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**RESEARCH ARTICLE**

# Blood glucose fluctuations in Diabetic and non Diabetic hemodialysis patients

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## *Abstract*

**Background**: Glucose homeostasis and insulin metabolism are complex in patients with chronic kidney disease. Though most uremic patients are insulin-resistant with associated glucose intolerance, hypoglycemia occurs in some patients undergoing hemodialysis (HD). Blood sugar levels can fluctuate widely due to various and opposing effects in end stage renal disease and dialysis. The aim of this study was to characterize the fluctuations in glucose levels during and after HD in diabetic and non diabetic patients that might be asymptomatic.

**Subjects and methods**: This cross-sectional observational prospective study included seventy patients with end stage renal disease (ESRD), who underwent maintenance HD therapy three times per week at Nephrology and Dialysis Unit, Zagazig, Egypt. The included subjects were divided into two groups; Group I: 35 control ESRD (non-diabetic) patients on regular HD, and Group II: 35 ESRD (Type II diabetic) patients on regular HD. All subjects of this study were subjected to full history taking, through physical examination, routine laboratory investigations, measurement of weight and height (for BMI calculation) and blood glucose level measurement before beginning of HD session, after 2 hours of beginning and at the end of dialysis and also measurement of glucose level in the dialysate passed out from patients 2 hours after the beginning and at the end of HD session.

**Results**: Among all 70 patients, 47 patients (67.2%) did not have hypoglycemia, and 23 patients (32.8%) had hypoglycemia {17 patients (24.3%) were asymptomatic and 6 patients (8.5%) were symptomatic}. In group 1 (35 non diabetic patients), 25 patients (71.4%) did not have hypoglycemia, and 10 patients (28.6%) had hypoglycemia {9 patients (25.7%) were asymptomatic and 1 patient (2.9%) was symptomatic}. In group 2 (35 diabetic patients), 22 patients (62.9%) did not have hypoglycemia, and 13 patients (37.1%) had hypoglycemia {8 patients (22.8%) were asymptomatic and 5 patients (14.3%) were symptomatic. Symptoms of hypoglycemia included; generalized body weakness in 5 cases (8.6%), hunger in 4 cases (5.7%), cold sweats in 3 cases (4.2%), shaking in 2 cases (2.9%), and confusion in one case (1.4%). Hypoglycemia improved when we encouraged non diabetic patients to eat carbohydrate rich meals before or during HD, and diabetic patients to omit or reduce insulin dose before the HD session. Most patients who developed hypoglycemia had normal BMI, or chronic energy deficiency grade 1 or 2. Only 5 of 35 diabetic patients (14.2%) developed hyperglycemia at the end of HD session, and required and increase in insulin dose. Moreover, a positive correlation was found between glucose levels in blood and dialysate fluid outflow in diabetic patients at the end of HD session.

**Conclusion**: We conclude that during HD, blood glucose tends to decrease in most patients; diabetic and non diabetic and some of them develop hypoglycemia, which may be symptomatic or asymptomatic, and dialysate

glucose tends to increase during HD session. Thus, blood glucose should be monitored carefully during HD sessions.



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## INTRODUCTION

In end stage renal disease (ESRD), both uremia and dialysis can complicate glycemic control by affecting the secretion, clearance and peripheral tissue sensitivity of insulin ***(1).*** Disturbance of carbohydrate metabolism is common in chronic hemodialysis (HD) patients and can predispose to spontaneous hypoglycemia ***(2).*** Although hypoglycemia is a complication of HD, there is a little information about its prevalence among patients on maintenance HD ***(3).*** It was previously detected that asymptomatic hypoglycemia occurs frequently in non diabetic patients on regular HD and that they may not be aware of it ***(4).*** Several factors, including uremic toxins, may increase insulin resistance in ESRD, leading to a blunted ability to suppress hepatic gluconeogenesis and regulate peripheral glucose utilization. In type 2 diabetes without kidney disease, insulin resistance leads to increased insulin secretion. Hypoglycaemia occurs in patients with ESRD, it has been reported more frequently than in the pre-dialytic period, and also during HD sessions, and even more frequently in diabetic subjects, but it is usually asymptomatic. The association of the high blood flow with the continuous flow of non-glucose dialytic solution through the dialyser might lead to a loss of serum glucose through the dialysate that could be related to more frequent episodes of hypoglycemia ***(5).*** Dialysis improves insulin resistance and people with diabetes who take insulin and have dialysis might need smaller doses of insulin after dialysis treatment than they do on days when they do not have dialysis. If they continue to take the doses of insulin after dialysis, they could have a greater chance of having dangerous low blood glucose ***(6).***

