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Original Research Article

# A Comparative Study on Biochemical Parameters before and After Haemodialysis in Renal Failure Patients at the Tertiary Health Care Centre

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**Abstract:**

**Introduction:** Changes in biochemical equilibrium state and the emergence of a range of clinical symptoms and indications are linked to renal failure. Haemodialysis may be required for the treatment of both chronic kidney disease (CKD) and acute kidney injury (AKI). Restoring the intracellular and extracellular fluid milieu that is indicative of normal kidney function is the main objective of hemodialysate.

**Method:** A prospective research was carried out in the department of general medicine at a medical college hospital in central India with permission from the institutional ethics council. The research comprised 100 diagnosed patients of CKD/AKI with completed hemodialysis sessions. Based on their medical histories, physical examinations, and results from haematological and renal biochemical tests performed both before and four hours after hemodialysate, each patient was assessed. Our research aims to examine the renal biochemical changes in individuals with AKI/CKD before and after hemodialysate, including haemoglobin, blood urea, serum creatinine, sodium, potassium, and calcium levels.

**Result:** A statistically significant decrease in urea and creatinine was seen 4 hours after HD, with mean values of 45.30 mg/dl and 2.82 mg/dl, respectively. The average haemoglobin decrease was statistically significant at 0.25 mg/dl. The average increase in calcium was statistically significant at 0.33 mg/dl. Eleven of the patients had hyponatremia, none had hypernatremia, and all of the patients' blood sodium levels were within normal range following HD. Nine individuals in all had hyperkalaemia, seven had hypokalaemia, and all cases had blood potassium levels within normal range following HD.

**Conclusion:** Significant reductions in blood urea and serum creatinine, notable increases in serum calcium and sodium concentrations and corrections to the serum potassium level are all brought about by hemodialysate. Patients receiving dialysis should have their electrolyte profiles regularly monitored, and their treatment should be customised to meet their unique requirements.

**Keywords**: AKI, CKD, Blood Urea, Serum Creatinine, Serum Sodium.



## Introduction

By removing waste products and extra fluid from the body, the kidney plays a crucial role in controlling the "Milieu interieur," or internal environment. Changes in metabolic balance and the appearance of a number of clinical symptoms are linked to renal failure. Haemodialysis may be required for the treatment of both chronic kidney disease (CKD) and acute kidney injury (AKI).Diffusive clearance refers to the removal of small solutes over a semipermeable membrane along their concentration gradient, while convective clearance involves the removal of solutes together with the flow of plasma water. [1] When the kidneys fail, this procedure eliminates excess fluids and toxic metabolic by products like urea from the plasma and restores the patient's electrolyte balance by dialyzing their blood against a solution that doesn't contain urea but still has the right amounts of electrolytes, free-ionized calcium, and other plasma constituents. [2] Restoring the extracellular and intracellular fluid environments that are indicative of healthy kidney function is the main objective of hemodialysate. [3] The list of conditions that qualify a patient for dialysis includes having uremic symptoms, having hyperkalemia that is unresponsive to conservative measures, continuing extracellular volume expansion while on diuretic therapy, having acidosis that is unresponsive to medication, having an inclination towards excessive bleeding, and having an estimated glomerular filtration rate (eGFR) or creatinine clearance less than 10 ml/min per 1.73 m2. [1] When we talk about the "optimal" dialysate, we mean a synthetic solution that contains every element present in normal plasma.

In addition to supplying certain molecules to the circulation of uraemia patients, this solution aids in the elimination of surplus chemicals created in their blood. These procedures correspond to the common mechanisms used in hemodialysis. [4] Six electrolytes make up the majority of dialysate's composition: sodium ($Na^+$), potassium ($K^+$), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), chloride ($Cl^–$), and bicarbonate ($HCO_3^–$).The dialyzer's semipermeable membrane barrier facilitates the interaction between blood and dialysate, which may lead to electrolytic changes that have both short- and long-term effects, eventually influencing mortality rates. [4] The simple equation developed by Lowrie and Lew in 1991 [11] is used to calculate the urea reduction ratio (URR).The formula $100 \times (1 - [Ct/Co])$ is used to calculate the Urea Reduction Ratio (URR), where Ct is the blood urea nitrogen level measured five minutes after dialysis ends and Co is the blood urea nitrogen level before to dialysis. [12]

