Academic Science Journal

Detection Impact of Hemodialysis in Regulation of Glucose Level in Two Groups of Uremic Patients (Diabetic and Non-Diabetic)

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Received: 9 November 2023 **Accepted: 23 January 2024**

DOI: https://doi.org/10.24237/ASJ.02.02.778B

Abstract

Dialysis and end-stage renal illness have opposing effects that might cause significant changes in glucose levels. A total of 100 uremic patients that were subjected to hemodialysis were tested to determine level of glucose, the uremic patients were in two groups diabetic and non-diabetic with consideration that the patients might be taking insulin or diabetes medication and eating before or during hemodialysis. The study aims to evaluate the effect of hemodialysis on the diabetic uremic patient in relation to the non-diabetic uremic patient by measuring blood glucose level for both study groups. The results show the distribution of patients studied according to study groups. Non diabetic Patients constitute 65 % and 35% of the cases are diabetic. The results also show the distribution of patients according to sex. Could be seen a predominance of male sex, represented by 54% of those studied and 46% are females. Hypoglycemia during dialysis was observed for most of non-diabetic dialyzed patients and only 3 (4.6%) of those was developed hyperglycemia. Only 11 of 35 diabetic patients (31.4%) experienced hyperglycemia at the conclusion of the HD session, necessitating a rise in insulin dosage. Conclusion: Dialysate glucose tends to rise during HD sessions, exception for some diabetic and non-diabetic patients who experience blood glucose decreases that may be symptomatic or asymptomatic. Dialysate glucose tends to decrease during HD sessions in the majority of patients. Therefore, it is important to follow up level of glucose in uremic patients subjected to hemodialysis.

Key words : diabetic and non-diabetic, hemodialysis, glucose

الكشف عن تاثير الديال الدموي في توازن مستوى الكلوكوز لدى مجموعتان من مرضى اليوريما (مصابين بالسكري وغير المصابين)

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الخلاصة

لغسيل الكلى ومرض الكلى في المرحلة النهائية تأثيرات سلبية متعارضة قد تسبب تغيرات كبيرة في مستويات الجلوكوز. تم اختبار مجموعه مكونة من 100 مريض بوليمي خضعوا لغسيل الكلى لتحديد مستوى الجلوكوز، وكان مرضى اليوريما في مجموعتين مرضى مصابين وغير مصابين بمرض السكري مع الأخذ في الاعتبار أن المرضى قد يكونوا يتناولون الأنسولين أو أدوية السكري ويتناولون الطعام قبل أو أثناء غسيل الكلى. تهدف الدراسة إلى تقييم تأثير غسيل الكلى على مريض اليوريما السكري مقارنة بمريض اليوريما غير المصاب بالسكري عن طريق قياس مستوى السكر في الدم لكلا مجموعتي الدراسة. وأظهرت النتائج توزيع المرضى الذين شملتهم الدراسة حسب مجموعات الدراسة. ويشكل المرضى غير المصابين بالسكري 65% و35% من الحالات مصابون بالسكري. كما أظهرت النتائج توزيع المرضى حسب الجنس. ويمكن ملاحظة غلبة الجنس الذكوري، حيث يمثلهم 54% ممن شملتهم الدراسة و46% إناث. لوحظ نقص السكر في الدم أثناء غسيل الكلى لدى معظم مرضى الكلى غير المصابين بالسكري، وفقط 3 (4.6٪) من هؤلاء أصيبوا بارتفاع السكر في الدم. عانى 11 فقط من 35 مريضًا مصابًا بالسكري (31.4%) من ارتفاع السكر في الدم في ختام جلسة HD، مما استلزم زيادة جرعة الأنسولين. الاستنتاج: يميل مستوى الجلوكوز في الدم إلى الارتفاع أثناء جلسات HD، باستثناء بعض مرضى السكري وغير المصابين بالسكري الذين يعانون من انخفاض مستوى السكر في الدم الذي قد يكون عرضيًا أو بدون أعراض. يميل الجلوكوز في الغسل الكلوي إلى الانخفاض خلال جلسات HD في غالبية المرضى. لذلك، من المهم متابعة مستوى الجلوكوز لدى مرضى اليوريما الذين يخضعون لغسيل الكلى.

