LEBDA MEDICAL JOURNAL, VOL. 11, NO. 1 (30 APRIL 2026), PP. 93–98.

Journal; [LMJ]; {Online ISSN:2520-095X} Medical Lebda

Lebda Medical Journal Homepage:
https://lebmedj.elmergib.edu.ly/index.php/LMJ/en

Received:16.01.2026; Revised:05.02.2026; Accepted:08.04.2026; Published:30.04.2026.

Biomarker Evaluation in Hemodialysis Patients at Al'assabiea Unit, Libya

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ABSTRACT

Background: Chronic kidney disease (CKD) is a progressive and irreversible condition associated with significant morbidity and mortality. Hemodialysis is widely used to remove metabolic waste products and maintain biochemical balance in patients with advanced renal failure. **Aims:** This study aimed to evaluate the effect of hemodialysis on key biochemical parameters in patients with chronic renal failure at the Al'assabiea Dialysis Unit, Libya.

Methods: A cross-sectional study was conducted including 10 patients with chronic renal failure undergoing regular hemodialysis and 10 healthy controls. Blood samples were collected before and after dialysis sessions. Biochemical parameters including urea, creatinine, glucose, uric acid, electrolytes, and hemoglobin were analyzed using standard laboratory methods. Statistical analysis was performed using SPSS, with $p<0.05$ considered significant. The p-values were calculated using paired and independent t-tests as appropriate, comparing pre- vs. post-dialysis values within the patient group, and patient values vs. controls.

Results: Hemodialysis resulted in a statistically significant reduction in urea and creatinine levels ($p<0.05$). Blood glucose levels increased significantly after dialysis ($p<0.05$). Hemoglobin levels were lower in patients compared to controls. No significant changes were observed in sodium, potassium, or chloride levels.

Conclusion: Hemodialysis is effective in reducing uremic toxins such as urea and creatinine in CRF patients. However, the observed increase in blood glucose highlights the importance of routine monitoring during dialysis sessions. Addressing anemia and ensuring metabolic stability remain essential components of patient management.

Keywords: Chronic renal failure, urea, creatinine, hemodialysis, blood glucose

1. Introduction

Chronic kidney disease (CKD) is defined as abnormalities of kidney structure or function lasting for more than three months with health implications [1]. It is characterized by a progressive and irreversible decline in renal function that may ultimately lead to end-stage renal

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disease (ESRD) [2]. CKD represents a significant global health burden, contributing to high morbidity and mortality worldwide [3]. The global prevalence of CKD ranges from approximately 9% to 13%, with higher rates reported in low- and middle-income countries [3,4].

Several risk factors for CKD have been reported in the Libyan context [5]. Elevated levels of urea and creatinine are key indicators of renal dysfunction, reflecting impaired clearance of nitrogenous waste products [6]. Hemodialysis is a life-sustaining therapy used to remove these toxins and maintain metabolic balance in patients with severe renal failure [7].

Aims: This study aims to evaluate the effect of hemodialysis on key biochemical parameters, including urea, creatinine, glucose, electrolytes, and hemoglobin, in patients with chronic renal failure at the Al'assabiea Dialysis Unit, Libya.

2. Methods: This cross-sectional study was conducted in March 2024 at the Al'assabiea Dialysis Unit, Libya. Ten CRF patients (aged 21–65 years) undergoing regular hemodialysis and ten healthy controls were included. Blood samples were collected pre- and post-dialysis.

Biochemical parameters including urea, creatinine, glucose, and uric acid were measured using standard enzymatic methods. Electrolytes were analyzed using an automated analyzer. Hemoglobin was measured using the Drabkin method.

Normal reference ranges (as per laboratory standards) were as follows:

Hemoglobin: 13.0–17.0 g/dL (males), 11.5–15.5 g/dL (females)

Urea: 15–40 mg/dL

Creatinine: 0.6–1.2 mg/dL

Blood glucose: 70–110 mg/dL

Sodium: 135–145 mEq/L

Potassium: 3.5–5.0 mEq/L

Chloride: 98–108 mEq/L

Statistical analysis was performed using SPSS. P-values were calculated using paired t-tests for pre- vs. post-dialysis comparisons within the patient group, and independent t-tests for comparisons between patients and controls. A p-value <0.05 was considered statistically significant.

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3. Results

Statistical analysis showed a statistically significant difference in age between chronic renal failure patients and the control group (p<0.05), while no significant differences were observed in sex distribution (Table 1).

Table 1: Demographic Characteristics of the Study Population (Stratified by Sex)

Parameter	Control Group (n=10)	Patient Group (n=10)	p-value*
Age (years)	33.90 ± 10.785	45.20 ± 17.599	0.04
Sex (Male/Female)	6M / 4F	5M / 5F	0.65
Hemoglobin (g/dL)			
- Male	14.20 ± 1.10	10.50 ± 1.80	<0.01
- Female	12.40 ± 1.30	9.60 ± 1.50	<0.01

*P-values were calculated using independent t-test for age and hemoglobin (stratified by sex), and chi-square test for sex distribution.

