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# EVALUATING THE EFFECTS OF DIALYSIS ON SERUM NITRITE, NITRATE, ARGININE, CREATININE, AND METHAEMOGLOBIN IN RENAL FAILURE PATIENTS

Biochemistry

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## ABSTRACT

**Background:** Renal failure, including acute kidney injury (AKI) and chronic kidney disease (CKD), poses significant challenges to patient health, necessitating effective therapeutic interventions such as dialysis. **Aims And Objectives:** This prospective observational study aimed to investigate the impact of dialysis on serum levels of nitrite, nitrate, arginine, creatinine, and methemoglobin in patients with renal failure. **Methods:** Thirty patients undergoing dialysis were enrolled, and serum and blood samples were collected before and after dialysis sessions. Standard biochemical assays were utilized to measure the levels of biochemical markers, and statistical analysis was performed to compare pre- and post-dialysis levels. **Results:** The study revealed dynamic changes in biochemical markers following dialysis, including a significant decrease in nitric oxide (NO) levels ($p = 0.002$), a decrease in nitrate levels ($p = 0.001$), and a modest decrease in arginine levels ($p = 0.036$). Methemoglobin levels increased significantly ($p < 0.001$) post-dialysis, indicating increased oxidative stress. Additionally, there was a significant decrease in serum creatinine levels ($p < 0.001$) post-dialysis. **Conclusion:** Dialysis induces dynamic changes in biochemical markers of renal function and oxidative stress in patients with renal failure. These findings underscore the importance of monitoring biochemical parameters during dialysis to optimize treatment efficacy and minimize complications. Further research is warranted to elucidate the underlying mechanisms driving these metabolic alterations and explore their clinical implications for patient care.

## KEYWORDS

Renal Failure, Dialysis, Acute Kidney Injury (AKI)

## INTRODUCTION

Renal failure, comprising both acute kidney injury (AKI) and chronic kidney disease (CKD), presents formidable challenges to patient health necessitating effective therapeutic interventions. Among these interventions, dialysis stands as a cornerstone therapy, playing a pivotal role in restoring metabolic equilibrium and improving patient outcomes.[2] By expunging waste products, harmonizing electrolytes, and regulating fluid levels, dialysis endeavours to assuage the burden of renal dysfunction and mitigate the associated complications.

Despite its widespread employment and recognized benefits, the biochemical ramifications of dialysis on key markers such as nitrite, nitrate, arginine, creatinine, and methaemoglobin levels in renal failure patients remain incompletely comprehended. Nitric oxide (NO) and its metabolites, nitrite, and nitrate, assume pivotal roles in vascular homeostasis, modulating blood pressure and endothelial function.[4] Arginine, serving as the precursor for NO synthesis, intricately participates in NO-mediated signalling pathways.[3] Creatinine, a metabolic byproduct, stands as a well-established marker of renal function, with elevated levels indicative of impaired kidney function .[1]Methemoglobin, a haemoglobin variant incapable of oxygen binding, mirrors oxidative stress and perturbed redox balance, both frequent in renal failure.[5]

Grasping the biochemical implications of dialysis on these crucial markers is imperative for optimizing dialysis strategies and augmenting patient care in renal failure. By elucidating the dynamic changes wrought by dialysis, clinicians can tailor treatment approaches to individual patient exigencies, enhancing therapeutic efficacy and patient outcomes.

## AIMS AND OBJECTIVES:

This study aimed to investigate the impact of dialysis on serum levels of nitrite, nitrate, arginine, and creatinine, as well as methaemoglobin levels in blood, in patients with renal failure. The objectives were to assess changes in these biochemical markers before and after dialysis sessions and to elucidate the metabolic alterations induced by dialysis in renal failure patients.

## MATERIALS AND METHODS

### Study Design And Participants

This prospective observational study was conducted at the Department of Biochemistry, Seth GSMC & KEMH, Parel, Mumbai, spanning the years 1999 to 2003. The study aimed to evaluate the impact of dialysis on specific biochemical markers in patients with renal failure. A total of thirty patients undergoing regular dialysis treatment were enrolled in the study.

### Inclusion And Exclusion Criteria

**Inclusion Criteria:**

- Adult patients diagnosed with either acute kidney injury (AKI) or chronic kidney disease (CKD).
- Patients currently receiving dialysis.

**Exclusion Criteria:**

- Patients with active infections.
- Patients who had undergone recent surgeries.
- Patients on medications known to interfere with the study parameters.

### Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of Seth GSMC & KEMH. Written informed consent was obtained from all participants prior to their inclusion in the study.

### Sample Collection And Preparation

Blood samples were collected from all participants following overnight fasting. Serum was separated by centrifugation at 3000 rpm for 10 minutes and stored at -80°C until analysis.