الكلمات المفتاحية: السكري وغير السكري ، غسيل الكلى ، الغلوكوز.

Introduction

Dialysis is a medical procedure that uses a machine to filter and clean the blood. When the kidneys are unable to carry out these processes normally, this aids in maintaining a healthy balance of body fluids and electrolytes. This procedure is referred to as renal replacement therapy. The first successful dialysis operation was performed in 1943. A abrupt, rapid decline in kidney function—previously known as acute renal failure—that may need the beginning of dialysis is referred to as acute kidney injury. Stage 5 of chronic kidney disease is a steady deterioration in kidney function. When the glomerular filtration rate is between 10% and 15% below normal, the creatinine clearance is less than 10 mL per minute, and uremia is present, stage 5 chronic renal failures is reached [1].

Diabetes mellitus (DM), a known and substantial risk factor for the emergence of cardiovascular disease, is the most frequent cause of end-stage renal failure globally. Because renal impairment decreases tissue sensitivity to insulin and decreases insulin clearance, it has a profound impact on the physiology of glucose homeostasis. Renal replacement therapy itself has an impact on glucose control: hemodialysis frequently results in hypoglycemia due to the dialysate's comparatively low glucose concentration, whereas peritoneal dialysis may produce hyperglycemia due to the dialysate's high glucose content. The likelihood of asymptomatic hypoglycemia is increased by autonomic neuropathy, which is frequent in diabetes and chronic kidney disease (CKD). There are few pharmacological options for enhancing glycemic control because of changes in medication metabolism. Diabetes and impaired glucose tolerance increase the likelihood of graft failure and mortality in the post-kidney transplant environment [2].

Around the world, increasing number of diabetic patients beginning dialysis. These patients differ significantly from the other dialysis patients in terms of their demographics, complications, comorbidities, and treatment-specific characteristics. They also require special care in the majority of hemodialysis-related areas, such as dialysis protocols, vascular access

(VA), or diabetes management; additionally, these patients frequently have anemia, vasculopathy, and retinopathy [3].

The most frequent reason for admission to renal replacement therapy (RRT) programs is end-stage renal disease (ESRD), which is a complication of diabetic nephropathy (DN). Increased exposure to risk factors, such as poor eating habits, inactivity, and obesity, as well as longer life expectancy, are linked to an increase in DM-related affectation. Consequently, a larger population reaches the ages at which this disease is more prevalent [4].

Numerous reasons make managing DM in individuals receiving dialysis difficult. Significant glycemic variability is caused by changes in the metabolism of carbohydrates, insulin, and hypoglycemic drugs as well as their pharmacokinetics. End stage kidney failure (ESKF) treatment has an impact on serum glucose levels, making it difficult to monitor glycemic management. As an example, the high glucose load in peritoneal dialysis fluid and fixed glucose concentration in hemodialysis fluid (dialysate) [5].

There are no studies in the province that describe how diabetic patients behave during hemodialysis and that the attending physician can use to reduce the morbidity and mortality of these patients and enhance their quality of life.

The kidney

The kidneys are crucial for preserving health. The kidneys keep the body's internal balance of water and minerals (sodium, potassium, chloride, calcium, phosphorus, magnesium, and sulphate) in good health. The kidneys are also used for the excretion of the acidic metabolic waste products that the body cannot eliminate through breathing. In addition, the kidneys perform endocrine system duties by generating renin, calcitriol, and erythropoietin. Red blood cell synthesis is aided by erythropoietin, and bone growth is aided by calcitriol [6]. Dialysis is a useless way of replacing kidney function since it does not repair the impaired endocrine functions of the kidney. Dialysis therapies replace part of these duties through the diffusion (waste elimination) and ultrafiltration (fluid removal) processes. In dialysis, highly purified (sometimes referred to as "ultrapure") water is utilized [7].

