACS cases. Acute stress illnesses such as ACS, stroke, STEMI, and acute heart failure are associated with the release of stress hormones. Adrenaline and cortisol are the main stress hormones related to glycogenolysis, lipolysis, and insulin deficiency, and these conditions result in increased glucose levels and a higher level of free fatty acids in the circulation system. In addition, acute hyperglycaemia can cause inflammatory activation. All of these mechanisms reduce myocardial contraction and contribute to pump failure [2, 5–7]. Previous studies have showed the effect of hyperglycaemia in stroke patients [19–21]. Parsons et al. [19] evaluated 63 acute stroke patients who were analysed with diffusion–perfusion-weighted magnetic resonance

Table 1 Baseline characteristics of the study patients

Characteristic	Group 1 (*n*: 47)	Group 2 (*n*: 45)	Group 3 (*n*: 46)	Group 4 (*n*: 45)	*p* value
Age (years)	54.8 ± 16.7	61.7 ± 15.3	65.3 ± 12.9	66 ± 15.8	.002
In-hospital stay (days)	10.2 ± 5.1	9.2 ± 3.6	8.9 ± 5.9	8.8 ± 7.6	.64
Male sex	27 (57.4 %)	16 (35.5 %)	19 (41.3 %)	23 (51.1 %)	.15
Comorbidities					
Hypertension	19 (40.4 %)	24 (53.3 %)	29 (63 %)	21 (46.7 %)	.16
Diabetes mellitus	7 (14.9 %)	7 (15.5 %)	13 (28.2 %)	24 (53.3 %)	<0.001
MI history	3 (6.4 %)	2 (4.4 %)	5 (10.9 %)	4 (8.9 %)	.67
Heart failure	4 (8.5 %)	1 (2.2 %)	7 (15.2 %)	5 (11.1 %)	.19
Chronic lung disease	7 (14.9 %)	7 (15.5 %)	6 (13 %)	8 (17.8 %)	.94
Current smoker	26 (55.3 %)	18 (40 %)	14 (30.4 %)	9 (20 %)	.004
Cerebrovascular disease	1 (2.1 %)	2 (4.4 %)	1 (2.2 %)	2 (4.4 %)	.86
DVT history	15 (31.9 %)	16 (35.5 %)	10 (21.7 %)	12 (26.7 %)	.49
Cancer	0	0	2 (4.3 %)	1 (2.2 %)	.29
Immobilisation (>3 days)	10 (21.3 %)	14 (31.1 %)	7 (15.2 %)	8 (17.8 %)	.27
Travel history	6 (12.8 %)	3 (6.7 %)	2 (4.3 %)	3 (6.7 %)	.46
Use of OCS	2 (4.2 %)	1 (2.2 %)	0	1 (2.2 %)	.56
Chronic renal disease	3 (6.4 %)	5 (11.1 %)	4 (8.7 %)	4 (8.9 %)	.88
Altered mental status	1 (2.1 %)	1 (2.2 %)	3 (6.5 %)	5 (11.1 %)	.09
Heart rate (beats/min)	108.9 ± 23	96.3 ± 17.3	100.2 ± 16.8	112.6 ± 27.4	.09
SBP (mmHg)	125 ± 18	131.9 ± 19.9	137.4 ± 26.4	123.3 ± 34.1	.28
Respiratory rate (breaths/min)	20 ± 4.2	19.1 ± 1.8	19.3 ± 2.2	21.9 ± 7.9	.27
Temperature	36.6 ± 0.3	36.5 ± 0.3	36.6 ± 0.2	36.5 ± 0.2	.77
O_2 saturation (%)	93.5 ± 3.1	93.2 ± 4.8	92.6 ± 4.1	88.8 ± 10.8	.09
PESI score	79.4 ± 36.3	83.9 ± 27.1	97.1 ± 40.2	114.9 ± 52.9	.04
Intensive care unit stay (days)	4 ± 2.7	3.9 ± 2	4.2 ± 2.5	4.6 ± 4	.72
Arterial blood gas analysis					
pH	7.45 ± 0.08	7.45 ± 0.04	7.40 ± 0.11	7.33 ± 0.15	.02
Lactate	2.9 ± 2.2	2 ± 1.5	3.3 ± 1.4	11.5 ± 25.3	.25
HCO_3	22.8 ± 5.4	22.1 ± 3.4	21.6 ± 4.6	19.6 ± 5.7	.36
Admission symptoms					
Chest pain	9 (19.1 %)	8 (17.8 %)	5 (10.9 %)	9 (20 %)	.64
Dyspnea	43 (91.5 %)	36 (80 %)	41 (89.1 %)	33 (73.3 %)	.04
Lower limb pain	26 (55.3 %)	18 (40 %)	13 (28.3 %)	16 (35.5 %)	.05
USG findings of DVT	22 (46.8 %)	19 (42.2 %)	11 (23.9 %)	13 (28.9 %)	.44
Electrocardiography					
Right bundle branch block	14 (29.8 %)	15 (33.3 %)	15 (32.6 %)	15 (33.3 %)	.70
$S_1Q_3T_3$	24 (51.1 %)	22 (48.9 %)	22 (47.8 %)	13 (28.9 %)	.16
T-wave inversion (V1–V3)	13 (27.6 %)	17 (37.8 %)	10 (21.7 %)	14 (31.1 %)	.60

