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Research Article

Stress Hyperglycemia as a Predictor for Outcome of Non-Diabetic Patients with Acute Cerebrovascular Disease - A Study of 490 Patients

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Abstract

Stress hyperglycemia is a condition characterized by high blood sugar levels that occur in response to physical or emotional stress. It is common among hospitalized individuals and those undergoing surgery. While stress hyperglycemia is typically temporary, it can still have negative effects on the body. Studies have shown that stress hyperglycemia is associated with worse clinical outcomes in patients with acute stroke. The retrospective study aimed to examine the association between stress hyperglycemia and stroke outcome using data that had already been collected. The study included 490 patients and found that stress hyperglycemia was associated with higher mortality rates in patients with acute stroke. The study concluded that stress hyperglycemia could be used as a predictor of stroke outcome. The results of the study were consistent with previous research on stress hyperglycemia and stroke outcome.

***Keywords**: Blood Sugar Level; Stress Hyperglycemia; Cerebrovascular Disease Outcome; Acute Stroke Prognostic Factor*

Introduction

Stress hyperglycemia is a condition characterized by high blood sugar levels that occur in response to physical or emotional stress. It is commonly seen in individuals who are hospitalized due to illness or injury, as well as those undergoing surgery. During times of stress, the body releases hormones such as cortisol and adrenaline, which can cause the liver to release glucose into the bloodstream. This can result in a temporary increase in blood sugar levels, even in individuals who do not have diabetes. While stress hyperglycemia is typically temporary and resolves once the underlying stressor has been addressed, it can still have negative effects on the body. Prolonged periods of high blood sugar can lead to complications such as dehydration, electrolyte imbalances, and impaired immune function. In some cases, stress hyperglycemia can also be a precursor to the development of diabetes, particularly in individuals with other risk factors such as obesity or a family history of the disease. Stress hyperglycemia can be used as a predictor of stroke outcome, as it has been found to be associated with worse clinical outcomes in patients with acute stroke. Studies have shown that stress hyperglycemia is common in patients with acute stroke and is associated with larger infarct size, greater disability, and higher mortality rates [1,2].

Aim of the Study

Aim is to study the association between stress hyperglycemia and stroke outcome.

Materials and Methods

Current study is retrospective cohort and designed to examine the association between stress hyperglycemia and stroke outcome using data that have already been collected. It uses electronic medical records to identify all patients with stroke passed through our stroke center for one year-period of time, excluding all diabetics, resulting in a total of 490 (247 males and 243 females). We divided them by four age groups (20 - 39, n = 4; 40 - 59, n = 100; 60 - 79, n = 254; 80 - 100, n = 132). We categorized patients into three blood sugar level groups (hypoglycemia < 2,8 mmol/l; local reference range = 2,8 - 5,6 mmol/l; and hyperglycemia > 5,6 mmol/l). We conducted a correlation analysis and we also calculated odd ratio (OR = (A*D)/(B*C)), where A, B, C, and D represent the number of patients in each group. Relative risk was also calculated using the formula (RR = [A/(A+B)]/[C/(C+D)]).)]). A Chi-square test was applied to establish relationships between nominal variables. The strength of the relationship was assessed by the Kramers Vi correlation coefficient. SPSS 26 software was used for statistical processing.

Results

We enrolled 490 patients (247 males and 243 females). The mean age was 70 years old with 71 years old median and range from minimum 23 years old to maximum 96 years old. The mean value of the blood sugar level was 6,80 mmol/l with median of 6,26 mmol/l and range from minimum 1,04 mmol/l to maximum 26,27 mmol/l. Mortality among all cases was up to 13,5% (n = 66) and 424 (86,5%) patients were discharged. Forty-two of died patients were males and twenty-four were females. Most of died cases were among age group from 80 to 100 years old (n = 31), followed by those among 60 - 79 years old group (n = 27) and lower mortality was registered among age group from 40 to 59 years old (n = 8) and none died below 39 years old. Only 2 patients (0,2%) were with hypoglycemia, 146 (29,8%) with normal blood sugar level and 342 (69,8%) have stress hyperglycemia, measured at the accommodation time. From the crosstab of blood sugar level and outcome the analysis reveals that the most died cases (n = 46) were among stress hyperglycemia group, followed by 9 died among the group with normal blood sugar level and 1 among the hypoglycemic group, which is statistically significant (p-value 0,02). Cramer`s V is 0,153. Chi-Square Test shows that the p-value for Fisher's Exact Test is less than 0.05, indicating a statistically significant relationship between the variables "sex" and "outcome" (Figure 1). Odd Ratio and Relative risk calculations of Blood sugar and Outcome shows the risk of death among the group with blood sugar above 5,6 mmol/l compared to the group with less than 5.6 mmol/l. OR = 2.7. RR = 2.42. If the odds ratio (OR) for death among individuals with blood sugar above 5.6 mmol/l compared to those with blood sugar below 5.6 mmol/l is 2.7, and the relative risk (RR) is 2.42, then we can infer that there is an increased risk of death associated with higher blood sugar levels. The OR of 2.7 suggests that the odds of death are 2.7 times higher among individuals with blood sugar above 5.6 mmol/l compared to those with blood sugar below 5.6 mmol/l. This means that the group with higher blood sugar levels has a higher likelihood of dying than the group with lower blood sugar levels. Similarly, the RR of 2.42 suggests that the risk of death is 2.42 times higher among individuals with blood sugar above 5.6 mmol/l compared to those with blood sugar below 5.6 mmol/l. This means that the group with higher blood sugar levels has a higher probability of dying than the group with lower blood sugar levels. Therefore, both the OR and RR suggest that there is an increased risk of death associated with higher blood sugar levels. This highlights the importance of maintaining healthy blood sugar levels to reduce the risk of adverse health outcomes such as death.

