

# Survey on blood glucose and electrolyte levels in patients with acute myocarditis treated at Bach Mai Hospital

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## ABSTRACT

**Background and Objectives:** Myocarditis is a condition characterized by inflammation of the heart muscle tissue due to various causes, with viruses being a common cause. During the progression of the disease, damage to the heart muscle can lead to acute heart failure, dangerous arrhythmias, cardiogenic shock, or even cardiac arrest, which can result in rapid death. Clinical markers such as chest pain, shortness of breath, and arrhythmias, along with diagnostic tools like electrocardiograms and cardiac ultrasounds, play a crucial role in diagnosing and predicting the disease. In addition to monitoring vital signs, tracking blood glucose and electrolyte levels is an important criterion for nurses in managing patients with acute myocarditis. This aids in making appropriate care and treatment decisions for each specific patient. The study aims to investigate blood glucose and electrolyte levels and their relationship with the severity of heart failure and ventricular arrhythmias in patients with acute myocarditis.

**Methods:** A retrospective review was conducted on the records of 119 patients with acute myocarditis treated at Bach Mai Hospital from 2017 to 2021. Biochemical results were included in a regression model to assess their correlation with the occurrence of adverse clinical outcomes during hospitalization.

**Results:** Among the 119 patients (66.4% male; average age  $33.93 \pm 15.87$  years), significant electrolyte disturbances included severe hyponatremia (6.7%), severe hypokalemia (5.8%), hyperkalemia (8.1%), and blood glucose disorders (31.1%). Severe hyponatremia was found to be predictive of ventricular arrhythmias and in-hospital mortality. Severe hypokalemia was also predictive of ventricular arrhythmias and in-hospital mortality. Hyperkalemia was associated with a higher risk of ventricular arrhythmias. Patients with severe conditions requiring intensive care, such as intravenous feeding or intravenous insulin administration, demonstrated a higher risk of in-hospital mortality.

**Conclusion:** Severe electrolyte disturbances, such as severe hyponatremia, severe hypokalemia, and hyperkalemia, have prognostic significance in patients with acute myocarditis.

**Keywords:** Acute myocarditis, arrhythmias in patients with acute myocarditis.

## SUBJECTS AND METHODS

### Research Design

The study was conducted as a retrospective cross-sectional descriptive study.

### Research Procedure:

- Step 1: Select patients diagnosed with acute myocarditis for the study.
- Step 2: Collect information on symptoms, clinical and subclinical signs, and surface electrocardiographic parameters based on medical records.
- Step 3: Divide the study population into groups based on specific criteria: presence/absence of blood glucose and electrolyte abnormalities.
- Step 4: Record the level of heart failure (NYHA classification) and the forms of arrhythmias diagnosed in patients across groups.
- Step 5: Summarize nursing interventions for the group of patients studied.

### Study Population

Patients diagnosed (or suspected) with acute myocarditis at Bach Mai Hospital from 2017 to 2021.

### Inclusion Criteria

Patients diagnosed (or suspected) with acute myocarditis according to the 2013 European Society of Cardiology criteria. The information in medical records must be complete and clear.

### Exclusion Criteria

Patient data from electrocardiograms that are not sufficient for measurement, analysis, and evaluation.

### Study Variables

Biochemical changes, including increased/decreased blood glucose levels, increased/decreased blood electrolyte levels, arrhythmias (such as ectopic beats, ventricular tachycardia, atrioventricular block), and the degrees of heart failure (based on NYHA classification).

## RESULTS

### Main Clinical Characteristics of Patients with Acute Myocarditis

Clinical characteristics of patients with acute myocarditis... (Note: The original text ends abruptly, so further details on clinical characteristics may follow in the full document.)

**Table 1.** Clinical Characteristics of Patients with Acute Myocarditis

Characteristics	Value
Age (TB ± SD)	33,93 ± 15,87
Male (n,%)	79 (66,4%)
Fever (n,%)	31 (26,05%)
Flu-like symptoms (n,%)	20 (16,8%)
Chest pain (n,%)	105 (88,2%)
Shortness of breath (n,%)	90 (75,6%)
Heart rate (cycles/min)	94,66 ± 26,41
Systolic blood pressure (mmHg)	106,11 ± 19,65

**Comments:** Patients with myocarditis tend to be relatively young, with an average age of 33.93 ± 15.87 years, and a predominance of male patients. The common symptoms leading to hospital admission are chest pain and shortness of breath. Most patients have stable blood pressure at the time of admission.