Values are mean ± SD. Values in parentheses are percentages

MI myocardial infarction; *DVT* deep venous thrombosis; *OCS* oral contraception; *GFR* glomerular filtration rate; SBP systolic blood pressure; *PESI* pulmonary embolism severity index; *USG* ultrasonography

imaging, and they reported that acute hyperglycaemia was associated with greater infarct size and worse functional outcome. Bruno et al. [20] found that higher admission glucose levels were associated with decreased neurologic improvement and increased rate of intracerebral haemorrhage in stroke patients. In another study, Poppe et al. [21]

Table 2 Laboratory findings of the patients

	Group 1 (*n*: 47)	Group 2 (*n*: 45)	Group 3 (*n*: 46)	Group 4 (*n*: 45)	*p* value
D-Dimer (ng/ml)	4035 ± 4108	5122 ± 4932	4705 ± 4786	5414 ± 7064	.71
Admission troponin I (ng/ml)	0.53 ± 0.59	0.77 ± 1.11	1.16 ± 2.77	1.42 ± 2.48	.17
CK-MB (U/l)	23.5 ± 11.1	48.8 ± 143.3	28.9 ± 22.6	35.7 ± 33.2	.44
Glucose (mg/dl)	102.6 ± 11.9	129.2 ± 7.8	164 ± 16.7	305.2 ± 103.7	<0.001
Creatinine (mg/dl)	1.02 ± 0.3	1.11 ± 0.6	1.23 ± 0.5	1.37 ± 0.7	.02
BNP (pg/ml)	548.8 ± 430.1	399.2 ± 259.4	663.6 ± 456.3	318.2 ± 95.1	.31
Haemoglobin (gr/dl)	13.5 ± 1.6	13.2 ± 5.4	13.1 ± 1.8	12.4 ± 2.2	.42
WBC (10^9/dl)	11.8 ± 3.5	11.4 ± 3.4	12.6 ± 4.8	13.1 ± 5.3	.23
Neutrophil (10^9/dl)	8.6 ± 3.2	8.7 ± 3.3	10 ± 4.6	10.6 ± 7.6	.15

Values are mean ± SD

CK-MB creatinine kinase-MB, *BNP* brain natriuretic peptide, *WBC* white blood cell

Table 3 Echocardiographic parameters of the patients

	Group 1 (*n*: 47)	Group 2 (*n*: 45)	Group 3 (*n*: 46)	Group 4 (*n*: 45)	*p* value
LVEF (%)	58.4 ± 9.1	58.5 ± 5.4	56.8 ± 8.6	57.1 ± 6.6	.73
RV TAPSE (mm)	15.4 ± 3	14.9 ± 2.8	14.8 ± 2.9	16.7 ± 5.5	.28
PASP (mmHg)	54.5 ± 11.4	55.3 ± 12.7	58.1 ± 17.5	55.4 ± 10.3	.69
LV diameter (mm)	55 ± 54	47 ± 40	57 ± 56	57 ± 44	.68
RV diameter (mm)	51 ± 8	38 ± 9	59 ± 9.1	76 ± 15	.71
LA diameter (mm)	3.7 ± 0.6	3.7 ± 0.4	3.9 ± 0.8	4 ± 0.5	.43
RV dilatation	36 (76.6 %)	38 (84.4 %)	37 (80.4 %)	29 (64.4 %)	.21
RV hypokinesia	0	2 (4.4 %)	1 (2.2 %)	3 (6.7 %)	.15
Presence of thrombus	3 (6.4 %)	2 (4.4 %)	5 (10.9 %)	7 (15.5 %)	.15