Table 2: Biochemical Parameters in CRF Patients Pre- and Post-Hemodialysis Compared to Controls

Parameter	Patients Pre-Dialysis (Mean ± SD)	Patients Post-Dialysis (Mean ± SD)	Control Group (Mean ± SD)	p-value (Pre vs. Post)*	p-value (Post vs. Control)**
Hemoglobin (g/dL)	9.990 ± 1.864	9.990 ± 1.864	13.170 ± 1.636	1.00 (NS)	<0.01
Uric Acid (mg/dL)	4.760 ± 1.799	4.760 ± 1.799	4.220 ± 1.065	1.00 (NS)	0.23 (NS)

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Parameter	Patients Pre-Dialysis (Mean ± SD)	Patients Post-Dialysis (Mean ± SD)	Control Group (Mean ± SD)	p-value (Pre vs. Post)*	p-value (Post vs. Control)**
Blood Glucose (mg/dL)	89.90 ± 21.594	116.90 ± 53.501	93.80 ± 11.896	<0.05	<0.05
Urea (mg/dL)	96.70 ± 31.924	23.30 ± 10.457	25.20 ± 4.467	<0.01	0.31 (NS)
Creatinine (mg/dL)	6.340 ± 2.118	2.710 ± 1.533	0.670 ± 0.116	<0.01	<0.01
Sodium (mEq/L)	139.79 ± 3.822	139.79 ± 3.822	139.14 ± 4.512	1.00 (NS)	0.36 (NS)
Potassium (mEq/L)	4.773 ± 0.408	4.773 ± 0.408	4.434 ± 0.355	1.00 (NS)	0.08 (NS)
Chloride (mEq/L)	104.40 ± 3.777	104.40 ± 3.777	102.60 ± 3.460	1.00 (NS)	0.14 (NS)

*NS: Not significant ($p \geq 0.05$)

**P-values:

Pre vs. Post: paired t-test (comparing pre-dialysis and post-dialysis values within the same patients)

Post vs. Control: independent t-test (comparing post-dialysis patient values with control group values)

The p-values in Table 2 were calculated as follows:

For pre-dialysis vs. post-dialysis comparisons: A paired t-test was used because the same patients were measured before and after dialysis. This test calculates the mean difference between paired observations and tests whether this difference is significantly different from zero.

For post-dialysis vs. control group comparisons: An independent t-test was used because the two groups (patients' post-dialysis and healthy controls) are independent of each other. This test compares the means of two separate groups.

Interpretation of results:

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Urea and creatinine showed statistically significant reductions after dialysis ($p<0.01$), confirming dialysis efficacy.

Blood glucose increased significantly after dialysis ($p<0.05$), possibly due to stress-induced hyperglycemia.

Hemoglobin was significantly lower in patients compared to controls ($p<0.01$), even after stratifying by sex, reflecting anemia of chronic disease.

Electrolytes showed no significant changes, indicating effective dialytic regulation.

4.Discussion

The significant reduction in urea and creatinine observed in this study confirms the effectiveness of hemodialysis in removing uremic toxins, consistent with previous findings [7,8]. Hemodialysis is known to efficiently clear small molecular weight solutes such as urea and creatinine from the bloodstream [8].

The observed increase in blood glucose levels after dialysis may be attributed to metabolic stress and hormonal responses during treatment. Previous studies have reported that glucose levels can increase during hemodialysis due to stress-induced hormonal changes and dialysate composition [9]. This increase was statistically significant ($p<0.05$), as shown in Table 2.

The stability of electrolyte levels in this study indicates that hemodialysis effectively maintains electrolyte balance, particularly sodium and potassium homeostasis [10]. This is essential for preventing complications such as arrhythmias.

The reduced hemoglobin levels in patients are consistent with anemia of chronic kidney disease, which is primarily caused by decreased erythropoietin production and impaired iron metabolism [11,12]. Stratification by sex was performed (as requested by the reviewer) and confirmed lower hemoglobin levels in both male and female patients compared to same-sex controls (Table 1).

5.Conclusion

This study confirms that hemodialysis effectively reduces urea and creatinine levels in CRF patients, improving their clinical status. It also highlights the need for glucose monitoring and psychological support during dialysis to enhance patient outcomes and quality of life.

Based on the findings of this study, several practical and strategic recommendations are proposed to enhance the management of chronic renal failure (CRF) in similar clinical settings. First, regular and systematic monitoring of renal function and key biochemical parameters in CRF patients is essential to track disease progression and dialysis efficacy. Second, the implementation of standardized glucose monitoring protocols during hemodialysis sessions is advised to manage the stress-induced hyperglycemia observed in this study. Third, integrating psychological support and stress-reduction interventions into the dialysis care pathway is crucial for improving patient well-being and treatment outcomes. Finally, further research focusing on early detection, region-specific management strategies, and the long-term quality of life for CKD patients in Libya is strongly recommended to inform national healthcare policies and improve clinical practices.

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Ethical approval:

This study was approved by the institutional Review Board of Higher Institute of Science and Technology (Approval No. IRB/ 2024/53) on January 20,2024.

CONFLICT OF INTEREST:

The author has declared that no competing interests.

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