

## Short Communication

# Association between admission blood sugar levels and length of stay among patients with acute heart failure: A cross-sectional study in Aceh, Indonesia

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## Abstract

Heart failure persists to be a major health problem worldwide. Numerous factors associated with this condition have been studied to determine its prognosis. History of diabetes mellitus is one of the factors extensively studied, nonetheless, the correlation between acutely elevated admission blood glucose in critically ill patients or stress hyperglycemia towards the prognosis of heart failure remains inconclusive among previously reported studies. Therefore, the aim of this study was to investigate the correlation between admission blood glucose and the length of stay of acute heart failure patients. A cross-sectional study was conducted in Dr. Zainoel Abidin Hospital, Banda Aceh, Indonesia from July to August 2020. Patients' data were retrieved from medical records documenting admission blood glucose and length of stay. Total sampling was employed, where eighty-five patients diagnosed as acute heart failure were included. The results showed that patients (n=85) had the general characteristics of being normoglycemic on admission (69.4%) and having 5–10 days length of stay (44.7%) with Killip 2 as the presiding Killip Class (50.6%). According to Gamma's Correlation Coefficient, the p-value of this study is 0.012 ( $p < 0.05$ ) with a correlation value of 0.454. Therefore, our study revealed the presence of a significant moderate-correlation between admission blood glucose and the length of stay among patients with acute heart failure.

**Keywords:** Acute heart failure, stress hyperglycemia, admission blood glucose, hyperglycemia, length of stay

## Introduction

Heart failure is considered as a significant global issue, affecting approximately 26 million individuals worldwide. Due to the increasing numbers, it is regarded as a global pandemic [1]. In Indonesia, the threat of this disease is prevalent. In 2013 alone, 229,696 (0.13%) Indonesian people were diagnosed with heart failure [2]. Individuals with hypertension and a history of stroke, myocardial infarction, or arrhythmia are at an increased risk of developing heart failure [3]. It is evident that heart diseases can trigger heart failure, which is a particular concern in Aceh (a province in Indonesia). According to the results from Indonesian Basic Health Research 2018 (RIKESDAS 2018), Aceh is one of the eight provinces with a higher prevalence of heart disease than the national average [4]. Various risk factors have been studied to determine the prognosis of heart failure, including diabetes mellitus (DM) [5]. The Framingham study unequivocally reported that people with diabetes mellitus have a 2.4 to 5-fold risk of suffering from heart failure



[5]. However, the relationship between acute elevation of blood sugar levels in heart failure patients without a history of diabetes mellitus and the prognosis of heart failure itself is still not widely understood [6].

Hyperglycemia triggered by acute stress reactions in critical situations, known as stress hyperglycemia, is often found in patients with various diseases, including heart failure [6]. Studies are still controversial regarding the association between admission blood sugar levels and the prognosis of acute heart failure patients. Some studies suggest that elevated admission blood sugar levels and stress hyperglycemia are associated with a significantly worse prognosis over a short period in acute heart failure patients, regardless of diabetes diagnosis and other clinical variables [6-8]. The poor prognosis is thought to be associated with the role of elevated blood sugar levels in worsening ventricular function through several pathways, including oxidative stress that damages cardiomyocytes [9]. However, other studies have argued that stress hyperglycemia does not significantly affect the prognosis of in-hospital mortality, short-term mortality, or length of stay [10,11].

On the other hand, stress hyperglycemia has been widely studied in patients with acute coronary syndrome and has become an integral part of the management of sudden cardiac arrest, according to the recommendations of the American Heart Association in 2013 [12]. The American Diabetes Association also recommends strict control of admission blood sugar levels regardless of the disease, which has little practical application in the management of heart failure [8]. Hence, it is crucial to gain more comprehension on the relationship between admission blood sugar levels and the length of stay of patients with acute heart failure, especially in areas with high prevalence such as Aceh Province.

## Methods

This study is an observational analytic study that uses a cross-sectional approach. The research was conducted at the Medical Record Installation of Dr. Zainoel Abidin Hospital in Banda Aceh from July to August 2020.