Discussion

Studies have been conducted to distinguish stress hyperglycemia from diabetes among a cohort of stroke patients. Upon analyzing the laboratory investigations of the respondents, the mean HbA1c level was found to be 5.69 ± 0.65 mmol/L, which was within the normal range for the entire patient group. Patients' Fasting Blood Sugar (FBS) was also tested, and the mean FBS level was 5.94 ± 0.86. In 62% of the patients, Impaired Fasting Glucose (IFG) was observed, while 12% of patients had FBS values indicative of diabetes, and 26% showed normal glycemic status. The average OGTT (measured 2 hours after administering 75 gm of glucose) impression was 8.53 ± 2.02 mmol/L. OGTT levels were found to be normal in 30% of patients, 54% had impaired glucose tolerance (IGT), and 16% of the respondents were found to be diabetic [3]. The weakness of the current study is that glycated hemoglobin was not examined to eliminate cases of hidden diabetes but our results confirm those of other studies. There have been numerous studies examining the association between stress hyper-

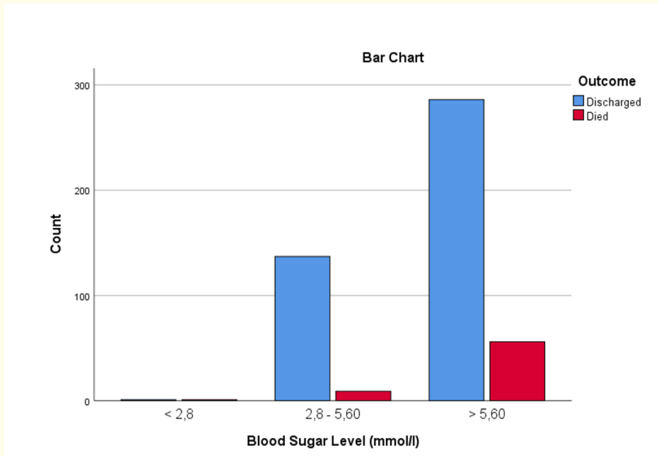

Figure 1: *Bar chart between blood sugar level and stroke outcome.*

glycemia and stroke outcomes, and the results have been generally consistent in demonstrating that stress hyperglycemia is a predictor of worse outcomes in patients with acute stroke [4]. Patients with high blood sugar levels had a significantly higher rate of mortality [5]. One of the earliest studies to investigate the association between stress hyperglycemia and stroke outcomes was published in 2002. The study found that higher admission glucose levels were associated with increased mortality rates and worse functional outcomes in patients with acute stroke [6]. Since then, numerous other studies have confirmed these findings and have also investigated the relationship between the duration of stress hyperglycemia and stroke outcomes [7-19]. While the exact mechanisms underlying the association between stress hyperglycemia and worse stroke outcomes are not fully understood, it is thought that stress-induced hyperglycemia may exacerbate ischemic brain injury through a variety of pathways, including oxidative stress, inflammation, and endothelial dysfunction [20]. Overall, there is some variability in the results across different studies, the weight of the evidence suggests that stress hyperglycemia can be a useful predictor of worse outcomes in patients with acute stroke, and may help guide clinical decision-making regarding monitoring and treatment.

Conclusion

Stress hyperglycemia is common in patients with acute stroke and is associated with worse clinical outcomes. The duration of stress hyperglycemia may be important. Treatment of stress hyperglycemia may improve stroke outcomes. Overall, stress hyperglycemia can be a useful tool in predicting stroke outcomes and can help healthcare providers identify patients who may require more intensive monitoring and treatment. Identifying stress hyperglycemia as a risk factor for poor stroke outcomes can help healthcare providers prioritize and tailor interventions for patients with this condition. Stroke is a leading cause of death and disability worldwide, and identifying modifiable risk factors for poor stroke outcomes can have significant public health implications [21].

