



Effect of Blood Glucose Monitored Before Dialysis on Hypoglycemia During Dialysis in Adult Acute Hemodialysis Patients: A Multicenter Study

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Abstract

Aim: Individuals receiving hemodialysis treatment may observe glucose fluctuations due to decreased plasma glucose concentration and insulin level. The aim of this study was to evaluate pre-dialysis blood glucose measurements in acute hemodialysis patients to reduce complications that may occur during this process.

Methods: The study design was an observational-retrospective one. A total of 200 files belonging to the last 3 months in three centers were scanned between August 1, 2022, and September 30, 2022. While the files were being scanned, the 30-question "Hypoglycemia in Hemodialysis" patient form was used, and the IBM Statistical package for the social sciences 26.0 statistical program was used to evaluate the data.

Results: Hypoglycemia developed during hemodialysis in 4 of 104 patients whose blood glucose was checked before hemodialysis and in 2 of 96 patients whose blood glucose was not measured. It was determined that there was no significant difference ($p>0.05$) in terms of the rate of development of hypoglycemia between patients whose blood glucose levels were checked before hemodialysis and those who did not.

Conclusion: The study's results suggest that acute hemodialysis patients' pre-dialysis hypoglycemia does not influence the hypoglycemia that develops during the session.

Keywords: Complications, glucose, hemodialysis, hypoglycemia

Introduction

Hemodialysis is the most commonly used method for treating chronic renal failure worldwide, as well as in our country. The Turkish Society of Nephrology used epidemiologic data for the Chronic Renal Disease in Turkey Prevalence Study. According to this study, 15.7% of the Turkish population has chronic kidney disease, and 26.6% of those with this disease also have diabetes. The prevalence of chronic kidney disease in people with diabetes is 32.4%. This rate is 2.5 times higher than that of patients without diabetes (1). In diabetes, fluctuations

with hyperglycemia and hypoglycemia occur (2). Hemodialysis treatment can cause glycemetic fluctuations due to decreased plasma glucose concentrations and insulin levels. Therefore, especially in diabetic hemodialysis patients, control of blood glucose and adjustment of drug doses are important (3). In the study by Kang et al. (2), hypoglycemia was observed in 16.8% of diabetic hemodialysis patients and 6.9% of non-diabetic patients in the first year of dialysis. Hayashi et al. (4) reported that although dialysate containing 100-150 mg/dL glucose was used in diabetic patients receiving hemodialysis treatment, hemodialysis-induced hypoglycemia unconsciousness

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was frequently experienced, and the sensor glucose level could fall well below the dialysate glucose concentration toward the end of hemodialysis. Studies have shown that hemodialysis treatment causes changes in blood glucose levels. When the literature is reviewed, there are a limited number of studies on the control of blood glucose levels in hemodialysis patients to reduce complications (5-10).

In routine hemodialysis applications, there is no clear recommendation for routine glucose measurement before dialysis in either diabetic or non-diabetic patients. Because the response to hypoglycemia may not be sufficient in acute hemodialysis patients, identifying these patients before they develop hypoglycemia may provide early recognition of serious adverse effects and may be preventive. The aim of this study was to determine the frequency of hypoglycemia that may develop during hemodialysis in acute hemodialysis patients with and without pre-hemodialysis blood glucose monitoring, as well as to reduce the complications that may occur during this process. We anticipate that the study's results will inform the development of treatment protocols.

Methods

Compliance with Ethical Standards

Ethical approval for this study was obtained from the Publication Ethics Committee For Social Sciences and Humanities for Istanbul Beykent University (approval no.: 62746, date: 22.07.2022). The research design was an observational-retrospective study. In the study, the files of 200 acute hemodialysis patients aged 18 years and over, belonging to the last three months, in the dialysis units of a total of three centers, including a university hospital, a

medical faculty, and two different training and research hospitals, were examined between August 1, 2022, and September 30, 2022. Patients were coded with the first two letters of their names, the first two letters of their surnames, and the last two digits of their date of birth (e.g., EGCE81). The 30-question "Hypoglycemia in Hemodialysis" patient form created while scanning the files was used (Figure 1).

