International Journal of Advanced Biotechnology and Research (IJBR)
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-8, Issue-4, 2017, pp838-843
http://www.bipublication.com

Research Article

Study of Correlation between Hyperglycemia and Mortality Rate in Traumatized Patients Hospitalized in ICU

Farshid Rahimi Bashar[1], Mohamad Ali Seifrabie[2], Mohammad Hossein Jarahzadeh[3*]. Tahereh Abbasi Geravand[2] and Zahra Abbasi Geravand[2]

[1]Department of Anesthesiology and Critical Care, School of Medicine,
Hamadan University of Medical Sciences, Hamadan, IRAN.
[2] Department of Social Medicine, School of Medicine,
Hamadan University of Medical Sciences, Hamadan, IRAN.
[3]*Department of Anesthesiology and Critical Care,
ShahidSadoughi University of Medical Sciences, Yazd, IRAN.
*Corresponding Author: Mohammad Hossein Jarahzadeh. Department of Anesthesiology and Critical Care,
ShahidSadoughi University of Medical Sciences, Yazd, IRAN.
Tel: 0098(353)8224101; Fax: 0098(353)8224100 ; E-mail: Drjarahzadehicm@gmail.com

ABSTRACT:
Considering the high rates of incidents which impose a great number of traumata on the community, one of the goals of medical society is to minimize the number of these patients. To achieve this goal and clarify the possible association between hyperglycemia and mortality rate among traumatized patients hospitalized in ICU, this study investigated the probable correlation between the two variables to be able to minimize the mortality rate by meticulously controlling blood sugar level. The population of this analytic cross-sectional study consisted of all traumatized patients who were hospitalized in the ICU of Be'that Hospital in Hamedan, Iran, from May 2013 to May 2014. The patients' blood sugar was measured at the time of admission and one day after hospitalization in the ICU. The patients were studied for blood sugar status, ICU stay, age, gender, VAP, and the correlation of these variables with mortality rate. The data were analyzed with SPSS15 using Student's t-test and Chi-square test with $P<0.05$. The results of statistical tests demonstrated that the minimum blood sugar at the time of admission and one day after hospitalization were both 72 mg/dL and the maximum blood sugar at the time of admission and one day after hospitalization were 280 and 243 mg/dL, respectively. The mean blood sugar levels were 122.69 and 125.48 mg/dL at the time of admission and one day after admission. There was a subject attrition rate of 17. There was no significant correlation between mortality rate and different levels of increase in blood sugar ($PV>0.05$). On the other hand, there was a significant correlation between blood sugar increase and incidence of ventilator-associated pneumonia ($P=0.005$). Our findings indicated no significant correlation between hyperglycemia and mortality rate among the traumatized ICU-hospitalized patients; yet, there was a direct significant correlation between hyperglycemia and the incidence rate of ventilator-associated pneumonia in traumatized ICU-hospitalized patients. Hence, the ICU stay of these patients may be shortened by controlling blood sugar level and, subsequently, VAP to diminish treatment costs.

Key Words: *Hyperglycemia, mortality, traumatized patients, ICU.*

[I] INTRODUCTION

Acute trauma stimulates the tension (stress) responses of the body through neural-hormonal reactions which induce changes in metabolism of glucose, proteins, and fats leading to increased blood sugar, i.e., hyperglycemia via hormones of body defense system and cytokine reactions [1].