### Subjects and methods:

This cross-sectional observational prospective study included seventy patients with ESRD, who underwent maintenance HD therapy three times per week at Nephrology and Dialysis Unit, Zagazig , Egypt. All patients used sodium bicarbonate solutions, glucose free dialysate and polysulfone dialysers. The included patients were divided into two groups; Group I: 35 control ESRD (non-diabetic) patients on regular HD and Group II: 35 diabetic ESRD patient of (type Π diabetic) patients on regular HD. All subjects of this study were subjected to full history taking, through physical examination, routine laboratory investigations and blood glucose level was measured before beginning of HD session, after 2 hours of beginning and at the end of dialysis and also measurement of blood sugar in the dialysate passed out from patients 2 hours and at the end of HD session. Body mass index (BMI) was calculated by relating the average of the weight and height taken using the following formula: BMI = weight (kg) \ height (m) ***(3).*** Exclusion Criteria included patients below 40 years old or above 70 years old, and Patients suffering from starvation, depression, decompensated liver diseases, drug-induced hypoglycemia, sepsis, alcohol consumption, congestive heart failure and malnutrition. Informed consent was taken from the patients to participate in this study. Statistical analysis: The collected data were analyzed by using computerized software statistical packages (SPSS version 20.0). Chi-square was used to compare proportions; Unpaired t test to compare mean ±SD between two groups, paired t test to compare data within groups and Pearson correlation coefficient was used for correlations. Test for Probability (P value): $P \geq 0.05$ non significant difference (NS), $P < 0.05$ significant difference (S), $P < 0.01$ highly significant difference (HS), and $P < 0.001$ very highly significant difference (VHS).

### Results:

***Table (1)*** shows demographic data for all studied ESRD patients on HD; (70) patients, divided into 2 groups: Group 1: including 35 Non-diabetic patients (26 males and 9 females), their mean age in years was 51.1 ±7.5 (40-70) years and Group 2: including 35 Diabetic patients (27 males and 8 females), their mean age in years was 52.1 ±6.2 (40-60) years, with no statistical difference between the 2 groups. ***Figure (1)*** shows comparison of mean±SD glucose levels in mg/dl in blood and dialysate fluid outflow in ESRD patients on HD, between non diabetic and diabetic patients,