The dialyzer's ability to remove urea from the blood, the length of the dialysis session, and the amount of urea that is distributed differently in each patient are all variables that contribute to the urea reduction ratio (URR). Therefore, the urea reduction ratio is a quantitative measure of a patient's urea clearance following a single haemodialysis session and may be used as a gauge for how well solute clearance is maintained over this course of treatment. [13-14] The dialyzer clearance (K) in millilitres per minute, the dialysis time (t) in minutes, and the urea distribution volume (V) in millilitres make up the parameter Kt/V. Frank Gotch and John Sargent are credited with developing the indication that is referenced in the text. [16] Daugirdas then significantly modified the indicator throughout the course of the 1990s. [17] As of right moment, this signal is the most widely used gauge of adequate dialysis. [18, 19] The HEMO study, a noteworthy RCT that was carried out in 2002, found a correlation between lower mortality among patients receiving hemodialysis and a single-pool Kt/V (spKt/V) ratio of more than 1.2. [20] The current goals include a urea reduction ratio of at least 65-70% in each hemodialysate session and a body water-indexed clearance × time product (Kt/V) of 1.2 or 1.05, contingent on the state of urea concentration equilibration. [1] Most patients who are diagnosed with end-stage renal disease usually get dialysis for nine to twelve hours a week, split evenly between three sessions. Customising the dose for hemodialysis is essential since it requires taking into account factors other than urea nitrogen levels. These take into account the effectiveness of ultrafiltration and the control of metabolic acidosis, hyperphosphatemia, and hyperkalaemia.

Serum creatinine and blood urea measurements are used to evaluate and diagnose AKI/CKD. Muscles create creatinine, which is eliminated by the kidneys along with other waste materials. [5] The waste product that passes from the kidneys and into the urine is urea, which is the result of the metabolism of dietary proteins. [6] Numerous investigations have assessed how hemodialysate affects haematological and biochemical markers. [7–10] Our study's objective is to look at the changes in renal biochemistry in patients with AKI/CKD before and after hemodialysate, including haemoglobin, blood urea, serum creatinine, sodium, potassium, and calcium levels.

## Methodology

This study, which is prospective in nature, was carried out in the general medicine department of a medical college hospital located in central India. Clearance from the Institutional Ethical Committee was acquired. In all, 100 hemodialysis treatments were part of the completed, diagnosed CKD/AKI patients. Based on their medical histories, physical examinations, and results from haematological and renal biochemical tests performed both before and four hours after hemodialysate, each patient was assessed. Prior to their enrollment in the trial, all patients provided written informed consent. The prefabricated proforma was filled up using the recorded data. The acquired data were examined with SPSS software after being input into a Microsoft Excel sheet.

**Inclusion Criteria:** Diagnosed cases of AKI and CKD requiring haemodialysis.

**Exclusion Criteria:**

1. Alcohol induced acidosis.
2. Drug overdose and toxins
3. Tumorlysis syndrome

## Result

A total of 100 haemodialysis sessions in 44 identified instances of AKI/CKD were examined; of these, 70% of HD was related to AKI and 30% to CKD, with 55% of the HD being male and 35%

female. The age range of 30-45 years old was the most frequently seen by patients with renal insufficiency who had undergone HD; their mean age was 38.86±14.84 (mean ± SD). [Table 1 & 2] Changes in serum electrolytes, haemoglobin, and renal parameters before and after hemodialysate are shown in Table 3. Prior to HD, the mean urea was 183.10 mg/dl (BUN=85.56 mg/dl) and after HD, it was 137.80 mg/dl (BUN=64.39 mg/dl). Thus, four hours after HD, the mean urea decrease was 45.30 mg/dl and was statistically significant. Pre- and post-HD mean creatinine values for an average of four hours of HD were 9.45 mg/dl and 6.63 mg/dl, respectively. Therefore, the 2.82 mg/dl creatinine decrease was statistically significant. The average haemoglobin values before and after HD were 9.46 mg/dl and 9.21 mg/dl, respectively, during the course of four hours of HD. Therefore, the mean haemoglobin decrease was statistically significant at 0.25 mg/dl. The mean values for calcium before and after HD were 8.96 mg/dl and 9.29 mg/dl, respectively. The mean increase in calcium was statistically significant at 0.33 mg/dl. Eleven of the patients had hyponatremia in the sodium instance; none had hypernatremia, and all of the patients' blood sodium levels were within normal range following HD. Four hours after HD, the mean sodium values were 140.33meq/litre and 138.77meq/litre, respectively. With a mean rise of 1.56 meq/litre, salt levels were statistically significant. Nine individuals in all had hyperkalaemia, seven had hypokalaemia, and all cases had blood potassium levels within normal range following HD. Four hours after hemodialysate (HD), the mean potassium values were 4.28 meq/litre and 4.35 meq/litre, respectively. Potassium increased by 0.07 meq/liter on average, a statistically significant amount.