Increased blood sugar causes aggravated cerebral damage, spinal trauma, and renal damage induced by diminished blood circulation, delayed gastric emptying, reduced blood phosphate, delayed wound healing, and disturbed performance of leukocytes [2, 3]. Acute hyperglycemia is caused by acute disorders which may be associated with detrimental consequences. This correlation has been investigated in patients who suffer from traumata, myocardial infarction, stroke, and in patients hospitalized in general ICU and hospital wards [4]. Various studies have reported the correlation between primary hyperglycemia and its sequalae in traumatized patients [5]. Increased blood level in patients hinders the normal defense mechanisms against infections and disturbs the normal inflammatory responses [6]. Under stressful circumstances, the excessive production of katecholamines stimulates glycogenesis and elevated level of glycogen. Moreover, insulin production is suppressed and peripheral insulin resistance is created. Generally, gluconeogenesis is increased through cortisol and glucagon, glucogenesis via epinephrine, and peripheral insulin resistance by glucagon and epinephrine. Continual increase of blood sugar in traumatized patients has been considered by physicians and it appears that the intensity of damage is associated with hyperglycemia level [7]. Many traumatized patients who develop degrees of increased blood sugar following trauma need emergency surgery which itself demands meticulous control of blood sugar level. Lack of careful control of blood sugar level imposes premature complications such as diabetic ketoacidosis, hyperosmolar coma, increased risk of infection, and impaired wound healing on the patient. Being aware of this issue and regarding the high rates of accidents and other traumatic incidents which superimpose many traumata on the community, the medical society aims at minimizing the mortality rates in this group of patients. To achieve this goal and elucidate the probable link between hyperglycemia and mortality rate of traumatized patients hospitalized in ICUs and also considering the point that there are no complete investigations of the correlation between the effects of hyperglycemia and ICU stay and its effects on the incidence of ventilator-associated pneumonia (VAP), this study embarked on expunging the association between hyperglycemia and mortality rate in traumatized patients by accurately controlling the blood sugar level of the patients.

[II] MATERIALS AND METHODS

In this prospective analytic cross-sectional study, the approval of Committee of Ethics in Research was obtained first from Hamedan University of Medical Sciences. The study was conducted on all traumatized patients (200 patients) who presented to hospital from May 2013 to May 2014 and hospitalized in the ICUs of Be'that Hospital in Hamedan, Iran. The inclusion criteria were: age greater than 17 years, being traumatized, ICU stay longer than 48 h, and APACHE SCORE II less than 25. The exclusion criteria were: patients with blood sugar level less than 70 mg/dL, and being diabetic. The patients who observed the inclusion criteria were investigated for age, gender, ICU stay, affliction with VAP, and patient’s status at the time of ICU discharge. The patients' blood sugar level was controlled during the first two days after hospitalizations in the ICU since in traumatized patients, blood sugar control during the first two days exerts the greatest effect on their prognosis. On this basis, the status of the patients' blood sugar level was divided into four groups: blood sugar less than 135, more than 135, less than 200, and more than 200. Ultimately, the patients' ICU stay, mortality, and affliction with VAP were surveyed. VAP is the most prevalent nosocomial infection in the ICUs. It is, in fact, a subcategory of hospital-acquired pneumonia which occurs in patients who have undergone mechanical ventilation through intratracheal tube or tracheostomy tube with no previous history of the infection. To define VAP, the following standard definitions were used: 1. Radiographic criteria, i.e., the presence of infiltration, opacity, or new progressive cavitations. 2. Signs and symptoms including: fever, leukopenia, leukocytosis along with recent ample

pyretic sputum, increased discharges needing suction, new coughing, dyspnea, tachypnea, auscultation of rales and respiratory bronchial sounds, wheezes, or exacerbation of gas exchanges. 3. Pathologic laboratory signs such as positive blood culture, and positive pharyngeal culture. To establish the diagnosis of VAP, the presence of the three criteria was obligatory. The patients were visited everyday by an ICU specialist and the patients' clinical signs were explored on the basis of the present checklist. APACHE II (Acute Physiology and Chronic Health Evaluation II) is a system used to classify the intensity or acuity of a disease in the ICU. It is one of the criteria of ICU scoring systems which involves scoring the 12 routine physiologic assessments including age, body temperature, mean arterial blood pressure, acidity of arterial blood, rate of heartbeat, respiration rate, levels of sodium, kalium, serum keratinine, hematocrit, WBC count, and Glasgow Coma Score during the first 24 h after ICU hospitalization. The score in this system may vary from 0 to 71. To match the patients with respect to their status before the study and remove the effects of confounding variables on the results, only patients with APACHE SCORE II of less than 25 entered the study. Finally, the effects of blood sugar in traumatized patients were compared with respect to VAP, ICU stay, and complications. The gleaned data were analyzed with SPSS15 using P-value less than 0.05.