### Blood Biochemistry Results

**Table 2.** Blood Biochemistry Characteristics of the Study Population

Characteristics	Value
Troponin T (ng/L)	1860,4 ± 1914,2
NT-proBNP (pmol/L)	439,5 ± 674,8
CK-MB (U/L)	77,1 ± 57,8
CRP-hs elevated (n,%)	45 (37,8%)
Creatinine (µmol/L)	73,0 ± 30,9
Glucose (mmol/L)	5,6 ± 3,2
Na+ (mmol/L)	134 ± 8,8
K+ (mmol/L)	3,6 ± 0,9
AST (U/L)	96,5 ± 83,6
ALT (U/L)	71,6 ± 93,1
Lactat (mmol/L)	2,9 ± 2,8



**Comments:** The biochemical tests reveal two characteristic conditions in acute myocarditis: myocardial cell damage and increased inflammatory response. A third characteristic is acute heart failure, which is indicated by elevated NT-proBNP levels.

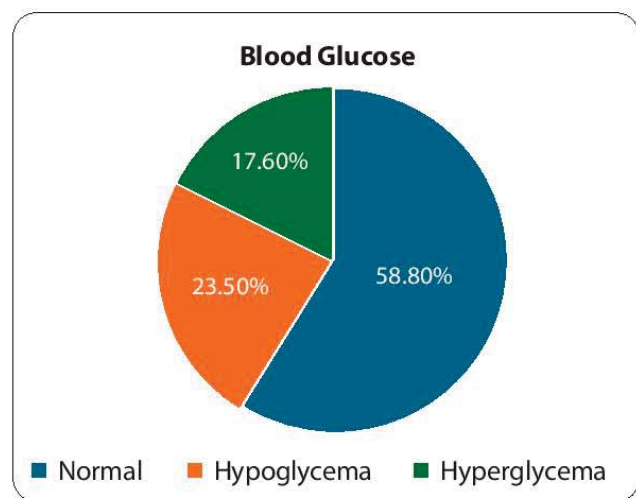
**Progression and Treatment Outcomes**

Progression	Rate (%)
Mechanical circulatory support	16
Mortality rate	4,2

**Comments:** The majority of patients were discharged in stable condition. There were 5 deaths (4.2%), and 19 patients (16%) required mechanical circulatory support via extracorporeal membrane oxygenation (ECMO).

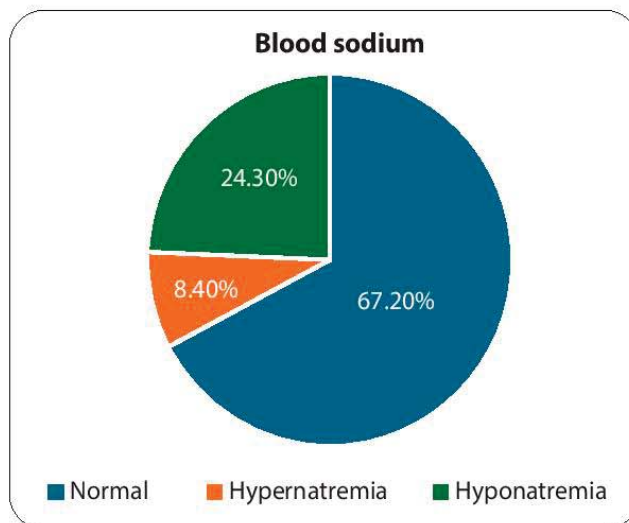
**Results of Blood Glucose and Electrolyte Levels in the Study Group**

*Some important changes in blood glucose and electrolyte levels of the study group*