before, 2 hours after the start and at the end of HD session. Before the start of HD session, there was a very highly significant difference between blood glucose levels (BGL) between non diabetic (139.1±36.2 mg/dl) and diabetic (238.9±56.2 mg/dl) patients. At 2 hours after the start of HD session, there was a very highly significant difference in BGL, between non diabetic (112.1±29.1 mg/dl) and diabetic (173.8±66.2 mg/dl) patients. At the end of HD session, there was a highly significant difference between BGL in non diabetic (99.3±38.5 mg/dl) and diabetic (150.6±97.8 mg/dl) patients. As regards dialysate fluid outflow glucose levels at 2 hours after the start of HD session, there was a very highly significant difference between non diabetic (37.6±18.3 mg/dl) and diabetic (63.4±27.8 mg/dl) patients. At the end of HD session, the dialysate outflow fluid glucose levels showed a very highly significant difference between non diabetic (70.3±30.2 mg/dl) and diabetic (101.6±37.6 mg/dl) patients. Within each group, there was a very highly significant difference in blood glucose levels before, 2 hours after the start and at the end of HD session. ***Table (2)*** shows the prevalence of hypoglycemia in ESRD patients during HD session. Among all 70 patients, 47 patients (67.2%) did not have hypoglycemia, and 23 patients (32.8%) had hypoglycemia {17 patients (24.3%) were asymptomatic and 6 patients (8.5%) were symptomatic}. In group 1 (35 non diabetic patients), 25 patients (71.4%) did not have hypoglycemia, and 10 patients (28.6%) had hypoglycemia {9 patients (25.7%) were asymptomatic and 1 patient (2.9%) was symptomatic}. In group 2 (35 diabetic patients), 22 patients (62.9%) did not have hypoglycemia, and 13 patients (37.1%) had hypoglycemia {8 patients (22.8%) were asymptomatic and 5 patients (14.3%) were symptomatic}. All patients who developed hypoglycemia showed hypoglycemia (blood glucose levels less than 70 mg/dl) at the end of HD session only, except one patient, who started to have hypoglycemia 2 hours after the start of HD session, in addition. ***Table (3)*** shows blood glucose levels in ESRD patients in non diabetics who developed hypoglycemia during HD session (without and with eating before HD session), and diabetics who developed hypoglycemia during HD session (before and after reduction of insulin taken before HD session) and also diabetic patients who developed more hyperglycemia during the HD session (before and after cautiously increasing of insulin taken before HD session). ***Table (4)*** shows prevalence of symptoms of hypoglycemia in ESRD patients who developed symptomatic hypoglycemia during HD session. ***Figure (2)*** shows the distribution of body mass index (BMI) in ESRD patients on HD. Most patients who developed hypoglycemia had normal BMI, or chronic energy deficiency (CED) grade 1 or 2. ***Figure (3)*** shows positive correlation between glucose levels in blood and dialysate fluid outflow in diabetic patients at the end of HD session. No correlation was found between blood glucose levels and glucose levels in dialysate outflow 2 hours after starting HD session, in diabetic or non diabetic patients. Also no correlation was found between blood glucose levels and glucose levels in dialysate outflow in non diabetic patients at the end of HD session. ***(Table 5)*** shows summary of changes in blood glucose levels in ESRD patients (all patients, non diabetic and diabetic) during HD session. Statistical analysis was done using SPSS version 20.0; (Statistical Package for the Social Sciences) software for analysis. According to the type of data, the following tests were used to test differences for significance. Differences between frequencies (qualitative variables) in groups were compared by Chi-square test. Differences between means (quantitative variables) by student's t test and in paired data by paired t test. Correlation was made using Pearson test.

***Table (1)*** **Showing the comparison of the mean value ±SD of the demographic and biochemical characteristics of studied groups.**

| Variable | | Group I (non diabetic) N (35) (Mean±SD) | Group II (Diabetic) N (35) (Mean±SD) | t | P |
|---|---|---|---|---|---|
| Age in years | | 51.1 ±7.5 (40-70) | 52.1 ±6.2 (40-60) | -0.6 | NS |
| Sex | Male | 74.3% | 77.1% | X2 | NS |
| | Female | 25.7% | 22.9% | | |
| Blood glucose (mg/dl) before the start of HD session | | 139.1±36.2 (89-190) | 238.9±56.2 (164-363) | 8.8 | <0.0001 VHS |
| Blood glucose (mg/dl) 2 hours after the start of HD session | | 112.1±29.1 (67-195) | 173.8±66.2 (86-296) | 5.3 | <0.0001 VHS |
| Blood glucose (mg/dl) at the end of HD session | | 99.3±38.5 (46-177) | 150.6±97.8 (36-398) | 3.1 | <0.003 HS |
| Dialysate outflow glucose (mg/dl) 2 hours after the start of HD session | | 37.6±18.3 (15-94) | 63.4±27.8 (21-132) | 5.2 | <0.0001 VHS |
| Dialysate outflow glucose (mg/dl) at the end of HD session | | 70.3±30.2 (19-131) | 101.6±37.6 (48-193) | 3.9 | <0.0001 VHS |