Values are mean ± SD. Values in parentheses are percentages

LVEF left ventricular ejection fraction, *RV* right ventricle, *TAPSE* tricuspid annuler plane systolic excursion, *PASP* pulmonary artery systolic pressure, *LV* left ventricle, *LA* left atrium

Table 4 In-hospital outcomes

	Group 1 (*n*: 47)	Group 2 (*n*: 45)	Group 3 (*n*: 46)	Group 4 (*n*: 45)	*p* value
All-cause mortality	1 (2.1 %)	3 (6.6 %)	7 (15.2 %)	13 (28.8 %)	<0.001
Major bleeding	5 (10.6 %)	6 (13.3 %)	7 (15.2 %)	8 (17.7 %)	.79
Intracranial haemorrhage	1 (2.1 %)	0	1 (2.1 %)	0	.58
Red cell transfusion	3 (6.3 %)	4 (8.8 %)	4 (8.6 %)	5 (11.1 %)	.68
Hemodialysis	0	1 (2.2 %)	1 (2.1 %)	4 (8.8 %)	.09
Cardiogenic shock	1 (2.1 %)	2 (4.4 %)	4 (8.6 %)	15 (33.3 %)	<0.001
Use of inotropic drug	1 (2.1 %)	1 (2.2 %)	5 (10.8 %)	15 (33.3 %)	<0.001
Mechanic ventilation	1 (2.1 %)	2 (4.4 %)	6 (13 %)	14 (31.1 %)	<0.001

Values in parentheses are percentages

evaluated 1098 ischemic stroke patients who were treated with t-PA, and they reported that admission hyperglycaemia was associated with death, symptomatic intracerebral haemorrhage, and unfavourable outcomes at 90 days. These findings might be related to impairment of the fibrinolytic system and increased brain lactate levels due to hyperglycaemia, which results in the conversion of hypoperfused tissue into infarction.

Acute PE, the third most common cardiovascular disease, is characterised by high morbidity and mortality. The

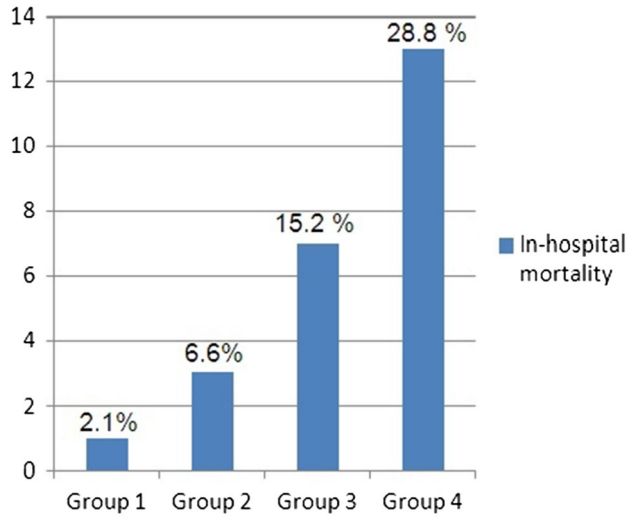

Fig. 1 In-hospital mortality rate by admission glucose level. In-hospital mortality rates were 2.1, 6.6, 15.2, and 28.8 % for patients in the admission glucose level groups: group I, ≤115 mg/dl; group II, 115–141 mg/dl; group III 141–196 mg/dla; and group IV ≥ 196 mg/dl, respectively ($p < 0.00$)

presence of shock or persistent arterial hypotension is described as high-risk PE, and the mortality rate of this condition is greater than 30 %. In PE, the pulmonary arterial bed is occluded by thrombi, which results in right ventricular (RV) pressure overload and RV dilatation. RV dilatation increases RV wall tension and myocyte stretching, which are related to RV ischemia and myocardial injury [9]. Therefore, PE is an acute stress illness that causes the release of various stress hormones, such as catecholamines, cortisol, and cytokines. These stress hormones are associated with glycogenolysis, lipolysis, and insulin resistance, and all of these metabolic responses result in elevated glucose levels and hyperinsulinaemia [22].