**Table 1: Demographic characteristics of study population**

| Parameters | Patients |
|---|---|
| Age (years) (mean ± SD) | 38.86±14.84 |
| Male | 32 |
| Female | 12 |
| No of AKI pts | 27 |
| No of CKD pts | 17 |
| Total no of patients | 44 |
| Total no HD sessions | 100 |

**Table 2: Number of Haemodialysis sessions in CKD/AKI patients**

| Type of renal failure | No. of HD sessions | Percentage |
|---|---|---|
| AKI | 70 | 70% |
| CKD | 30 | 30% |
| Total | 100 | 100% |

**Table 3: Biochemical parameters before and after HD sessions in all patients**

| Laboratory parameters | Pre dialysis mean | Post dialysis mean | Difference | Significance |
|---|---|---|---|---|
| Urea | 183.11±59.77 | 137.81±54.31 | 44.30 | t=35.45; p<0.0001 |
| Creatinine | 9.46±3.94 | 6.64±3.42 | 2.82 | t=31.28; p<0.0001 |
| $Na^+$ | 138.78±3.86 | 140.01±1.76 | 1.56 | t=5.59; p<0.0001 |
| $K^+$ | 4.29±0.61 | 4.36±0.32 | 0.07 | t=1.63; p>0.05 |
| $Ca^{2+}$ | 8.97±0.56 | 9.28±0.48 | 0.33 | t=13.82; p<0.0001 |
| Hb | 9.47±1.86 | 9.22±1.75 | 0.25 | t=6.87; p<0.0001 |

**Table 4: Biochemical parameters before and after HD sessions in AKI patients**

| Laboratory parameters | Pre dialysis mean | Post dialysis mean | Difference | Significance |
|---|---|---|---|---|
| Urea | 180.81±63.34 | 135.41±56.82 | 44.30 | t=25; p<0.0001 |
| Creatinine | 8.59±3.76 | 6.22±3.29 | 2.82 | t=28.06; p<0.0001 |
| $Na^+$ | 138.71±3.68 | 140.29±1.66 | 1.56 | t=4.95; p<0.0001 |
| $K^+$ | 4.24±0.59 | 4.35±0.30 | 0.07 | t=1.98; p<0.05 |
| $Ca^{2+}$ | 9.17±0.50 | 9.46±0.44 | 0.33 | t=10.35; p<0.0001 |
| Hb | 10.09±1.75 | 9.82±1.95 | 0.25 | t=5.49; p<0.0001 |

**Table 5: Biochemical parameters before and after HD sessions in CKD patients**

| Laboratory parameters | Pre dialysis mean | Post dialysis mean | Difference | Significance |
|---|---|---|---|---|
| Urea | 188.44±51.14 | 143.36±48.36 | 44.30 | t=42.63; p<0.0001 |
| Creatinine | 10.60±4.13 | 7.59±3.56 | 2.82 | t=15.53; p<0.0001 |
| $Na^+$ | 138.91±4.29 | 140.41±1.98 | 1.56 | t=2.65; p<0.05 |
| $K^+$ | 4.38±0.60 | 4.36±0.35 | 0.07 | t=0.27; p>0.05 |
| $Ca^{2+}$ | 8.49±0.37 | 8.90±0.28 | 0.33 | t=8.61; p<0.0001 |
| Hb | 8.00±1.19 | 7.79±1.21 | 0.25 | t=4.86; p<0.0001 |

## Discussion

The clinical condition known as uremia is marked by elevated blood urea levels. Along with metabolic problems, this illness is characterised by hormone, electrolyte, and fluid imbalances. These symptoms appear at the same time as renal function gradually declines. [21]

Piorry coined the term "uraemia," which comes from the Greek words "ouron" (urine) and "haima" (blood). It refers to the clinical condition associated with renal failure. [22, 23] Uremia can arise in acute kidney injury (AKI) if renal function is rapidly lost, but it is more prevalent in chronic kidney disease (CKD), particularly in its later stages. Renal transplantation, peritoneal dialysis, or hemodialysate are the available treatments for uraemia.

