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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, Madhya Pradesh

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Abstract:

Introduction: Renal failure is associated with alterations in biochemical equilibrium conditions as well as the manifestation of various clinical symptoms and indications. The utilisation of haemodialysis may be necessary for the management of both acute kidney injury (AKI) as well as chronic kidney disease (CKD). The primary goal of haemodialysis is to restore the intracellular and extracellular fluid environment that is characteristic of normal kidney function.

Method: After approval from the institutional ethical committee, a prospective study was conducted in the Department of General Medicine, NSCB Medical College Hospital, Jabalpur in the period 1st September 2009 to 5th October 2010. Total 100 diagnosed cases of CKD/AKI were included in the study with the Haemodialysis sessions done. All patients were evaluated on the basis of history, examination, haematological and renal biochemical investigations done before and 4 hours after haemodialysis. The aim of our study is to investigate the renal biochemical changes like haemoglobin, blood urea, serum creatinine, sodium, potassium and calcium levels in patients with AKI/CKD before and after haemodialysis.

Result: The mean decrement of urea and creatinine was 45.30 mg/dl, 2.82 mg/dl respectively, 4 hours after HD and it was statistically significant. The mean decrement of haemoglobin was 0.25 mg/dl and was statistically significant. The mean increment in calcium was 0.33 mg/dl and was statistically significant. 11 cases were hyponatremic, none of the patients were hypernatremia and after HD serum sodium level was within normal limit in all cases. Total 9 cases were hyperkalaemia, 7 cases were hypokalaemia and after HD serum potassium was within normal limit in all cases.

Conclusion: Haemodialysis leads to the significant decrease in blood urea, serum creatinine, significant increase in serum calcium and sodium concentration and correction of serum potassium level. It is important to closely monitor the electrolyte profiles of patients undergoing dialysis, and to tailor the therapy to each individual's specific needs.

Keywords: AKI, CKD, Blood Urea, Serum Creatinine, Serum sodium.

Introduction

The kidney assumes a vital function in the regulation of the internal environment, known as "Milieu interieur," by the elimination of waste materials and excess fluid from the living being. Renal failure is associated with alterations in biochemical homeostasis as well as the manifestation of various clinical manifestations. The utilisation of haemodialysis may be necessary for the management of both acute kidney injury (AKI) as well as chronic kidney disease (CKD). Small solutes are removed across a semipermeable membrane down their concentration gradient ("diffusive" clearance) and/or along with the movement of plasma water ("convective" clearance) [1]. It is a procedure that removes excess fluids and toxic end products of metabolism such as urea from the plasma, when the kidneys fail and correct electrolytes balance by dialyzing the patient's blood against fluid containing no urea but with appropriate concentrations of electrolytes, free-ionized calcium and some other plasma constituents [2]. The primary goal of haemodialysis is to restore the intracellular and extracellular fluid environment that is characteristic of normal kidney function [3]. The indications for dialysis encompass a range of factors, including the presence of uremic symptoms, hyperkalaemia that does not respond to conservative treatments, on-going expansion of extracellular volume despite the use of diuretic therapy, acidosis that does not improve with medical interventions, a tendency to bleed excessively, and a creatinine clearance or estimated glomerular filtration rate (eGFR) below 10 ml/min per 1.73 m2 [1].

The "optimal" dialysate refers to a synthetic solution that encompasses all the components found in normal plasma. This solution facilitates the removal of excessive chemicals produced in the blood of patients with uraemia, while also providing certain compounds to their bloodstream. These processes align with the standard mechanisms employed in haemodialysis [4]. The composition of dialysate primarily comprises six electrolytes, namely sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), & bicarbonate (HCO_3^-). The interaction between blood and dialysate, facilitated by the semipermeable membrane barrier of the dialyzer, might cause electrolytic alterations that may result in both immediate and long-term consequences, ultimately affecting mortality rates. [4].

The calculation of the urea reduction ratio (URR) is performed using a straightforward equation established by Lowrie and Lew in 1991[11]. The Urea Reduction Ratio (URR) is determined using the equation $100 \times (1 - [Ct/Co])$, where Ct represents the blood urea nitrogen level taken five minutes after the completion of dialysis, and Co represents the blood urea nitrogen level before to dialysis [12].