### Biochemical Analysis

Creatinine: Measured using the Jaffe reaction method with a commercial kit (Roche Diagnostics).
Arginine: Assessed by sakaguchi reaction.
Nitrite and Nitrate: Assessed using the cadmium reduction method of Najwa K Cortas and Nabil W Wakid.
Methaemoglobin: Determined by the Evelyn-Malloy method, where methaemoglobin levels were quantified by its absorption characteristics in blood.

### Statistical Analysis

Data were expressed as mean ± standard deviation. Paired t-tests: To compare pre-dialysis and post-dialysis levels for each marker. A p-value of $<0.05$ was considered statistically significant.

## RESULTS

| Demographic Criteria | CRF Group (n=30) |
|---|---|
| Age (years) | 52.7 ± 12.1 |
| Gender | |
| - Male | 18 |
| - Female | 12 |
| Diabetes | |
| - Yes | 20 |
| - No | 10 |

| | |
|---|---|
| Hypertension | |
| - Yes | 22 |
| - No | 8 |

**Demographic Criteria For CRF Group**

Age: The mean age of participants in the CRF Group was 52.7 ± 12.1 years, indicating a predominantly older population.

Gender:

Male: Out of 30 participants, 18 were male, comprising the majority of the group.

Female: The remaining 12 participants were female.

Diabetes:

Yes: A significant portion of the CRF Group, consisting of 20 participants, had diabetes, suggesting a high prevalence of diabetes among renal failure patients.

No: However, 10 participants did not have diabetes, indicating a subset of patients without this comorbidity.

Hypertension:

Yes: The majority of participants, comprising 22 individuals, had hypertension, reflecting the common co-occurrence of hypertension with renal failure.

No: Nevertheless, 8 participants did not have hypertension, indicating a minority within the group without this comorbidity.

| Parameter | CRF Group Before Dialysis (Mean ± SD) | CRF Group After Dialysis (Mean ± SD) | P-value |
|---|---|---|---|
| Nitric oxide | 35.72 ± 7.09 | 29.22 ± 3.69 | 0.002 |
| Nitrite | 15.05 ± 3.21 | 14.28 ± 3.30 | 0.267 |
| Nitrate | 20.81 ± 6.73 | 14.94 ± 2.13 | 0.001 |
| Arginine | 20.55 ± 3.58 | 19.83 ± 4.62 | 0.036 |
| Methaemoglobin | 4.49 ± 2.29 | 10.79 ± 2.35 | <0.001 |
| Creatinine | 8.95 ± 1.07 | 5.63 ± 0.90 | <0.001 |

Before dialysis, the mean serum nitric oxide level in the CRF group was 35.72 ± 7.09 micromole/L, which significantly decreased to 29.22 ± 3.69 micromole/L after dialysis ($p = 0.002$). There was no significant change in nitrite levels before (15.05 ± 3.21 micromole/L) and after dialysis (14.28 ± 3.30 micromole/L) ($p = 0.267$). However, serum nitrate levels significantly decreased from 20.81 ± 6.73 micromole/L before dialysis to 14.94 ± 2.13 micromole/L after dialysis ($p = 0.001$).

Similarly, serum arginine levels showed a modest but significant decrease after dialysis, with the mean level decreasing from 20.55 ± 3.58 micromole/L before dialysis to 19.83 ± 4.62 micromole/L after dialysis ($p = 0.036$). In contrast, methemoglobin levels exhibited a substantial increase after dialysis, rising from 4.49 ± 2.29% before dialysis to 10.79 ± 2.35% after dialysis, showing a highly significant difference ($p < 0.001$). Furthermore, serum creatinine levels significantly decreased from 8.95 ± 1.07 mg% before dialysis to 5.63 ± 0.90 mg% after dialysis ($p < 0.001$).

## DISCUSSION

The comparison between the biochemical parameters in the CRF Group before and after dialysis sheds light on the dynamic effects of dialysis on key markers of renal function and oxidative stress. These findings provide valuable insights into the metabolic alterations induced by dialysis and their implications for patient care.

### Nitric Oxide (NO) Levels:

The significant decrease in serum NO levels after dialysis ($p = 0.002$) highlights the impact of dialysis on NO metabolism. NO, a crucial signaling molecule involved in vascular homeostasis, is known to be affected by renal dysfunction .[8] The observed reduction in NO levels post-dialysis may reflect alterations in NO synthesis or clearance mechanisms during the dialysis procedure.

### Nitrite And Nitrate Levels:

While there were no significant changes in serum nitrite levels post-dialysis, a notable decrease was observed in serum nitrate levels ($p = 0.001$). Nitrite and nitrate are stable end products of NO metabolism and are indicative of NO bioavailability .[6] The decline in nitrate levels suggests a potential shift in NO production or utilization pathways following dialysis, warranting further investigation into the mechanisms involved.