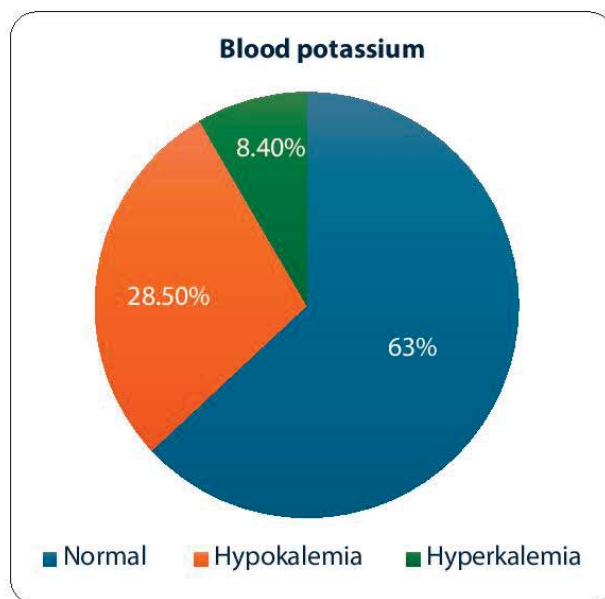
**Chart 1.** Blood glucose levels of the study group

**Comments:** From the survey of 119 patients with Myocarditis, nearly 60% of the patients had normal blood glucose levels, however, 1/4 of the patients experienced hypoglycemia, and 1/5 of the patients admitted to the hospital had hyperglycemia. In our study, 28 patients (23.5%) had hyperglycemia, of which 20 patients (71.4%) had a history of diabetes and were undergoing treatment with medication.



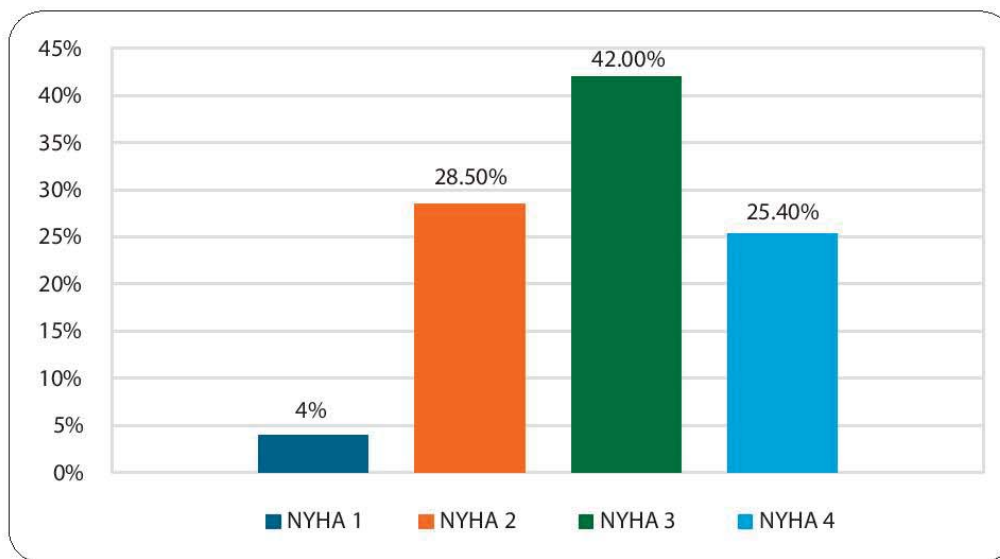
**Chart 2.** Blood sodium levels of the study group

**Comments:** 1/4 of the patients had hyponatremia. In our study, 10 patients had hypernatremia, of which 6 patients (60%) had a prior history of kidney failure.



**Chart 3.** Blood potassium levels of the study group.

**Comments:** Nearly 30% of patients had hypokalemia, while the majority had normal potassium levels (63%). In our study, 10 patients had elevated potassium levels upon admission, of which 8 patients (80%) had a history of kidney failure or were diagnosed with kidney failure at the time of admission.



**Chart 4.** NYHA classification of the study group at the time of admission

**Comments:** Nearly half of the patients admitted had respiratory failure at NYHA level 3, with only 4% exhibiting mild respiratory failure at NYHA level 1.