The respondents in this study were 85 patients with acute heart failure who were selected using the total sampling method. The inclusion criteria included: (1) new-onset acute heart failure patients (de novo) after myocardial infarction; (2) patients admitted to the cardiac intensive care unit or cardiac ward of Dr. Zainoel Abidin Hospital in 2019; (3) patients aged over 18 years. The exclusion criteria were: (1) patients with a history of chronic obstructive pulmonary disease; (2) patients with a history of chronic kidney disease; (3) patients with incomplete medical record data in accordance with the research methodology.

The main data taken in this study were secondary data from medical records in the form of blood sugar level examination results at admission, which were classified into hypoglycemia (<70 mg/dL), normoglycemia (71–199 mg/dL), and hyperglycemia ( $\geq 200$  mg/dL), as well as the Length of Stay of patients classified into <5 days, 5–10 days, and >10 days, as suggested in a previous study [13]. The characteristic data taken included age, gender, history of type 2 diabetes mellitus, and patient Killip class. The relationship between admission blood sugar levels and Length of Stay was analyzed using the gamma correlation test on SPSS version 22 ([www.ibm.com/spss](http://www.ibm.com/spss)).

## Results

### Patients' characteristics

Characteristics of patients included in this study are presented in **Table 1**. The patients in this study were classified according to age groups set by the Ministry of Health, with the highest number (n=35; 41.2%) falling in the 56–65 years range. The predominant gender experiencing acute heart failure was male (n=70; 82.4%), while only 15 women (17.6%) were included. There were 30 patients (35.3%) who had a history of type 2 diabetes mellitus and 55 patients (64.7%) who did not have a history of type 2 diabetes mellitus. The patients were predominantly in Killip class II compared to Killip class III and IV (n=43; 50.6%). The admission blood sugar levels of acute heart failure patients were predominantly in the normoglycemia group (n=59; 69.4%),

followed by the hyperglycemia group (n=26; 30.6%). Patients with hypoglycemia blood sugar levels were not found in this study. The Length of stay of patients with acute heart failure was dominated by the 5–10 day group (n=38; 44.7%), while the group of fewer than 5 days has the least number (n=21; 24.7%).

**Table 1. Characteristics of patients with acute heart failure admitted to the provincial referral hospital**

Characteristics	n (%)
Age (years)	
26–35	2 (2.4)
36–45	13 (15.3)
46–55	22 (25.9)
56–65	35 (41.2)
>65	13 (15.3)
Gender	
Male	70 (82.4)
Female	15 (17.6)
History of type 2 diabetes mellitus	
Yes	30 (35.3)
No	55 (64.7)
Killip class	
II	43 (50.6)
III	15 (17.6)
IV	27 (31.8)
Admission blood glucose	
Normoglycemia	59 (69.4)
Hyperglycemia	26 (30.6)
Length of stay	
< 5 days	21 (24.7)
5–10 days	38 (44.7)
>10 days	26 (30.6)

### Association between admission blood glucose and length of stay

Results from the association analysis between the admission blood glucose and the length of stay among patients with acute heart failure are presented in **Table 2**. Those with normoglycemia were more frequent to have 5 to 10-day stay in the hospital. The number of hyperglycemia patients was higher in the group with a length of hospitalization above 10 days (n=12). The Gamma correlation test between the two categorical variables (admission blood glucose and length of stay) revealed a significant positive correlation ( $p=0.012$ ) with a correlation coefficient value of 0.454.

**Table 2. Association between admission blood glucose and length of stay**

Blood glucose status on admission	Length of stay, n			Total	p-value	$\gamma$
	< 5 days	5–10 days	>10 days			
Normoglycemia	18	27	14	59	0.012	0.454
Hyperglycemia	3	11	12	26		

## Discussion

Herein, patients were mostly within the range of 56–65 years old (n=35, 41.2%) and male (n=70, 82.4%). In previous research, acute heart failure patients were predominated by those aged around 60–75 years old [14–17]. This indicates that the population in our study is slightly younger as compared to those reported previously which were reported from Korea, Japan, and Switzerland, respectively. Normally, cardiac function is negatively affected by aging, as higher production of reactive oxygen species (ROS) and inflammatory factors is found in elderly populations as compared to younger population [18]. The fact that we have younger population in this present study should alarm the public health researchers and policymakers on relatively high cardiovascular disease burden in Indonesia [19]. As for the gender, higher proportion of male patients in the case of acute heart failure is common and has been reported in several studies [14–17]. A study correlates the cardioprotective effect of sex hormone (estrogen) in female toward this finding [20]. According to the Killip classification in this present study, most patients were

in class II (n=43, 50.6%), followed by those in class IV (n=27, 31.8%) and class III (n=15, 17.6%). This is in line with previous research which states that the proportion of patients with Killip class above II only covers 21% of the total 4057 patients [21].