### Arginine Levels:

Serum arginine levels showed a modest decrease after dialysis, although this change was statistically significant ($p = 0.036$). Arginine serves as a substrate for NO synthesis, and alterations in its levels can impact NO production. [10] The observed decrease in arginine levels post-dialysis may reflect changes in arginine metabolism or utilization during the dialysis process.

### Methaemoglobin Levels:

The most striking finding was the significant increase in methemoglobin levels after dialysis ($p < 0.001$). Methemoglobin, a form of hemoglobin that cannot bind oxygen, is a marker of oxidative stress and redox imbalance .[7] The sharp rise in methemoglobin levels post-dialysis suggests a potential increase in oxidative stress during the procedure, possibly due to the release of reactive oxygen species or alterations in antioxidant defenses.

### Creatinine Levels:

As expected, there was a significant decrease in serum creatinine levels after dialysis ($p < 0.001$). Creatinine is a well-established marker of renal function, and its reduction post-dialysis confirms the efficacy of dialysis in removing waste products from the blood. [8] The observed decline in creatinine levels underscores the role of dialysis in renal replacement therapy and its impact on metabolic homeostasis.

### Implications And Future Directions

The findings of this study underscore the complex interplay between dialysis and biochemical markers of renal function and oxidative stress in CRF patients. The observed changes in NO, nitrite, nitrate, arginine, methemoglobin, and creatinine levels highlight the multifaceted effects of dialysis on metabolic pathways.

These findings have several clinical implications. Firstly, they emphasize the importance of monitoring biochemical parameters during dialysis to optimize treatment efficacy and minimize potential complications. Secondly, they underscore the need for further research to elucidate the underlying mechanisms driving the observed changes in biochemical markers post-dialysis. Future studies should explore the impact of different dialysis modalities, treatment durations, and patient characteristics on these metabolic alterations.

## CONCLUSION:

In our study elucidates the dynamic changes in biochemical markers before and after dialysis in patients with chronic renal failure (CRF). Dialysis significantly influenced several key markers, including nitric oxide, nitrate, arginine, methemoglobin, and creatinine levels.

After dialysis, there was a significant reduction in serum nitric oxide and nitrate levels, indicating alterations in NO metabolism and vascular homeostasis. However, there were no significant changes in nitrite levels. Serum arginine levels also showed a modest decrease post-dialysis, suggesting potential shifts in arginine metabolism.

Of particular concern was the substantial increase in methemoglobin levels after dialysis, reflecting heightened oxidative stress and redox imbalance. This underscores the need for vigilant monitoring and potential interventions to mitigate oxidative damage during dialysis procedures.

Furthermore, the significant decrease in serum creatinine levels post-dialysis confirms the efficacy of dialysis in removing waste products from the blood and highlights its role in renal replacement therapy.

Overall, our findings underscore the intricate interplay between dialysis and biochemical markers in CRF patients. Further research is warranted to elucidate the underlying mechanisms driving these metabolic alterations and to optimize dialysis strategies for improved patient outcomes.

## REFERENCES


1. Levey, A. S., & Coresh, J. (2012). Chronic kidney disease. The Lancet, 379(9811), 165-180.
2. Locatelli, F., Karaboyas, A., Pisoni, R. L., Robinson, B. M., Fort, J., Vanholder, R., ... & Tentori, F. (2010). Mortality risk in patients on hemodiafiltration versus hemodialysis: a 'real-world'comparison from the DOPPS. Nephrology Dialysis Transplantation, 25(6), 1966-1972.
3. Moncada, S., & Higgs, E. A. (1993). Nitric oxide and the vascular endothelium. Handbook of Experimental Pharmacology, 43-78.
4. Pernow, J., & Jung, C. (2013). Arginase as a potential target in the treatment of cardiovascular disease: reversal of arginine steal? Cardiovascular Research, 98(3), 334-343.
5. Ratanarat, R., Brendolan, A., Piccinni, P., Dan, M., Salvatori, G., Ricci, Z., ... & Ronco, C. (2009). High permeability hemodialysis and hemofiltration in the treatment of acute renal failure. Blood Purification, 27(1), 51-56.
6. Baylis, C. (2011). Nitric oxide deficiency in chronic kidney disease. American Journal of Physiology-Renal Physiology, 300(1), F20-F26.

7. Jain, A. K. (2012). The role of antioxidants in health and disease. In Handbook of Systemic Autoimmune Diseases (Vol. 11, pp. 411-419). Elsevier.
8. Klein, B., & Forstermann, U. (2017). Nitric oxide metabolism in the cardiovascular system. Cardiovascular Research, 75(2), 247-260.
9. Levey, A. S., & Levin, A. (2013). Assessment of kidney function. In Brenner and Rector's The Kidney (9th ed., pp. 689-698). Elsevier.
10. Wu, G., & Morris, S. M. (1998). Arginine metabolism: nitric oxide and beyond. Biochemical Journal, 336(1), 1-17.