The urea reduction ratio (URR) is determined by several factors, including the clearance of urea through the blood by the dialyzer, the duration of the dialysis procedure, along with the volume of distribution of urea specific to each patient. Hence, the urea reduction ratio serves as a quantitative assessment of a particular patient's urea clearance after a solitary haemodialysis session, and may be employed as an indicator of the sufficiency of solute clearance throughout this therapy. [13-14].

The parameter Kt/V, where K represents the dialyzer clearance in ml/min, t represents the dialysis duration in minutes, and V represents the urea distribution volume in millilitres. The development of the indicator mentioned in the text may be attributed to Frank Gotch and John Sargent [16]. Subsequently, Daugirdas made significant adjustments to the indicator throughout the 1990s [17]. This indicator has now been the predominant measure of dialysis adequacy [18,19]. The HEMO research, a significant randomised controlled trial conducted in 2002, discovered that a single-pool Kt/V (spKt/V) value greater than 1.2 is correlated with reduced mortality among patients undergoing haemodialysis [20]. The present objectives encompass achieving a urea reduction ratio of greater than 65-70% during each haemodialysis session, as well as attaining a body water-indexed clearance × time product (Kt/V) of either 1.2 or 1.05, depending on the equilibration status of urea concentrations [1]. The majority of patients diagnosed with end stage renal disease typically have dialysis for duration of 9 to 12 hours per week, which is evenly distributed among three sessions. The individualization of the Haemodialysis dosage is crucial, as it necessitates the consideration of parameters beyond urea nitrogen levels. These considerations encompass the sufficiency of ultrafiltration, as well as the management of hyperkalaemia, hypophosphatemia, & metabolic acidosis.

Measurement of blood urea and serum creatinine levels is used to assess and diagnose AKI/CKD. Creatinine is produced from muscles and is excreted through the kidneys along with other waste products [5]. Urea is the metabolized product of dietary proteins, the waste product filtered through the kidney into the urine [6]. Many studies have evaluated the effect of haemodialysis on haematological and biochemical parameters [7-10]. The aim of our study is to investigate the renal biochemical changes like haemoglobin, blood urea, serum creatinine, sodium, and potassium and calcium levels in patients with AKI/CKD before and after haemodialysis.

Methodology

This is a prospective observational study conducted in the Department of General Medicine NSCB Medical College Hospital, Jabalpur from 1st September 2009 to 5th October 2010. Institutional Ethical Committee clearance was obtained. Total of 100 Haemodialysis sessions were included in done in diagnosed cases of CKD/AKI.

All patients were evaluated on the basis of history, examination, haematological and renal biochemical investigations done before and 4 hours after haemodialysis. A written informed consent was obtained from all the patients before enrolling them for the study. The recorded information's were entered in the preformed proforma. The data obtained were entered in a Microsoft excel sheet and analysed using SPSS software.

Inclusion criteria:

1. Diagnosed cases of AKI and CKD requiring haemodialysis.

Exclusion criteria:

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

Result

Total of 100 haemodialysis sessions done in 44 diagnosed cases of AKI/CKD were studied out of which 70 % HD were of AKI and 30 % HD were of CKD, male constituting 65 % and female constituting 35 %.

Most common age group presenting with renal failure who had undergone HD was between 30-45 yrs. and mean age was 38.86±14.84 (mean ± SD)(Table 1&2). Table 3 describes changes in renal parameters, serum electrolytes and haemoglobin before and after haemodialysis. The mean urea before and after HD was 183.10 mg/dl (BUN=85.56mg/dl) and 137.80 mg/dl (BUN=64.39mg/dl) respectively. So the mean decrement of urea was 45.30 mg/dl 4 hour after HD and it was statistically significant. Mean value of Creatinine, pre and post HD in average 4 hours of HD was 9.45 mg/dl and 6.63 mg/dl respectively. So decrement of creatinine was 2.82 mg/dl and was statistically significant. Mean value of haemoglobin pre and post HD in average 4 hours of HD was 9.46 mg/dl and 9.21 mg/dl respectively. So mean decrement of haemoglobin was 0.25 mg/dl and was statistically significant. In case of calcium, mean value pre and post HD was 8.96 mg/dl and 9.29 mg/dl respectively. Mean increment in calcium was 0.33 mg/dl and was statistically significant. In case of sodium total 11 cases were hyponatremic, none of the patients were hypernatremia and after HD serum sodium level was within normal limit in all cases.

Mean value of sodium pre and post HD 4 hours after HD was 138.77meq/litre and 140.33meq/litre respectively. Mean increment of sodium was 1.56meq/litre and was statistically significant. Total9 cases were hyperkalaemia, 7 cases were hypokalaemia and after HD serum potassium was within normal limit in all cases.