#### Correlation between Heart Failure Severity and Blood Glucose and Electrolyte Levels

**Table 4.** Correlation of NYHA heart failure levels 1,2 – NYHA 3,4 with blood glucose and electrolyte levels.

Index	OR	95% CI	p
Blood glucose	1,48	[0,53-5,62]	0,45
Blood sodium	2,56	[0,62-7,34]	0,27
Blood potassium	1,23	[0,42-12,3]	0,87

**Comments:** No correlation has been observed between blood glucose fluctuations, electrolyte levels, and heart failure severity between the two groups, NYHA 1,2 and NYHA 3,4.

#### Relation to In-Hospital Ventricular Arrhythmias

**Table 5.** Correlation between ventricular arrhythmias and severe electrolyte disturbances.

Index	OR	95% CI	p
Severe Hyponatremia (Natri < 125 mmol/L)	2,6	[2,14 – 10,42]	<b>0,02</b>
Hypernatremia (Natri >150 mmol/L)	1,56	[0,62 – 2,91]	0,27
Severe Hypokalemia (Kali < 2,5 mmol/L)	7,8	[1,2 – 12,4]	<b>0,03</b>
Hyperkalemia (Kali > 5 mmol/L)	3,5	[2,34 – 7,42]	<b>0,04</b>

**Comments:** Severe electrolyte disturbances (severe hyponatremia, severe hypokalemia, hyperkalemia) are significant predictors of increased rates of ventricular arrhythmias in the study group.

### Relation to Mortality Outcomes

**Table 6.** Correlation of clinical outcomes (mortality and non-mortality) with severe electrolyte disturbances.

Index	OR	95% CI	p
Severe Hyponatremia (Natri < 125 mmol/L)	10,2	[1,2 – 22,1]	<b>0,018</b>
Hypernatremia (Natri > 150 mmol/L)	1,15	[0,58 – 3,6]	0,97
Severe Hypokalemia (Kali < 2,5 mmol/L)	8,7	[2,12 – 18,3]	<b>0,023</b>
Hyperkalemia (Kali > 5 mmol/L)	1,45	[0,78 – 3,4]	0,54

**Comments:** Severe electrolyte disturbances (severe hyponatremia, severe hypokalemia) are significant predictors of increased mortality rates in the study group.

### Results of Some Nursing Care in the Study Group

#### Nursing Care for Patients with Blood Glucose Disorders

**Table 7.** Some nursing care for patients with blood glucose disorders and its correlation with clinical outcomes (mortality and non-mortality) in the study group.

Chỉ số	OR	95% CI	p
<b>Hypoglycemia</b>			
Intravenous glucose infusion	1,15	[0,58 – 9,6]	0,97
Oral feeding	8,7	[0,76 - 18,3]	0,78
Intravenous feeding	6,85	[1,27 – 10,4]	0,002
Tube feeding	10,2	[0,46 – 22,1]	0,82
<b>Hyperglycemia</b>			
Blood glucose monitoring	1,9	[0,58 – 10,6]	0,82
Intravenous insulin infusion	4,6	[3,6 - 102,3]	0,03
Subcutaneous insulin injection	3,85	[0,27 – 9,4]	0,54
Oral diabetes medication	5,2	[0,46 – 8,1]	0,69

**Comments:** In the group of patients requiring intravenous feeding or intravenous insulin infusion to treat hyperglycemia, there is a significant predictive value for mortality outcomes in the study group. In our study, there were 10 patients who needed intravenous feeding, among whom 6 were critically ill, had acute myocarditis with complications of cardiogenic shock,

required ECMO, and were experiencing multi-organ failure, making enteral feeding impossible and necessitating intravenous nutrition.

Additionally, in the group of patients requiring intravenous insulin infusion, there were 9 patients, all of whom had a prior history of diabetes that had been diagnosed previously.



**Table 8.** Some nursing care for patients with electrolyte disturbances and its correlation with clinical outcomes (mortality and non-mortality) in the study group.