***Table (2)*** **Showing the prevalence of hypoglycemia (symptomatic or asymptomatic) in ESRD Patients on HD (non-diabetic and diabetic) and its timing during HD session.**

| ESRD patients on HD | Hypoglycemia (Blood glucose less than 70 mg/dl) | Asymptomatic | Symptomatic | 2 Hours after the start of HD session | At the end of HD session |
|---|---|---|---|---|---|
| All patients (n = 70) | 32.8% n = 23 | 24.3% n =17 | 8.5% n =6 | 1.4% n = 1 | 31.4% n = 22 |
| Group 1 (Non-diabetic) (n = 35) | 28.6% n =10 | 25.7% n =9 | 2.9% n =1 | 2.9% n = 1 | 25.7% n =9 |
| Group 2 (Diabetic) (n = 35) | 37.1% n =13 | 22.8% n =8 | 14.3% n =5 | none | 37.1% n =13 |

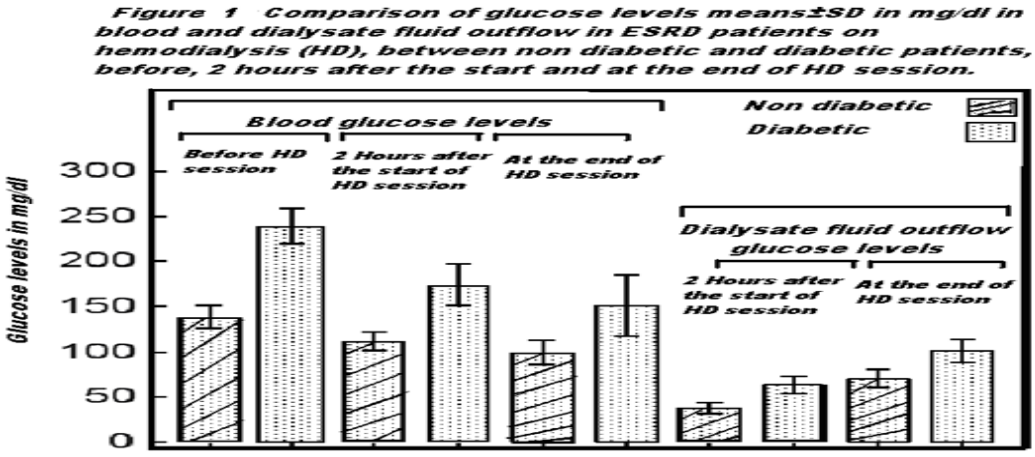



***Table (3)*** **Showing blood glucose levels in ESRD patients in non diabetics who developed hypoglycemia during HD session (without and with eating before HD session), and diabetics who developed hypoglycemia during HD session (before and after reduction of insulin taken before HD session) and also diabetic patients who developed more hyperglycemia during the HD session (before and after cautiously increasing of insulin taken before HD session).**