If the blood glucose measurements of the patients were below 70 mg/dL (3.9 mmol/L) (with or without symptoms), hypoglycemia was considered. Neurogenic (tremor, palpitation, sweating, anxiety, paresthesia) and neuroglycopenic symptoms (dizziness, weakness, lethargy, delirium, confusion, seizure, coma) were considered hypoglycemia symptoms (11). Symptomatic hypoglycemia was defined as having typical hypoglycemia symptoms along with a glucose level of ≤ 70 mg/dL (3.9 mmol/L). Asymptomatic hypoglycemia, on the other hand, did not have typical hypoglycemia symptoms but did have a glucose level of ≤ 70 mg/dL (3.9 mmol/L). It was considered an event.

Statistical Analysis

The IBM Statistical package for the social sciences 22.0 statistical program was used for statistical analyses. Descriptive statistics (mean, standard deviation, median, and percentage) methods were used to evaluate the central tendency and distribution of the study variables. In the comparison of the two groups, the Student's t-test was used to compare normally distributed data for categorical variables, and the Mann-Whitney U test was used to compare non-normally distributed data. The chi-square test was used for non-categorical variables in the

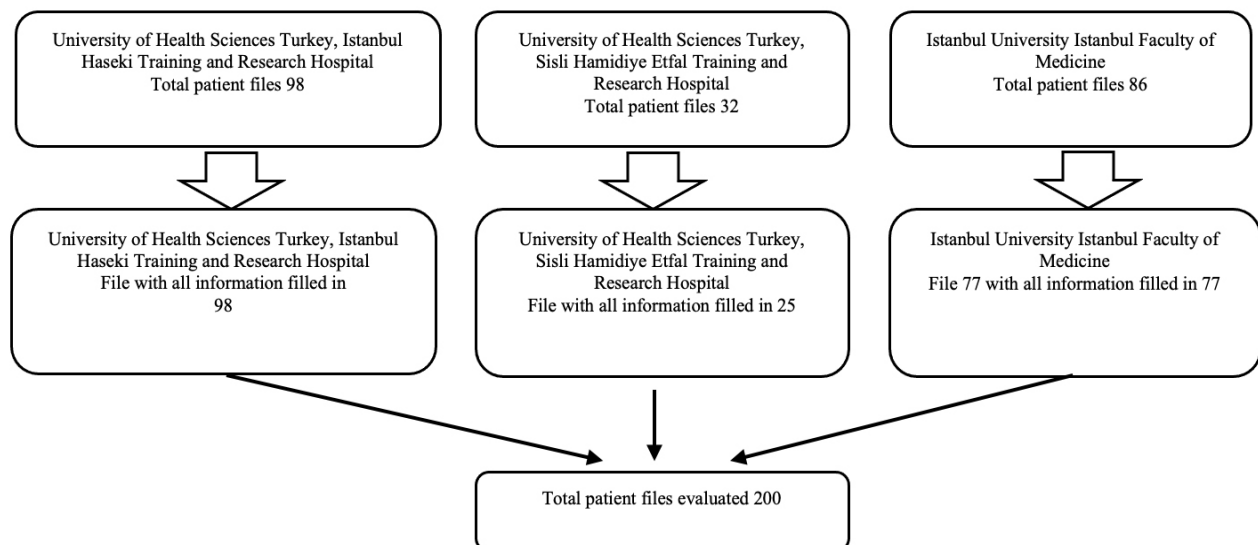


Figure 1. Flowchart of patient files included in the study

comparison of the two groups. The results were evaluated at a 95% confidence interval and a significance level of $p < 0.05$.

Results

A total of 200 acute hemodialysis patient files, including 98 (49%) from University of Health Sciences Turkey, Istanbul Haseki Training and Research Hospital, 25 (12.5%) from University of Health Sciences Turkey, Sisli Hamidiye Etfal Training and Research Hospital, and 77 (38.5%) from Istanbul University, Istanbul Faculty of Medicine, were reviewed, and data were collected. Table 1 displays the epidemiologic and demographic characteristics of the patients. Of the patients, 107 (53.5%) were male, and the mean age was 62 ± 15.7 years. Seventy-seven (38.5%) patients were primary school graduates, and the most common cause of primary kidney disease was hypertensive nephrosclerosis (41%), followed by diabetic nephropathy (36.5%). When comorbidities were evaluated, 103 (51.5%) had diabetes mellitus. Thirty-seven (18.5%) had a family history of diabetes mellitus. The most common indication for acute hemodialysis was uremia (42%; Figure 2). When the antidiabetic drug and insulin use status of diabetic patients were analyzed, 42 (48%) were using oral antidiabetic drugs and 73 (70.9%) were using insulin (Table 1).