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Statement of Ethics

This study protocol was reviewed and approved by Local Ethics Committee of Trakia University - Stara Zagora city, Bulgaria, approval number 14/02 OCT 2020. All patients voluntarily signed an informed consent form prior to inclusion in the study.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Data Availability Statement

The datasets generated and analyzed in the current study are available from the corresponding author on reasonable request.

Bibliography

1. Cai ZM., *et al*. "Fasting blood glucose-to-glycated hemoglobin ratio and all-cause mortality among Chinese in-hospital patients with acute stroke: a 12-month follow-up study". *BMC Geriatrics* 22.1 (2022): 508.
2. Giuseppe De Luca., *et al*. "Stone, for the DESERT cooperation; Impact of Diabetes on Long-Term Outcome After Primary Angioplasty: Insights from the DESERT cooperation". *Diabetes Care* 36.4 (2013): 1020-1025.
3. Patwary MSA., *et al*. "Glycaemic Status in Acute Stroke in Nondiabetic Patient". *Journal of Medicine* 22.1 (2021): 22-26.
4. Zhu B., *et al*. "Stress Hyperglycemia and Outcome of Non-diabetic Patients After Acute Ischemic Stroke". *Frontiers in Neurology* 10 (2019): 1003.
5. Habibur Rahaman., *et al*. "A study on incidence of stress hyperglycemia in acute ischemic stroke in non-diabetic patients and its prognostic significance". *Asian Journal of Medical Sciences* 13.12 (2022): 117-122.
6. Bruno A., *et al*. "Admission glucose level and clinical outcomes in the NINDS rt-PA Stroke Trial". *Neurology* 58.9 (2002): 1360-1365.
7. Muscari A., *et al*. "Prognostic significance of diabetes and stress hyperglycemia in acute stroke patients". *Diabetology and Metabolic Syndrome* 14.1 (2022): 126.
8. Capes SE., *et al*. "Stress hyperglycemia and prognosis of stroke in nondiabetic and diabetic patients: a systematic overview". *Stroke* 32.10 (2001): 2426-2432.
9. Uyttenboogaart M., *et al*. "Moderate hyperglycaemia is associated with favourable outcome in acute lacunar stroke". *Brain* 130.4 (2007): 1626-1630.
10. Jin H., *et al*. "Persistent hyperglycemia is associated with poor outcome in acute intracerebral hemorrhage: a prospective cohort study". *Mediators of Inflammation* (2014): 618180.
11. Won SY., *et al*. "Admission hyperglycemia is associated with a poor outcome in critically ill patients with acute stroke". *Journal of Stroke and Cerebrovascular Diseases* 24.2 (2015): 400-406.
12. Zou X., *et al*. "The relationship between admission hyperglycemia and outcomes in different subtypes of acute ischemic stroke". *Medicine* 96.42 (2017): e8029.
13. Johnston KC., *et al*. "Admission glucose levels predict mortality and hemorrhagic transformation in patients with acute ischemic stroke". *Stroke* 41.1 (2010): 49-53.

14. Alvarez-Sabín J., *et al*. "Impact of admission hyperglycemia on stroke outcome after thrombolysis: risk stratification in relation to time to reperfusion". *Stroke* 35.11-1 (2004): 2493-2498.

15. Baird TA., *et al*. "Persistent poststroke hyperglycemia is independently associated with infarct expansion and worse clinical outcome". *Stroke* 34.9 (2003): 2208-2214.

16. Rosso C., *et al*. "Hyperglycemia and the fate of apparent diffusion coefficient-defined infarcts in acute ischemic stroke". *Stroke* 43.2 (2012): 424-429.

17. Ji R., *et al*. "Stroke in the very elderly: risk factors, clinical features, and outcomes in patients aged ≥85 years". *Aging and Disease* 5.5 (2014): 363-371.

18. Song EC., *et al*. "Hyperglycemia exacerbates brain edema and perihematomal cell death after intracerebral hemorrhage". *Stroke* 44.2 (2013): 545-548.

19. Wang C., *et al*. "Predictive value of persistent stress hyperglycemia for severe functional disability in acute ischemic stroke". *Journal of Stroke and Cerebrovascular Diseases* 25.6 (2016): 1316-1321.

20. Zhang J., *et al*. "The association between stress hyperglycemia and unfavorable outcomes in patients with anterior circulation stroke after mechanical thrombectomy". *Frontiers in Aging Neuroscience* 14 (2023): 1071377.

21. Konstantinos Tziomalos., *et al*. "Stress hyperglycemia and acute ischemic stroke in-hospital outcome". *Metabolism - Clinical and Experimental* 67 (2017): 99-105.

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