Dialysis

A machine is used in the medical treatment of dialysis to filter and purify the blood. This helps to maintain a healthy balance of bodily fluids and electrolytes when the kidneys are unable to perform these functions properly. This procedure is referred to as renal replacement therapy. The first effective dialysis operation was completed in 1943 [8]. An abrupt, rapid decline in kidney function—previously known as acute renal failure that may need the commencement of dialysis is referred to as acute kidney injury. A persistent decline in kidney function characterizes stage 5 of chronic kidney disease. When uremia is present, the creatinine clearance is less than 10 mL per minute, and the glomerular filtration rate is between 10% and 15% of normal, stage 5 chronic renal failures is reached. [7]

Principle

The concepts of solute diffusion and fluid ultrafiltration across a semi-permeable membrane underlie the operation of dialysis. The tendency of compounds in water to diffuse from an area of high concentration to an area of low concentration is known as the diffusion property [9]. A semi-permeable membrane allows blood to pass through on one side while allowing a particular dialysis fluid, called dialysate, to pass through on the other. A semipermeable membrane is a thin layer of material having holes of different sizes. The membrane allows the passage of smaller solutes and fluid, but it prevents the passage of larger things, such as red blood cells and large proteins. The kidneys filter the blood as it enters them, separating the larger chemicals from the smaller ones in the glomerulus) [9]. This mimics that process. Hemodialysis and peritoneal dialysis, the two primary types of dialysis, each have a unique method for eliminating waste products and extra water from the blood.

Types of dialyses

1. Hemodialysis

By pumping the patient's blood through the blood compartment of the dialyzer, hemodialysis exposes the blood to a partly permeable membrane. The dialyzer is made of tens of thousands of tiny, hollow synthetic fibers. The fiber wall makes up the semipermeable membrane. When blood flows through the fibers and dialysis solution circles around the exterior of the fibers, water and wastes move between these two solutions [10]. After that, the circuit returns the purified blood to the body. Ultrafiltration is carried out by increasing the hydrostatic pressure across the dialyzer membrane. To do this, negative pressure is normally applied to the dialysate compartment of the dialyzer. This pressure gradient allows water and dissolved solutes to move from blood to dialysate during a typical 4-hour treatment, allowing for the evacuation of several liters of excess fluid. Studies have demonstrated the beneficial therapeutic benefits of dialyzing for 6 to 8 hours, 5 to 7 times per week. This kind of hemodialysis, also known as nocturnal daily hemodialysis, has been shown in a research to greatly increase both small and big molecular weight clearance and decrease the need for phosphate binders. [10]. These lengthy, frequent treatments are frequently completed while the patient is dozing off at home, but home dialysis is a flexible treatment, allowing for daily and weekly schedule changes. Studies generally demonstrate that both prolonged therapy and frequency are clinically beneficial [11], Figure 1.

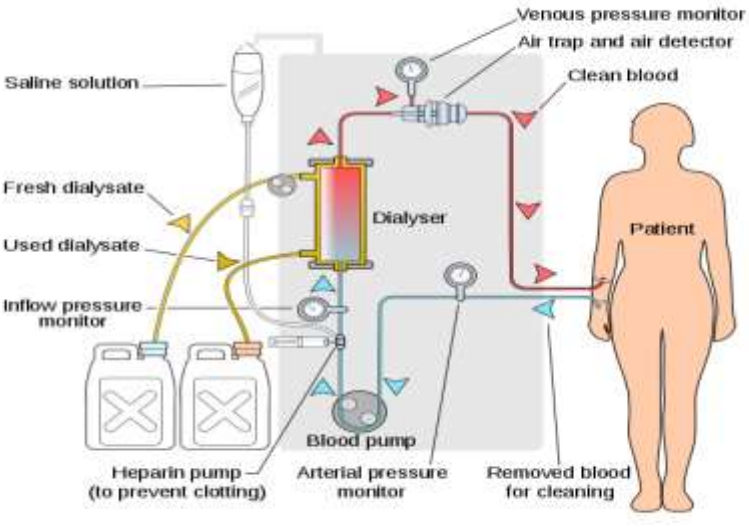

Figure 1: Schematic of a hemodialysis circuit (Frankel, 2016) .