The mean urea levels in our research were 137.80 mg/dl (BUN=64.39 mg/dl) and 183.10 mg/dl (BUN=85.56 mg/dl) before and after HD, respectively. Four hours after HD, the mean urea decrease was 45.30 mg/dl, and this difference was statistically significant. After four hours of HD on average, the mean values of creatinine were 6.63 mg/dl and 9.45 mg/dl, respectively. There was a statistically significant 2.82 mg/dl decrease in creatinine.

Patients with CKD receiving hemodialysis had a substantial decrease in blood creatinine and urea in the Deepika Modi et al study. [24] The results aligned with the Gonella-Geetha-Meenakshi research and the Shekhar S et al investigation, which demonstrated the noteworthy contribution of hemodialysate to the removal of urea and creatinine from the bloodstream. [8, 25] After receiving haemodialysis therapy, it was discovered in the Putra, R. N. et al research that 1 sample (1.8%) had low urea levels, 27 samples (50%) had normal serum levels, and 26 samples (48.2%) still had high urea levels. Post HD serum creatinine reduced in all of the samples. [26]

The average haemoglobin values before and after heart surgery were 9.46 mg/dl and 9.21 mg/dl, respectively, in our research. Therefore, the mean haemoglobin decrease was statistically significant at 0.25 mg/dl. This is in line with a research by Yasir A.H. Hakim et al. that found that following hemodialysate, 98.5% of patients had decreased haemoglobin concentrations. [27] Four hours after HD, the mean salt values in our sample were 140.33meq/litre and 138.77meq/litre, respectively. Eleven of the patients had hyponatremia, none had hypernatremia, and all of the patients' blood sodium levels were within normal range following HD. In the current study, it was discovered that post-dialysis patients' average blood sodium levels were marginally higher than pre-dialysis patients' average serum sodium levels.

According to Seethalakshmi et al., individuals who had undergone hemodialysis had a mean sodium (Na+) concentration that was greater (138.00 ± 4.41) than those who had not (136.87 ± 4.14). [28] The mean blood Na+ levels of post-hemodialysis patients (138.00±4.41) were found to be higher than those of pre-hemodialysis patients (136.87±4.14), according to a research by Nauman et al. [29] Similar outcomes were reported by Shekhar Study [8].In contrast, Gouri A. Gulavani et al. discovered that serum sodium levels in individuals undergoing hemodialysate were lower than those in those undergoing pre-hemodialysis (P Value: 0 573). Not important) [30] Nine individuals in all in our research had hyperkalaemia, seven had hypokalaemia, and all cases had blood potassium levels within normal range following HD. Four hours after hemodialysate (HD), the mean potassium values were 4.28 meq/litre and 4.35 meq/litre, respectively.

Hypokalaemia (below 3.5 mEq/l) was also discovered in 28 instances (41.18%) in the Liggy Andrew et al research after dialysis. [31] When compared to the mean serum potassium levels of pre-dialyzed patients, the study by Shekhar S et al. showed a significant drop in serum potassium levels (P<0.001) among post-dialyzed patients. [8]

The average calcium levels before and after hemodialysate were determined to be 8.96 mg/dl and 9.29 mg/dl, respectively, in the current study. It was determined that the 0.33 mg/dl rise in calcium levels that was seen was statistically significant. Sekhar et al [8] and Bhagat et al [32] noted a significant increase in serum calcium levels after hemodialyser treatment.

## Conclusion:

For patients with both AKI and CKD, hemodialysis is a renal replacement treatment that can save lives and is readily available at a reasonable cost. Serum calcium and salt concentrations rise significantly after hemodialysate, while blood urea and serum creatinine levels are significantly decreased. It also aids in the replenishment of serum potassium levels. Whether caused by an illness or as a result of dialysis, dyselectrolytemia has both short- and long-term effects. It eventually raises the death rate among patients receiving hemodialysate, mostly because of cardiovascular issues. Dialysis patients should have their electrolyte profile regularly monitored, and their therapy should be customised to meet their individual requirements.

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