Blood glucose was checked in 104 (52%) patients before dialysis, whereas blood glucose was not checked in 96 patients before dialysis (Table 2). The mean blood glucose level of the patients whose blood glucose levels were checked was 138 ± 54 mg/dL (minimum: 66 mg/dL, maximum: 294 mg/dL). The mean systolic and diastolic blood pressures before dialysis were 139 ± 17 mmHg and 79 ± 16 mmHg, respectively. During dialysis, two patients received oral nutrition, while four received oral or intravenous nutrition support. There was no significant

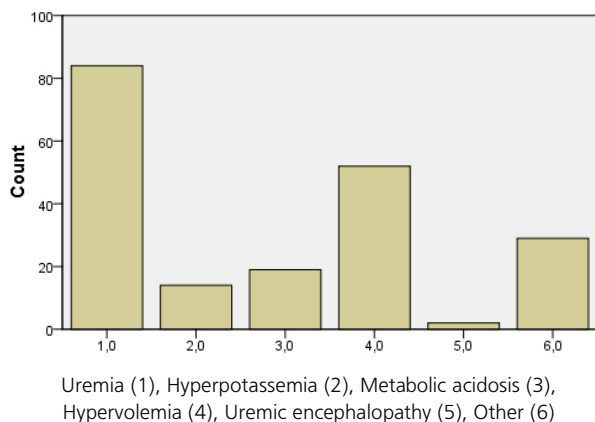


Figure 2. Indications for patients to undergoing acute hemodialysis

Table 1. Epidemiological and demographic characteristics of the patients (n=200)

	N (%)
Centre	
University of Health Sciences Turkey, Istanbul Haseki Training and Research Hospital	98 (49)
University of Health Sciences Turkey, Sisli Hamidiye Etfal Training and Research Hospital	25 (12.5)
Istanbul University, Istanbul Faculty of Medicine	77 (38.5)
Gender	
Woman	93 (46.5)
Man	07 (53.5)
Age (average)	62 ± 15.7
Educational status	
Illiterate	21 (10.5)
Literate	37 (18.5)
Primary school	77 (38.5)
Middle-high school	64 (32)
University	1 (0.5)
Causes of primary kidney disease	
Diabetic nephropathy	73 (36.5)
Hypertensive nephrosclerosis	82 (41)
Chronic glomerulonephritis	5 (2.5)
Autosomal dominant polycystic kidney disease	3 (1.5)
Other	22 (11)
Unknown	15 (7.5)
Diabetes	
There is	103 (51.5)
There isn't	97 (48.5)
Family history of diabetes	
There is	37 (18.5)
There isn't	39 (19.5)
Unknown	124 (62)
Indications for patients to undergoing acute hemodialysis	
Uremia	84 (42)
Hyperkalemia	14 (7)
Metabolic acidosis	19 (9.5)
Hypervolemia	52 (26)
Uremic encephalopathy	2 (1)
Other	29 (14.5)
Antidiabetic drug and insulin use status of patients with diabetes (n=103)	
Antidiabetic drug use	
There is	42 (40.8)
There isn't	61 (59.2)
Insulin use	
There is	73 (70.9)
There isn't	30 (29.1)
Descriptive statistical methods (mean, standard deviation, frequency, percentage)	

difference between the genders of the patients with and without blood glucose monitoring ($p < 0.05$), whereas the patients with blood glucose monitoring were older ($p < 0.05$). There was no significant difference between the urea, creatinine, albumin, and potassium values before dialysis between both groups ($p > 0.05$). Diabetes was present in 58 (55.7%) of 104 patients with blood glucose monitoring, whereas 45 (46.8%) of 96 patients without blood glucose monitoring had diabetes, and the rates of diabetes were similar in both groups ($p > 0.05$).

Hypoglycemia developed in 6 (3%) of 200 patients during hemodialysis. It was observed that blood glucose decreased during hemodialysis in 4 (2%) patients in the group whose blood glucose was checked before hemodialysis and in 2 (1%) patients in the group whose blood glucose was not checked. The rates of hypoglycemia during dialysis in patients with and without blood glucose monitoring were similar ($p > 0.05$) (Table 3). All patients who developed hypoglycemia responded to hypoglycemia treatment.