2. Peritoneal dialysis

Dialysate, a sterile solution containing glucose, is injected through a tube into the peritoneal cavity, the abdominal cavity that houses the intestine. The peritoneal membrane acts as a partly permeable membrane in this cavity. [12]

The patient undergoes peritoneal dialysis at home, frequently by themselves and without assistance. This exchange occurs four to five times a day; throughout the night, automated systems may perform more frequent exchange cycles. Although peritoneal dialysis is less effective than hemodialysis because it is performed for a longer period of time, the overall results in terms of waste elimination as well as salt and water removal are comparable to hemodialysis. This relieves patients of the requirement to visit a dialysis facility on a regular basis, numerous times each week. Peritoneal dialysis can be performed with little to no specialized equipment, with the exception of bags of new dialysate [12]. Figure 2.

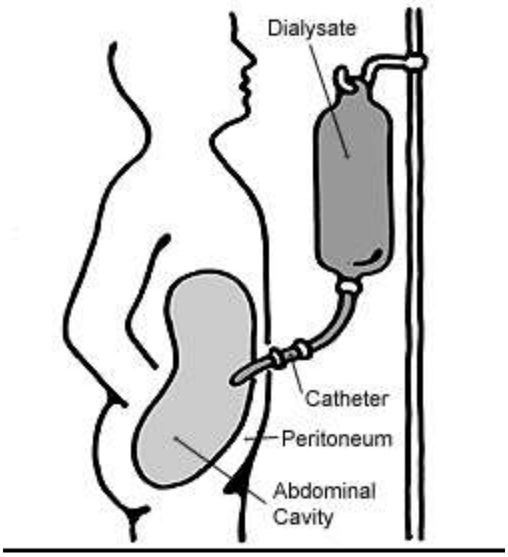

Figure 2: Diagram of peritoneal dialysis (Lim, 2016).

3. Hemofiltration

Hemofiltration is a similar process to hemodialysis, albeit using a different principle. The blood is forced through a dialyzer or "hemofilter" similar to what is done during dialysis instead of dialysate. Pressure gradients lead water to flow swiftly over the very permeable membrane, "dragging" along a variety of dissolved substances, including those with huge molecular weights that hemodialysis cannot efficiently remove. To replenish salts and water lost from the blood during this process, a "substitution fluid" is continuously infused into the extracorporeal circuit [13] Figure 3.

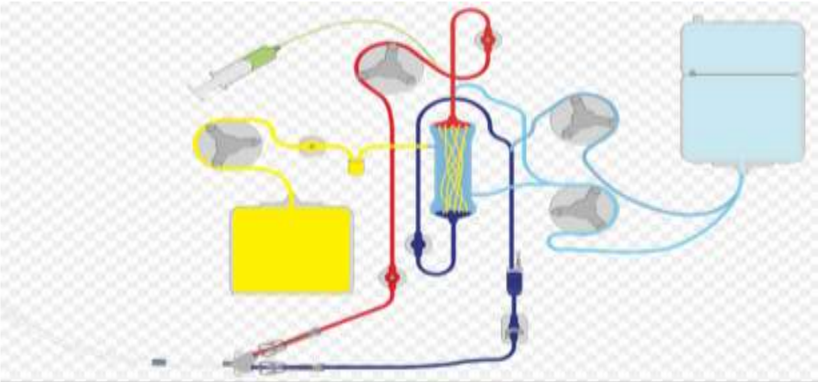

Figure 3: Continuous veno-venous hemofiltration with pre- and post-dilution (CVVH) [13].

4. Blood filtering

Hemodiafiltration, a combination of hemodialysis and hemofiltration, is used to treat acute kidney injury (AKI) to remove toxins from the blood when the kidneys are not working properly Figure 4 [13].

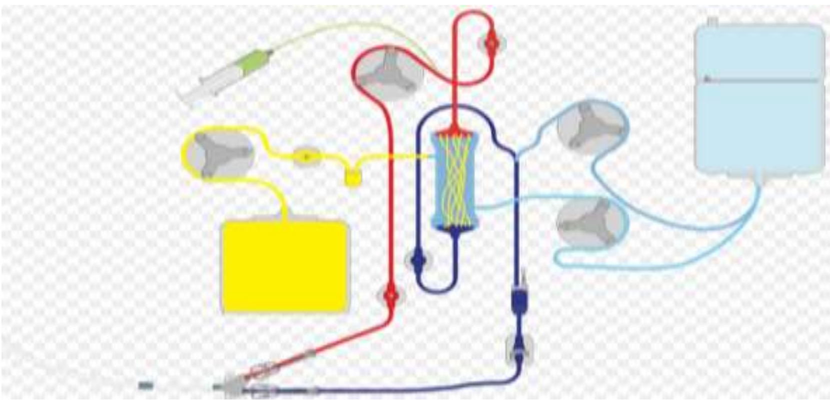

Figure 4: Continuous veno-venous hemodiafiltration (CVVHDF) [13].