Index	OR	95% CI	p
<b>Sodium level disturbances</b>			
Hypertonic sodium infusion	8	[5,8 – 39,6]	<b>0,004</b>
Salty diet	4,7	[0,76 - 18,3]	0,78
Hypotonic sodium infusion	6,85	[0,27 – 19,4]	0,92
<b>Potassium level disturbances</b>			
Oral potassium supplementation	2,3	[0,28 – 12,6]	0,72
Intravenous potassium infusion	6,6	[3,6 - 82,3]	<b>0,02</b>
Medication for hypokalemia	4,25	[0,25 – 7,4]	0,89
Dialysis	5,9	[4,2 – 119,1]	<b>0,001</b>

**Comments:** In the group of patients receiving hypertonic sodium infusion or intravenous potassium infusion/dialysis for potassium lowering, there is a significant association with predicting mortality outcomes in the studied group of patients.

## DISCUSSION

### Prognostic Value of Certain Blood Sugar and Electrolyte Disturbances in Patients with Acute Myocarditis

#### Blood Glucose Disturbances

Through our study, we found that blood glucose disturbances occurred in about 40% of the patients, with hypoglycemia (28 patients, accounting for 23.5%) and hyperglycemia (20 patients, accounting for 17.6%). In our research, blood glucose disturbances were not related to mortality outcomes or increased risk of ventricular arrhythmias. However, in the group of patients requiring intravenous nutritional fluid (10 patients), there was a significant association predicting mortality outcomes in the studied group with  $p=0.002$ . Most of these patients were severely ill with myocarditis, having complications such as cardiogenic shock, leading to multiple organ failure, where the gastrointestinal tract could not absorb food, necessitating intravenous nutrition.

### Electrolyte Disturbances

#### Sodium Disturbances

In our study, sodium disturbances occurred in about 30% of patients, with hyponatremia (29 patients, accounting for 24.3%), which is consistent with the study by Ali K and colleagues; hypernatremia (10 patients, accounting for 8.4%). Among these, the group with severe hyponatremia (sodium levels  $<125$  mmol/L) had 8 patients, significantly predicting mortality outcomes ( $p=0.018$ ) and increased risk of ventricular arrhythmias ( $p=0.02$ ). Regarding the pathophysiological mechanism, low sodium levels lead to ionic imbalances in cells, including cardiac myocytes, affecting electrical conduction in the heart and increasing the risk of ventricular arrhythmias. Additionally, hyponatremia impacts the metabolism of other vital organs such as the brain and kidneys, increasing the risk of mortality, especially in patients with severe hyponatremia.

In our study, there were 29 patients with hyponatremia, of which 9 patients (31%) had severe hyponatremia. Among this group, there were 6 cases of cardiogenic shock requiring ECMO intervention, with multiple organ failure, necessitating hypertonic sodium infusion.

### Potassium Disturbances

In our study, potassium disturbances occurred in nearly 40% of patients, with hypokalemia (34 patients, accounting for 28.5%), similar to the findings of Jiacong Lu. In our research, patients with hyperkalemia primarily had a history of diagnosed renal failure or this was the first time it was detected. Therefore, when there is hyperkalemia, dialysis methods should be applied, alongside medication to adjust potassium levels. In the context of myocarditis, alongside potassium level disturbances, these are factors that promote arrhythmias in this patient group.

Both the severe hypokalemia group and hyperkalemia group significantly predict mortality outcomes and increased risk of ventricular arrhythmias.

### Nursing Care

Nursing care plays a crucial role in managing patients with blood sugar and electrolyte disturbances. In our study, the parameters predicting mortality risk were present in severely ill patients requiring intensive care treatment, such as those needing intravenous nutrition, severe hyponatremia requiring hypertonic sodium infusion, or patients with hypokalemia needing intravenous potassium infusion. This helps improve clinical practice, and nurses need to collaborate with doctors to make timely and accurate treatment decisions.

### CONCLUSION

Through the study of 119 cases of acute myocarditis, we found that electrolyte disturbances, including severe hyponatremia and severe hypokalemia, are significant prognostic parameters

for adverse clinical outcomes. Additionally, nursing care plays an essential role, especially in patients with severe electrolyte disturbances.

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