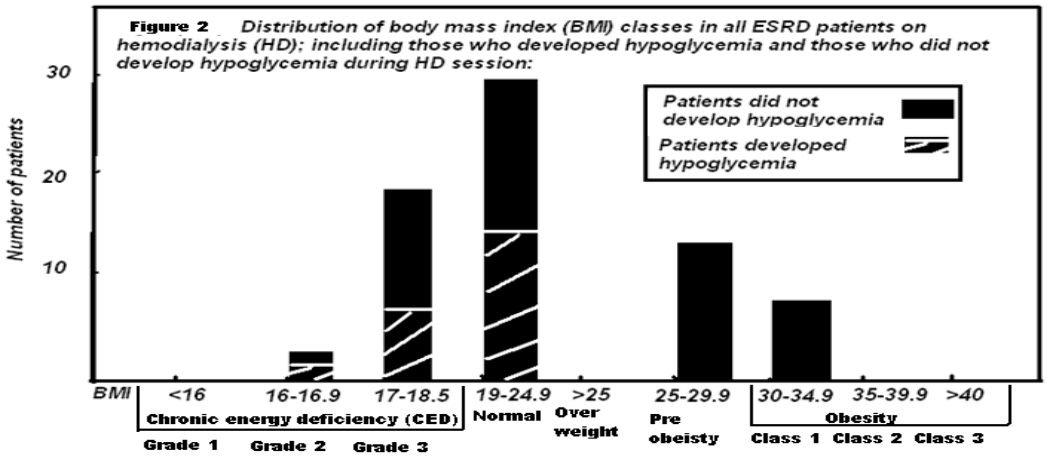
| ESRD patients on HD | HD session measurements before and after modifying meals, and insulin doses | Before the start of HD session (mg/dl) | 2 Hours after the start of HD session (mg/dl) | At the end of HD session (mg/dl) | t | P |
|---|---|---|---|---|---|---|
| Non diabetics with hypo-glycemia n (10) | HD session without eating before session | 126.6±36.5 | 83.1±16.2 | 56.3±4.9 | 0.56 | NS |
| | HD session with eating before session | 136.6±34.7 | 96.4±37.1 | 117.8±31.9 | 5.7 | <0.0001 VHS |
| Diabetics with hypo-glycemia n (13) | HD session before reduction of insulin taken before session | 222.4±65.8 | 107.7±15.1 | 54.9±6.7 | 1.7 | NS |
| | HD session after reduction of insulin taken before session | 256.1±41.6 | 159.2±53.9 | 115.6±37.7 | 57. | <0.0001 VHS |
| Diabetics with hyper-glycemia n (5) | HD session before increasing insulin taken before session | 214.4±36.6 | 238.4±34.9 | 309.4±57.4 | 0.6 | NS |
| | HD session after cautiously increasing insulin taken before session | 201.4±37.4 | 204.4±32.1 | 206±86.8 | 2.2 | S |

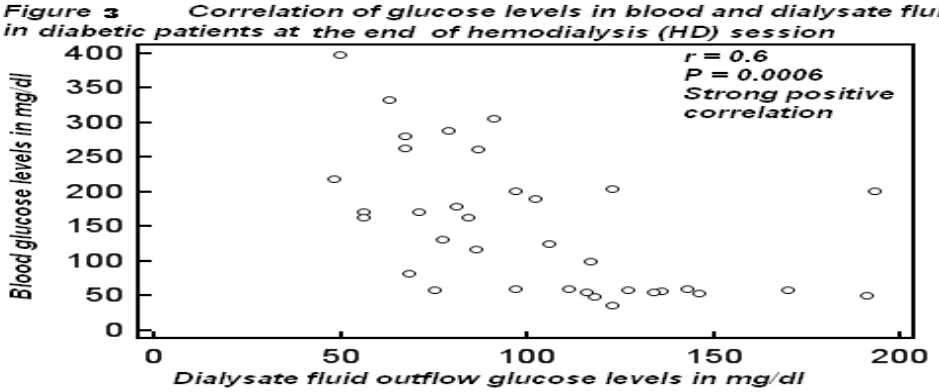
***Table 4*** **Showing prevalence of symptoms of hypoglycemia in ESRD patients who developed symptomatic hypoglycemia during HD session.**

| Symptoms of hypoglycemia in symptomatic hypoglycemic ESRD patients during HD session | Number of patients developing these symptoms | Percentage of all ESRD patients on HD n = 70 | Percentage of hypoglycemic patients n = 23 |
|---|---|---|---|
| Generalized body weakness | 5 | 8.6% | 14.2% |
| Hunger | 4 | 5.7% | 11.4% |
| Cold sweats | 3 | 4.2% | 8.6% |
| Shaking | 2 | 2.9% | 5.7% |
| Mental confusion | 1 | 1.4% | 2.9% |