[III] RESULTS

A total of 200 patients hospitalized in the ICU of Be'that Hospital in Hamedan, Iran, who observed the inclusion criteria participated in the study. Sixty-five patients (%32.50) were male and 135 patients (%67.50) were female. The minimum age was 17 and the maximum age was 88 years with a mean age of 52.59 years. The minimal values of blood sugar in the first and second day after admission were 243 and 280, respectively. The mean value of blood sugar was 122.69 for the first 24 h and 125.48 for the second 24 h. Moreover, of 65 women hospitalized in ICU, 6 patients (%3) had mortality and 22 patients (%11) had, on the whole, a blood sugar value greater than 126. No significant correlation was observed between first day hyperglycemia and female mortality rate (P=0.3). Also, of 135 males hospitalized in the ICU, 11 patients (%5.5) had mortality. There was, nonetheless, no significant correlation between first day hyperglycemia and male mortality (P=0.4). Additionally, there was no significant association between age groups and mortality rate among individuals with either hyperglycemia or hypoglycemia. Seventeen cases of death were observed among the 200 traumatized patients of which 9 patients had blood sugar values greater than 126 [Table-1].

Blood sugar in age groups	Live Num(%)	Death Num(%)	Total
17<age<30	11(100)	0	11(58.13)
30<age<45	14(100)	0	14(28.17)
45<age<55	5(100)	0	5(17.6)
55<age<65	17(48.89)	2(52.10)	19(45.23)
65<age	25(12.78)	7(88.21)	32(50.32)
Total	71(89.88)	9(11.11)	81(100)

Table: Mortality rate on the basis of blood sugar level greater than 126 in age groups

Furthermore, there was no significant correlation between the incidence of hyperglycemia in the first day of admission and mortality (P=0.2). Also, there was no association between second day hyperglycemia and mortality rate (P=0.09) [Table-2].

Mortality		blood sugar<126 Num(%)	blood sugar>126 Num(%)	P-Value
First day	Live	111(60.65)	72(39.34)	0.2
	Death	8(47.05)	9(52.94)	
Second day	Live	113(61.75)	70(38.25)	0.9
	Death	7(41.17)	10(58.82)	

Table 2. Correlation between hyperglycemia and mortality rate in traumatized patients on the basis of first day and second day blood sugar level in the ICU.

Finally, there was a significant correlation between hyperglycemia and blood sugar value less than 126 and VAP [Table-3].

Blood Sugar		Yes Num(%)	NO Num(%)	P-Value
first 24 h	<126	27(22/68)	92(77/31)	0.02
	>126	37(45/67)	44(54/32)	
second 24 h	<126	26(21/66)	94(78/33)	0.029
	>126	38(47/50)	42(52/50)	

Table 3. Correlation between VAP in traumatized patients with blood sugar less than and more than 126 in the first and second 24 h.