Our present findings revealed that patients hospitalized for 5–10 days were predominant as compared to those hospitalized <5 (n=21, 24.7%) or >10 days (n=26, 30.6%). This result was in line with data from a multinational study reporting that the average length of stay in several geographical areas was 6.9, 6, and 5.2 days [22]. However, data from another study showed a different result, where patients with a length of stay <5 days were much more prevalent (75.6%) and the average value was 3.8 days [23]. The trend of different average lengths of stay between countries is thought to be influenced by various things, including internal factors such as the quality of hospitals and the insurance system [24].

In this present study, as many as 59 patients (69.4%) had normoglycemia when admitted to the hospital, while the rest were identified as having hyperglycemia (n=26, 30.6%). Correlation between the blood glucose status on admission and hospitalization duration was found to be significant ( $p=0.012$ ). This result was supported by data from HEARTS where patients with normoglycemia admission blood sugar levels are far more dominant (71%) compared to hyperglycemia (29%) [8]. The report from the Korean Acute Heart Failure Registry (KorAHF) also suggested similar results where hyperglycemic cases were not predominant [25].

Herein, we found that a significant correlation between admission blood glucose and length of stay. Previously, it has been suggested those with normoglycemia were likely to have a shorter length of hospitalization as compared to patients with hyperglycemia, regardless of their diseases [26]. However, in the case of chronic and progressive heart failure, such as those with congestion, the correlation was not found [13]. Blood glucose level has been found as a significant determinant for short-term outcomes of heart failure patients, including in-hospital mortality, 30-day mortality, and one-year mortality [6-8,27].

Hyperglycemia acts as the positive feedback loop for heart failure. In patients with acute heart failure, a decrease in cardiac output is the main trigger for the activation of compensatory neuroendocrine systems which will eventually increase plasma glucose levels concomitant to cortisol release [26, 28]. In the events of decreased blood flow (such as ischemia and decreased cardiac output), glucose concentration in blood vessels must be increased to allow the molecule diffusion into cells within the microvascular flow [28]. Nonetheless, increase glucose level may induce myocardium damage attributed to the increase of anaerobic myocardial metabolic pathways, hence the formation of lipolysis-derived reactive oxygen species [26]. Increased circulating free fatty acids from the lipolysis may also trigger the process of arrhythmogenesis [27]. Further, higher plasma glucose levels are also directly proportional to the increased production of glycated proteins such as HbA1C which can cause direct damage to the myocardium, as well as disrupt the function of the membrane and the protein itself [8,26].

The limitation of this study is that medications affecting the level of serum blood glucose were not considered. Additionally, mortality and readmission were not assessed. As the strength, in this study, the patients had new-onset acute heart failure caused by acute coronary syndrome, so the bias that could arise due to previous interventions could be avoided.

## Conclusion

There is a relationship between admission blood sugar levels and length of hospitalization for acute heart failure patients, where each increase in the blood sugar level group is associated with an increase in the length of hospitalization group. In general, the blood sugar levels of acute heart failure patients are within the normal range of normoglycemia. Further research is needed to find the relationship between admission blood sugar levels and the prognosis of acute heart failure patients involving other outcomes such as mortality, the incidence of lethal arrhythmias, ejection fraction values, and readmission to the hospital.

## Ethics approval

The study was approved by the Ethical Clearance Committee of Universitas Syiah Kuala with registration number 1171012p (129/EA/FK-RSUDZA/2020).

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None.

### Competing interests

All authors declare that they have no conflicts of interest.

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### Underlying data

All data underlying the results are available from the corresponding author upon reasonable request.

### How to cite

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