One patient (16.7%) experienced prolonged dialysis due to hypoglycemia during hemodialysis, while six patients did not terminate their hemodialysis treatment (Table 4). Other than hypoglycemia, 38 patients developed complications during hemodialysis. The most common complication was hypotension, which occurred in 27 patients.

Table 2. Pre-dialysis blood glucose level and hypoglycemia status during hemodialysis

	N (%)
Blood glucose measurement before hemodialysis	
There is	104 (52)
There isn't	96 (48)
Development of hypoglycemia during hemodialysis	
There is	6 (3)
There isn't	197 (97)
Descriptive statistical methods (frequency, percentage)	

Table 3. Comparison of the number of patients with or without blood glucose monitoring before hemodialysis and those who developed hypoglycemia

	Developing hypoglycemia (n=6)	
	N (%)	p-value
Blood glucose level before hemodialysis (n=104)	4 (2)	0.430
Blood sugar not checked before hemodialysis (n=96)	2 (1)	
Chi-s Square test		

Discussion

This multicenter study included 200 acute hemodialysis patients, with approximately half diagnosed with diabetes, and found a 3% frequency of hypoglycemia during hemodialysis in these patients. In the study by Kang et al. (2), the rate of hypoglycemia in diabetic patients in the first 6 months of dialysis was 16.8%, whereas the rate of hypoglycemia in patients without diabetes was 6.9%. In addition, age, female gender, race, presence of a central venous catheter, lower residual renal function, and longer duration of dialysis sessions were found to affect hypoglycemia, and the risk of all-cause mortality was higher in patients with hypoglycemia. In a single-center study by Habte-Asres et al. (12) on 56 dialysis patients with diabetes, hypoglycemia was found in 23.6% of the patients. The rates of patients with hypoglycemia in this study and the literature differ. The study measured the blood glucose level during dialysis. However, the literature does not provide clear information about the timing of the glucose measurement. The discrepancy in the results could possibly be due to the timing of the blood glucose check. In addition, oral and parenteral nutrition during dialysis may have affected the results. Furthermore, in these patients, decreased caloric intake, decreased renal gluconeogenesis, and decreased insulin clearance may contribute to the increased risk of hypoglycemia. In addition, poor glycogen stores due to malnutrition, prolonged half-lives of insulin or oral antidiabetics, and the use of drugs that regulate the response to hypoglycemia (lower than normal blood glucose), such as beta blockers, may contribute to low blood glucose. In daily practice, glucose dialysate is recommended only in diabetic patients because of the risk of intradialytic hypoglycemia. Although all patients included in our study were hemodialyzed with 100 mg/dL glucose dialysate, hypoglycemia still developed in 3% of the patients. Although a rate of 3% may seem low, it may be preventive to be more careful in this

Table 4. The effect of hypoglycemia developing during hemodialysis on treatment

	N (%)
Treatment termination status of the patient who developed hypoglycemia during hemodialysis	
Yes	0 (0)
No	6 (100)
Prolongation of the treatment of the patient who developed hypoglycemia during hemodialysis	
Yes	1 (16.7)
No	5 (83.3)
Descriptive statistical methods (frequency, percentage)	

regard, considering the additional complications that may occur after hypoglycemia. In patients with hypoglycemia, intradialytic catabolism increases, and severe fatigue occurs after dialysis. When hypoglycemia is excessive, symptoms sometimes become more severe and may lead to major arrhythmias, particularly in patients with ischemic heart disease (13).

Patients who undergo hemodialysis may die due to hypoglycemia. Therefore, continuous monitoring and control of blood glucose, especially before hemodialysis, is important. Literature studies support this view (14-16).

The study's retrospective nature and exclusion of many data points from the evaluation due to their incompleteness in the patient files resulted in a smaller sample size. Studies with larger sample sizes, or those that take the number of sessions as a sample, are believed to yield more meaningful data. In addition, the percentage differences in the files selected from the centers [98 (49%) from University of Health Sciences Turkey, Istanbul Haseki Training and Research Hospital, 25 (12.5%) from University of Health Sciences Turkey, Sisli Hamidiye Etfal Training and Research Hospital, and 77 (38.5%) from Istanbul University, Istanbul Faculty of Medicine] are considered the limitations of the study.