5. Intestinal dialysis

In intestinal dialysis, soluble fibers in the form of acacia fiber are added to the meal, which the colon's bacteria can breakdown. This bacterial growth leads to an increase in the nitrogen excreted in fecal feces. An alternate technique is ingesting 1 to 1.5 liters of non-absorbable mannitol or polyethylene glycol solutions every four hours [13].

Materials and Methods

Materials

1. Blood glucose kit
2. Human blood

Tools

1. Hemodialysis machine
2. Spectrophotometer
3. Blue, yellow tips and gel tubes.
4. Pipette

A sample of 100 hemodialyzed patients, including diabetic and non-diabetic patients of different ages and blood glucose level were measured before and after hemodialysis session at dialyses unit in Baquba Teaching Hospital in Diyala from 15 March to 15 April 2022.

- They were then asked to participate, with the understanding that the study would only use the information they provided. However, they were also made aware that they had the option to decline.
- The primary data for the investigation was gathered from the dialysis unit. The following variables were evaluated in the study such as:
- The primary data for the investigation was obtained from the dialysis unit. The following variables were considered in the study such as:

1. Age group
2. Gender

3. Nutritional status
4. Therapy status

- Blood glucose level were measured before and after hemodialysis for each group of patients using Glucose-TR reagent kit (SPINREACT), as following:

1. 5 ml blood were taken from patient's vein using 5ml sterilized syringe then poured in Gel tube.
2. The tubes were centrifuged by centrifuge to obtain serum, free of hemolysis.
3. According to standard directions of company the glucose estimated by using 2 tubes.
4. Tube 1: containing 1 ml of R1(reagent) and 10 µl of serum.
5. Tube 2: containing 1 ml of R1 and 10 µl of standard (R2).
6. Mix well and incubated for 10 min at 37°c or 20 min at room temp (15-25°c).
7. Read the absorbency (A) of both tubes (1 and 2) using spectrophotometer at wavelength 505 nm.
8. Glucose concentration (mg/dl) in sample obtained by using the formula
   $[\frac{(A)sample}{(A)standard} \times 100$ (standard concentration)]
9. Reference value: 60 – 110 mg/dl.

Results and Discussion

The distribution of patients studied across research groups is shown in Table 1. Void of diabetes Patients make up 65% of instances and 35% of those cases involve diabetes. Additionally displays the patient distribution by sex. With 54% of the participants being men and 46% being women, it is possible to detect a majority of the male sex.

Table 1: the distribution of patients according to sex and study group.

	SAMPLES	%	NON. DIABETIC PATIENTS	%	DIABETIC PATIENTS	
No. of males	54	54%	36	36%	18	18%
No. of females	46	46%	29	29%	17	17%
Total	100	100%	65	65%	35	35%

Table 2: glucose level for non-diabetic group

	GLUCOSE LEVEL BEFORE HD(MG/DI)		GLUCOSE LEVEL AFTER HD(MG/DI)	
Age group	Median±IQR	Mean-Range	Median±IQR	Mean-Range
15-25	110.12±69.735	107-176.6	88.10±83.33	102.3143.79
26-35	121.76±59.7	119.8-128	120.34±52.5	113.39-94.98
36-45	103.1±120.3	112.6-174.3	99.74±104.62	119.8-173.97
46-55	87.30±41.8	130.6-305.3	90.07±77.37	111.74-141.31
56-65	83.22±29.8	87.8-103.5	79.41±24.2	88.6-111.41
66-75	98.34±12.54	99.7-22.8	90.99±12.2	909.6-18.6
76-85	120.6±65.4	124.4-75.6	109.02±87.99	141.4-172.94