In the present study, we found that elevated blood glucose levels were related to in-hospital mortality, inotropic drug usage, and cardiogenic shock. Several mechanisms might explain the association between elevated glucose levels and in-hospital mortality in PE. First, hyperglycaemia is related to the activation of the coagulation system. Ceriello et al. [23] reported that elevated glucose levels activated the coagulation system by increasing factor VII (FVII) activity. Vaidyula et al. [24] investigated healthy subjects with euglycaemia, hyperglycaemia with normoinsulinaemia, or hyperinsulinaemia. They measured soluble tissue factor (sTF), thrombin–antithrombin (TAT) complexes, and FVII and FVIII activity. All of these coagulation factors were elevated, especially in patients with both hyperglycaemia and hyperinsulinaemia. Secondly, hyperglycaemia directly affects the endothelium and decreases the protective glycocalyx layer, which results in platelet–endothelial adhesion and the release of coagulation factors [25]. In addition, hyperglycaemia causes the glycation of the coagulation factors and alters their activity [14]. Thirdly, hyperglycaemia is often accompanied by hyperinsulinaemia, which increases the expression of plasminogen activator inhibitor 1 (PAI-1). PAI-1 reduces the activity of t-PA, and this condition results in a decrease of fibrinolysis. In addition, hyperinsulinaemia increases the prothrombotic effect of hyperglycaemia.

Several previous studies have also evaluated the association between hyperglycaemia and venous thromboembolism (VTE). Mraovic et al. [26] reported that pre-surgery glucose level was related to increased risk of PE after orthopaedic surgery, and Hermanides et al. [27] showed that elevated admission glucose levels were associated with VTE. In a large population study, Scherz et al. [28] evaluated 13,621 patients with acute PE, categorising the patients into five groups according to admission glucose levels. They showed that admission glucose level was independently associated with short-term mortality. Differently, in the present study, all of the patients were treated with thrombolytic agents. In addition, our study had long-term clinical outcomes, with a mean follow-up time of 34 months. The cut-off admission glucose level of 161 mg/dl was ideal for predicting in-hospital mortality. We reported that in the present study, admission glucose level was an independent predictor of in-hospital mortality in patients with PE who were treated with thrombolytic therapy. Different effects of hyperglycaemia, such as procoagulant effect, decrease of fibrinolysis, endothelial dysfunction, glycation of coagulation factors, and hyperglycaemia-mediated hyperinsulinaemia, might be the possible mechanisms of our findings. However, admission glucose level did not predict long-term mortality in our study. This finding might be related to decreased procoagulant activity, increased fibrinolysis, and regression of transient hyperglycaemia after successful thrombolytic therapy in PE patients who were discharged from the hospital.

Study Limitations

This study has potential limitations, due to its retrospective design. In addition, we used single-centre data, which could result in selection bias; however, we were careful to include consecutive patients. Measures of coagulation and fibrinolysis markers, such as sTF, FVII, and FVIII activity, as well as TAT complexes and PAI-1, were not available. Despite adjusting for multiple risk factors, there might have been some confounding factors that affected glucose levels, such as concomitant inflammatory and infectious diseases, undiagnosed DM, impaired glucose tolerance, and

metabolic syndrome. We had no data regarding insulin use or glucose-lowering therapy and the possible effects of in-hospital mortality. Finally, we had no glucose level data during in-hospital stay and after discharge, and as such, the prognostic factor of transient or persistent elevated serum glucose level could not be evaluated.

Conclusion

Our findings indicate that in patients with PE who were treated with thrombolytic agents, admission hyperglycaemia was associated with in-hospital mortality. However, admission glucose level did not predict long-term mortality. Admission glucose level is a simple, inexpensive, easily available, and effective laboratory parameter for predicting in-hospital mortality in PE cases. Further studies should evaluate the effects of glucose-lowering treatments and whether they can prevent unfavourable clinical outcomes in hyperglycaemic patients with PE.

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Compliance with Ethical Standards

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