Hypotension is the most common acute complication during hemodialysis (20-30%), followed by cramps (5-20%), nausea and vomiting (5-15%), pruritus (5%), headache (5%), back and chest pain (2-5%), chills, and fever (2%). The most common complication observed in our patients included in the study was hypotension (13.5%). Hypoglycemia is not as common as these complications; however, severe hypoglycemia may prolong the duration of dialysis and cause severe neurological findings, making it a complication that requires the attention of the dialysis team regardless of its frequency.

Diabetic kidney disease is the most common cause of end-stage renal failure worldwide and in our country, and diabetes is an important risk factor for both chronic and acute kidney damage. According to the 2022 Report of the Turkish Society of Nephrology, diabetes ranks first with a rate of 36.29%, hypertension with a rate of 31.65%, and glomerulonephritis with a rate of 4.61% in the etiologies of hemodialysis patients in 2022 (17). In the present study, hypertensive nephrosclerosis was the most common cause of primary renal disease, with a rate of 82 (41%), and diabetic nephropathy was the second most common cause, with a rate of 73 (36.5%). The results of this study are different from those in the literature. This difference is believed to be due to the study's small sample size.

In our study, 84 (42%) patients were admitted to acute hemodialysis for uremia, 52 (26%) for hypervolemia, 19 (9.5%) for metabolic acidosis, 14 (7%) for hyperpotassemia (the potassium level in the blood is higher than it should

be), 2 (1%) for uremic encephalopathy, and 29 (14.5%) for other indications. In the study conducted by Gülle et al. (18), the indications for emergency hemodialysis were found to be hypervolemia (31.8%), hyperpotassemia (22.7%), uremic findings (21%), and metabolic acidosis (19.2%) in order of frequency. Although the indications determined in this study and the literature are the same, the differences in the frequency of occurrence are striking. The socio-economic and cultural differences in the selected patient group, the barriers to health care access, and the status of the control group may influence the differences between the two studies.

Study Limitations

Studies with a larger sample size or a sample of more sessions are believed to yield more meaningful data. Additionally, the percentage differences in the files selected from the centers [98 (49%) from University of Health Sciences Turkey, Istanbul Haseki Training and Research Hospital, 25 (12.5%) from University of Health Sciences Turkey, Sisli Hamidiye Etfal Training and Research Hospital, and 77 (38.5%) from Istanbul University, Istanbul Faculty of Medicine] are deemed limitations of the study. Despite these limitations, the study holds value as it is the first in the literature to measure blood glucose prior to hemodialysis. This study is valuable because it raises awareness of the importance of glycemic control in hemodialysis patients.

Conclusion

Hypoglycemia developed in 6 (3%) of 200 patients during hemodialysis. Four (2%) patients who had their blood glucose checked before hemodialysis experienced a decrease in blood glucose during hemodialysis, while 2 (1%) patients did not have their blood glucose checked. There was no significant correlation between the rates of hypoglycemia during dialysis in patients with and without blood glucose monitoring. Despite the seemingly low rate of 3% and the lack of significant correlation between the two groups, this rate holds significance as hypoglycemia can potentially result in death. In routine hemodialysis practice, there is no clear recommendation for routine glucose measurement before dialysis in both diabetic and non-diabetic patients. Because the response to hypoglycemia may not be adequate in acute hemodialysis patients, identifying these patients before hypoglycemia develops may be preventive by providing early recognition of serious adverse effects. These studies should be increased, and treatment protocols and guidelines should be developed.

Ethics

Ethics Committee Approval: Approval for this study was obtained from the Publication Ethics Committee

For Social Sciences and Humanities for Istanbul Beykent University (approval no.: 62746, date: 22.07.2022).

Informed Consent: Since the data used in the study were obtained from the hospital registration system, an individual informed consent form was not required.

Authorship Contributions

Concept: I.C., E.C., V.Z.Y., Design: I.C., E.C., V.Z.Y., Data Collection or Processing: I.C., N.K., E.C., Analysis or Interpretation: N.K., E.C., Literature Search: I.C., N.K., E.C., V.Z.Y., Writing: I.C., N.K., E.C.

Conflict of Interest: No conflict of interest was declared by the authors.

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