***Table 5 Summary*** **of changes in blood glucose levels in ESRD patients (all patients, non diabetic and diabetic) during HD session:**

| Prevalence of blood glucose level changes during HD session | Total ESRD patients during HD session<br>n = 70 | Non diabetic ESRD patients during HD session<br>n = 35 | Diabetic ESRD patients during HD session<br>n = 35 |
|---|---|---|---|
| Decreased at 2 hours after the start of HD session | n = 56<br>80% | n = 29<br>82.8% | n = 27<br>77.1% |
| Decreased at the end of HD session | n = 60<br>85.7% | n = 30<br>85.7% | n = 30<br>85.7% |
| Hypoglycemia (less than 70 mg/dl) before the start of HD session | none | none | none |
| Hypoglycemia (less than 70 mg/dl) 2 hours after the start of HD session | n = 1<br>1.4% | n = 1<br>2.9% | none |
| Hypoglycemia (less than 70 mg/dl) at the end of HD session | n = 23<br>32.8% | n = 10<br>25.7% | n = 13<br>37.1% |
| Increased at 2 hours after the start of HD session | n = 16<br>22.9% | n = 8<br>22.9% | n = 8<br>22.9% |
| Increased at the end of HD session | n = 8<br>22.9% | n =3<br>8.6% | n = 5<br>14.3% |
| Hyperglycemia (blood glucose levels more than 200 mg/dl)<br>Before the start of HD session | n = 25<br>71.4% | n = 4<br>11.4% | n = 21<br>60% |
| Hyperglycemia (blood glucose levels more than 200 mg/dl) at 2 hours after the start of HD session | n = 14<br>40% | none | n = 14<br>40% |
| Hyperglycemia (blood glucose levels more than 200 mg/dl) at the end of HD session | n = 11<br>31.4% | none | n = 11<br>31.4% |
| Significant hyperglycemia, which required increase of insulin dose before session | n = 5<br>14.2% | none | n = 5<br>14.2% |




## Discussion:

Disturbance of carbohydrate metabolism is common in chronic hemodialysis (HD) patients and can predispose to spontaneous hypoglycemia ***(2).*** In this work, we studied 70 patients with end stage renal disease (ESRD), on regular HD, divided into 2 groups: Group I: 35 non-diabetic patients and 35 type II diabetic patients. Their clinical status during HD session, in addition to measurement of blood glucose levels was made for all of them at the start, after 2 hours and at the end of HD session. In addition, glucose levels in the dialysate outflow had been measured after 2 hours and at the end of HD session. We found that 23 of a total of 70 HD patients (32.8%) developed hypoglycemia during HD session, 10 of 35 (non diabetic) (28.6%) and 13 of 35 diabetic (37.1%). A study done on the blood glucose level on patients on regular HD in Kenya showed that 16% percent of ESRD patients on HD had hypoglycemia and 8% of patients were already hypoglycemic at baseline before initiation of HD ***(3)***. Glucose homeostasis and insulin metabolism are complex in patients with chronic renal failure. Though most uremic patients are insulin-resistant with associated glucose intolerance, hypoglycemia occurs in some patients undergoing HD. Both impaired insulin degradation and reduced renal gluconeogenesis in uremic patients increase the risk of hypoglycemia ***(8).*** Several factors, including uremic toxins, may increase insulin resistance in ESRD, leading to a blunted ability to suppress hepatic gluconeogenesis and regulate peripheral glucose utilization. In type 2 diabetes without kidney disease, insulin resistance leads to increased insulin secretion. This does not occur in ESRD because of concomitant metabolic acidosis, deficiency of 1, 25 dihydroxyvitamin D, and secondary hyperparathyroidism. HD further alters insulin secretion, clearance, and resistance as the result of periodic improvement in uremia, acidosis, and phosphate handling ***(10).*** In this study, patients presenting with hypoglycemia reported or exhibited confusion, cold sweats, shaking with hunger and generalized weakness as the most common symptoms. Some study patients had to be discontinued from the HD process due to severe hypoglycemia within the last hour of HD. Although blood glucose levels started to decrease after the start of HD session in 56 cases (60%), they did not reach the hypoglycemic levels; less than 70 mg/dl, 2 hours after the start of HD session, and their number increased to 60