[IV] DISCUSSION

Acute trauma triggers the stress responses of the body through neurohormonal reactions which brings about alterations in metabolism of glucose, proteins, and fats resulting in increased blood sugar, i.e., hyperglycemia by hormones of body defense system and cytokine reactions [1]. Increased blood sugar induces exacerbated cerebral damage, spinal trauma, and renal damage induced by suppressed blood circulation, delayed stomach emptying, decreased blood phosphate, delayed wound healing, and impaired performance of leukocytes [8, 9]. Various studies have focused on primary hyperglycemia, i.e., hyperglycemia at the time of hospitalization or during the first 24 h after admission, in patients with head trauma. However, glucose levels after the first day are considered in relation to hormone levels or age in these studies [10, 11]. Hyperglycemia may be associated with complications similar to those of uncontrolled diabetes such as increased mortality rate, increased infectious complications, and weak wound healing [8]. On the whole, increase in gluconeogenesis is accomplished through cortisol and glucagon, glucogenesis via epinephrine, and peripheral insulin resistance by glucagon and epinephrine. Continual increase of blood sugar in traumatized patients has been noticed by physicians and it appears that the intensity of damage is associated with hyperglycemia level [7]. In this study, 200 patients entered the study. Of these, 65 were female and 135 were male. The mean age of the patients was 52.59 years . The mean blood sugar value was 122.69 at admission and 125.48 during 24 h after admission. The first day blood sugar value was greater in males than in females so that the mean blood sugar value was 123.77 for men and 120.4 for women. This was true for the second day so that the male blood sugar value was 126.34 and the female blood sugar value was 123.70; yet, on the whole, the mean of the second day blood sugar value was smaller than the mean of the first day blood sugar value. The study by Vogelzang investigated 5234 non-traumatized and 865 traumatized ICU patients. The traumatized patients were mostly younger and included more males than the non-traumatized patients with lower blood glucose level at the time of hospitalization and lower hyperglycemia index. In this study, hyperglycemia in traumatized patients was more strongly correlated than other patients who are in a more severe condition. The hyperglycemia index in traumatized patients was more strongly correlated with mortality rate compared to other non-traumatized patients [12]. Furthermore, Falciglia's study explored hyperglycemia-associated mortality in critically ill patients. In this study, hyperglycemia was correlated with mortality independent of disease acuity while the normoglycemic patients had lower mortality [13]. In our study, 17 patients died in the course of the study of whom 11 were male and 6 were female. The dead patients constituted %5.8 of the whole patients. However, this difference was not significant; in other words, gender is not correlated with mortality. Also, of these, only 9 patients had blood sugar value above 126 and the Chi-square test was not significant meaning that the first day glucose level was not associated with mortality; moreover, second day glucose level was not correlated with mortality, though albeit the P-value was greatly smaller than the first day. A total of 270 patients took part in Jebalameli's study that compared the blood sugar level at admission in traumatized ICU patients. The mean blood sugar levels in patients with TS=11-16 (Trauma Score), TS=6-10, and TS=1-5 were 130.74, 273.78, and 340 g/dL, respectively. In this study, increased plasma sugar level in the acute stage of the trauma was a common finding. Additionally, the intensity of increase in plasma sugar level was directly correlated with the intensity of trauma and the intensity of cerebral damage [14]. Amanda's study investigated the correlation between hyperglycemia and mortality in traumatized patients. A total of 516 patients hospitalized in the ICU after trauma entered the study. Primary hyperglycemia occurred in 483 patients at the level of ≥110 mg/dL, in 311 patients at the level of ≥150 mg/dL, and in 90 patients at the level of ≥200 mg/dL. There was a significant correlation between glucose level ≥200

mg/dL and the rate of infection and mortality (independent of the characteristics of the damage). Hence, it is mandatory to maintain the blood glucose level in traumatized patient below 200 mg/dL and it is not necessary to reduce it to below 110 mg/dL [15]. In our study, of 65 women hospitalized in the ICU, only 6 patients had mortality while only 22 patients had, on the whole, blood glucose level greater than 126 meaning that there was no correlation between blood sugar level and mortality in women who were checked for first day glucose level. Furthermore, of 135 men hospitalized in the ICU, only 11 had mortality. Of these, 59 patients had, on the whole, blood glucose level greater than 126 meaning that there was no correlation between blood sugar level and mortality in men who were checked for first day glucose level. Mukherjee's study surveyed the correlation between insulin resistance and VAP in traumatized patients. Their findings revealed that measuring the increase in insulin resistance two days before clinical suspicion to VAP in wounded patients can be helpful indicating that insulin resistance indices may provide beneficial clinical information in tentative diagnosis of VAP [16]. In our study, there was a significant correlation between blood sugar level at ICU admission and 1 day after ICU admission with VAP in all blood sugar groups who were investigated.

[V] CONCLUSION

Our findings demonstrated that there was no significant correlation between hyperglycemia and mortality in traumatized patients hospitalized in the ICU. Yet, there was a direct significant correlation between hyperglycemia and VAP in traumatized ICU patients. Hence, ICU stay and the related costs may be reduced by controlling blood sugar level and subsequently, controlling VAP in these patients.

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