Table 3: Glucose level for diabetic group

	glucose level before HD(mg/di)		glucose level after HD(mg/di)	
Age group	Median±IQR	Mean-Range	Median±IQR	Mean-Range
15-25	169.13±108.9	174.6-259.54	150.21±97.38	144.6-245.78
26-35	186.80±109.02	180.1-161.92	183.23±142	190.45-218.27
36-45	165.42±10.3	225.3-251.73	200.0±8.3	209.5-117.93
46-55	221.2±117.19	202.8-248.14	150.4±110.11	168.6-221.72
56-65	125.4±159.7	166.7-269.92	122.56±105.05	138.38-225.2
66-75	160.9±69.05	161.3-74.64	150.53±25.47	162.98-50.42

The majority of non-diabetic dialyzed patients (approximately 95.4%) experienced hypoglycemia throughout treatment, and only three (4.6%) of them experienced hyperglycemia (table 2). This finding concurs with that of[14], who discovered that the majority of hemodialysis patients had hypoglycemia 77.08% of CKD non-diabetic individuals. When we advised non-diabetic patients to eat meals high in carbohydrates before or during HD and diabetic patients to skip or lower their insulin dose before to the HD session, hypoglycemia improved. Most patients with hypoglycemia have a long-term energy deficit.

Only 11 of the 35 diabetic patients (31.4%) who had HD sessions experienced hyperglycemia and needed to increase their insulin dosage (table 3). Additionally, at the conclusion of an HD session, diabetic patients' blood glucose levels and dialysate fluid outflow were revealed to be positively correlated. The findings also indicate hypoglycemia (68.6%) in diabetic hemodialyzed individuals, which is consistent with findings from Lai, L. et al., 2021. The incidence of hypoglycemia varies between the four time periods, and these variations are statistically significant. The incidence of hypoglycemia in the first 60 to 120 minutes is the greatest, at 69.4%. Hemodialysis Dialysis for diabetes patients may cause hypoglycemia for a number of different causes. First, the accumulation of insulin in the body is a result of the patient's own kidney failure, kidneys' reduced capacity to inactivate and excrete insulin, or the use of hypoglycemic drugs. Second, whereas insulin, a macromolecule, cannot be easily removed by dialysis therapy, glucose, a small-molecule material, may freely pass through the filter membrane of the dialyzer during hemodialysis. Third, because it is difficult to store glucose-containing dialysate and nosocomial infections are common, sugar-free dialysate is often used in hospitals in China [15] found that with the sugar-free dialysate, about 5.5–6.0 g glucose can be lost per hour.

In terms of demographic traits, problems, and treatment goals, these patients stand apart from the other dialysis patients in a big way. They are all suffering from ESRD, or end-stage chronic renal failure. They require special care in the majority of hemodialysis (HD)-related areas, such as dialysis regimens, vein access (VA), or the management of the diseases that are frequently present in these patients, such as diabetes, anemia, vasculopathy, and retinopathy. The most frequent reason for admission to renal replacement therapy (RRT) programs is end-stage renal disease (ESRD), which is a complication of diabetic nephropathy (DN). Increased exposure to risk factors, such as poor eating habits, inactivity, and obesity, as well as longer life expectancy, are linked to an increase in DM-related affectation. Consequently, a larger population reaches the ages at which this disease is more prevalent [4].

Conclusion

We come to the conclusion that most patients' blood glucose levels tend to decline during HD; nevertheless, some patients—both diabetic and non-diabetic—develop hypoglycemia, which may be symptomatic or asymptomatic. Dialysate glucose also tends to rise during HD sessions. Therefore, during HD sessions, blood glucose levels should be constantly checked.

Ethical aspects

The study was carried out in conformity with ethical guidelines for human biomedical research. Therefore, the patients' informed consent was requested. The investigation's goals were also explained to them. They were then asked to participate, with the understanding that the study would only use the information they provided. However, they were also made aware that they had the option to decline.

Recommendations

1. More study about the effects of hemodialysis on chronic infection patients.
2. Study the effect of hemodialysis on the immunity of patients.

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