cases (85%), at the end of HD session. We found that 17 cases (24.3%) of all patients developed asymptomatic hypoglycemia; 9 of 35 non diabetics (25.7%), and 8 of 35 diabetics (22.8%), while 6 of all 70 cases were symptomatic 8.5%; one non diabetic (2.9%), and 5 diabetic (14.3%). Almost all except one hypoglycemic cases occurred at the end of HD session rather than 2 hours after the start of HD session; 22 of all 70 cases (31.4%); 9 of 35 non diabetic (25.7%), and 13 of 35 diabetic (37.1%). Another study had found a larger percentage of HD patients develop hypoglycemia less than 60 mg/dl, but the patients were non-diabetics and were not allowed to eat during the 4 hours of HD presumably to assess the effects of HD on blood glucose during a fasting state. This may partially explain the large variability in the prevalence of hypoglycemia between the Nigerian study and current study **(9).** Hypoglycaemia occurs in patients with chronic renal insufficiency. In ESRD, it has been reported more frequently than in the pre-dialytic period, and also during HD sessions, and even more frequently in diabetic subjects, but it is usually asymptomatic. Probably for this reason, it has not been properly estimated. ESRD and HD exert opposing forces on insulin secretion, action, and metabolism often creating unpredictable serum glucose values. For example, one would think that a patient who has insulin resistance would need more supplemental insulin; however, the reduced renal gluconeogenesis and insulin clearance seen in ESRD may result in variable net effects in different patients. In addition, ESRD and HD alter the pharmacokinetics of diabetic medications. Together, all of these factors contribute to wide fluctuations in glucose levels and increase the risk of hypoglycemic events ***(10).*** In the interpretation of the finding of different studies one should kept in mind that different studies have used different hypoglycemia cut-off points and categorization depending on the model type of the glucometer and other variables like medical factors which may partially explain the variation in results. During the early days of HD, the dialysis fluid used to contain glucose, both to achieve hypertonicity and the consequent ultrafiltration and to prevent hypoglycemic episodes. Currently, most HD facilities use a sodium bicarbonate solution that does not include glucose in its composition, which provides advantages such as cost reduction and less risk of contamination. However, the association of the high blood flow with the continuous flow of this non-glucose dialytic solution through the dialyser might lead to a loss of serum glucose through the dialysate that could be related to more frequent episodes of hypoglycemia ***(5).*** HD process itself is a major cause of hypoglycemia. Though patients may have asymptomatic hypoglycemia while on HD and not be aware of it, those patients are particularly at risk and they should be dialyzed with a dialysis fluid containing at least 5.5mmol\l glucose. In a study investigating the mechanism of hypoglycemia caused by HD it was concluded that during HD using a high bicarbonate dialysate, the HD induced decrease in plasma glucose was possibly a result of diffusion of glucose from plasma into erythrocyte. As peripheral neuropathy is a common complication of diabetes mellitus, many diabetic patients on regular HD may have asymptomatic hypoglycemia and not be aware of it. These are a serious problem and explain why most patients showed hypoglycemia were asymptomatic ***(4).*** In our study, we found that symptoms of hypoglycemia included; generalized body weakness in 5 cases (8.6%), hunger in 4 cases (5.7%), cold sweats in 3 cases (4.2%), shaking in 2 cases (2.9%), and confusion in one case (1.4%). We noticed that all non-diabetic patients who suffered from hypoglycemia during HD showed improvement in their blood glucose level after encouraged them to eating before HD or taking small frequent meal and snacks during HD. There was significant improvement especially at the end of HD. During HD the intake of high carbohydrate energy giving foods is very important in the prevention of hypoglycemia. Patients who presented with hypoglycemia may have not had a meal prior to the commencement of HD. This is in agreement with ***(12)***, who found that some patients had to be discontinued from HD due to severe hypoglycemia. Although the causes and mechanisms of hypoglycemia in ESRD are multifactorial, it is possible that food intake during HD was an important and significant predictor of the sustainability of normal blood glucose level during HD process, since diminished glucose availability due to reduction in substrate is thought to be the most important mechanism leading to hypoglycemia. In our study, diabetic patients also showed hypoglycemia during HD and all of them on insulin therapy and taking their insulin in the day of dialysis. After encouraging them to decreasing the insulin doses or not taking it on the day of dialysis, there was significant improvement in their blood glucose level at the end of dialysis. This is in agreement with ***(6)***, who found that insulin injection showed a higher trend for risk of hypoglycemia and patients who were diabetics and on insulin therapy may have avoided carbohydrate foods and were therefore not able to replace the glucose losses during dialysis. Also it is known that HD improves insulin resistance and diabetic patients on dialysis may need smaller doses of insulin before and after HD to avoid hypoglycemia. Dialysis improves insulin resistance and people with diabetes who take insulin and have dialysis might need smaller doses of insulin after dialysis treatment than they do on days when they do not have dialysis. If they continue to take the doses of insulin after dialysis, they could have a greater chance of having dangerous low blood glucose. In our study, there was a positive relationship between body mass index (BMI) and minimum blood glucose level, and over 40% of the participants had a normal BMI and 25% had grade I chronic energy deficiency (CED). This is in agreement with ***(3),*** who found that majority of patients who suffered from hypoglycemia had normal and lower BMI but this was not significant as patients may have left with positive fluid

balance confounding the actual dry weight post. Malnutrition in patients on HD has been documented by many studies and a high prevalence of protein energy malnutrition (PEM) is quiet evident. The prevalence of PEM in chronic renal failure is reported to be between 30-76% and is particularly common in elderly patients especially those with chronic renal failure secondary to diabetes mellitus. Patients presenting with PEM are more likely to present with hypoglycemia during HD due to diminished glycogen stores. While we measured the glucose level in blood to patients during the HD session, we also measured the glucose level in dialysate passed out from patients during HD and we noticed that as the patient's glucose level decreased in blood during HD, the glucose level in dialysate outflow increased. We found a positive correlation between glucose levels in blood and dialysate fluid outflow in diabetic patients at the end of HD session, which is in agreement with ***(13)***, who reported that glucose molecules are also lost during HD session but the actual amount has not been calculated, and ***(14)***, who also found that intermittent HD dialyzes out blood glucose which affects blood glucose homeostasis. Glucose-added dialysis solution at 90 mg/dl significantly reduced the number and severity of hypoglycemic episodes and although it caused higher mean blood glucose in diabetic patients during HD, its use seems advisable in all patients ***(11).*** We also found that only 5 of 35 diabetic patients (14.2%) developed hyperglycemia at the end of HD session, and required and increase in insulin dose. Patients treated with HD may also develop hyperglycemia due to low doses of insulin they taken or insulin resistance ***(7).*** Physicians and nurses should be aware of the importance of checking blood glucose levels for HD patients, at least once during HD session, particularly if patients are noticed to have symptoms or signs of hypoglycemia or previously detected attacks of hypoglycemia during HD. Many hypoglycemic attacks may pass unnoticed, and patients may falsely be managed as if they have hypotension. Non diabetic patients are at a similar risk to that of diabetic patients, and they may not even be aware of hypoglycemia symptoms, unlike diabetic patients who may be aware of it. Nutritional status is so important and should be improved. Diabetic patients, who have repeated hypoglycemic attacks during HD, should be advised to reduce or omit insulin dose before HD session. Non diabetic and diabetic patients should be encouraged to eat carbohydrate rich meals during HD, to avoid fatal hypoglycemia. Glucose rich dialysate should be studied and compared to glucose free dialysate, at least for patients with repeated hypoglycemic attacks during HD.

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