Mean value of potassium pre and post haemodialysis 4 hour after HD was 4.28meq/litre and 4.35meq/litre respectively. Mean increment of potassium was 0.07meq/litre and was statistically significant.

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

Uraemia is a clinical phenomenon characterised by increased levels of urea in the bloodstream. This condition is accompanied by imbalances in fluid, electrolytes, and hormones, as well as metabolic abnormalities. These manifestations occur concurrently with the progressive decline of renal function [21]. The term "uraemia," derived from the Greek words "ouron" (urine) and "haima" (blood), was initially employed by Piorry to denote the clinical manifestation linked to renal insufficiency. [22,23]. Uraemia occurs more commonly in chronic kidney disease (CKD), especially in the later stages, but may also develop in acute kidney injury (AKI) if loss of kidney function is rapid. The treatment for uraemia is either haemodialysis, peritoneal dialysis, or kidney transplantation.

In our study the mean urea before and after HD was 183.10 mg/dl (BUN=85.56mg/dl) and 137.80 mg/dl (BUN=64.39mg/dl) respectively. The mean decrement of urea was 45.30 mg/dl 4 hour after HD and it was statistically significant. Mean value of Creatinine, pre and post HD in average 4 hours of HD was 9.45 mg/dl and 6.63 mg/dl respectively. The decrement of creatinine was 2.82 mg/dl and was statistically significant. In Deepika Modi et al study, patients with CKD undergoing haemodialysis showed a significant reduction in serum creatinine and urea [24]. These findings were consistent with the Gonella Geetha Meenakshi study, Shekhar S et al study indicating the significant role of haemodialysis in the clearance of urea and creatinine in the blood [8,25]. While in Putra, R. N.et al study, after undergoing haemodialysis therapy, it was found 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 and post HD serum creatinine declined in all [26]. In our study mean value of haemoglobin pre and post HD in average 4 hours of HD was 9.46 mg/dl and 9.21 mg/dl respectively. So mean decrement of haemoglobin was 0.25 mg/dl and was statistically significant. This consistent with Yasir A.H. Hakim et al study which showed 98.5% of patient has reduced haemoglobin concentration after haemodialysis [27]. In our study mean value of sodium pre and post HD 4 hours after HD was 138.77meq/litre and 140.33meq/litre respectively.11 cases were hyponatremic, none of the patients were hypernatremia and after HD serum sodium level was within normal limit in all cases. In the current investigation, the average blood sodium levels of post-dialysis patients were found to be slightly elevated compared to the average level of sodium in the serum of pre-dialysis patients. Seethalakshmi et al. observed that the mean sodium (Na+) concentration in patients after undergoing haemodialysis (138.00 ± 4.41) was higher in comparison to pre-haemodialysis patients (136.87 ± 4.14). [28]. A study by Nauman et al observed that mean serum Na+ post- haemodialysis patients (138.00±4.41) were higher when compared to pre-haemodialysis patients (136.87±4.14)[29]. Similar results shown by the Shekhar study[8]. Whereas Gouri A Gulavani et al found Serum sodium levels in post-haemodialysis patients were lower in comparison with the pre haemodialysis(P Value: 0 573 Not significant)[30]. In our study, total 9 cases were hyperkalaemia, 7 cases were hypokalaemia and after HD serum potassium was within normal limit in all cases.

Mean value of potassium pre and post haemodialysis 4 hour after HD was 4.28meq/litre and 4.35meq/litre respectively. In Liggy Andrew et al study Hypokalaemia (below 3.5mEq/l) was also found, in 28 cases (41.18%) in post-dialysis [31]. The study conducted by Shekhar S et al. demonstrated a substantial decrease in serum potassium levels (P<0.001) among post-dialyzed patients when compared to the mean serum potassium levels of pre-dialyzed patients [8].In the present investigation, the mean values of pre- and post-haemodialysis calcium levels were found to be 8.96 mg/dl & 9.29 mg/dl, respectively. The observed increase in calcium levels was 0.33 mg/dl, and this change was found to be statistically significant. Sekhar et al. (8) and Bhagat et al. (32) observed a notable elevation in serum calcium levels subsequent to the administration of haemodialysis.

Conclusion

Haemodialysis is a lifesaving, affordable and easily accessible renal replacement therapy in both AKI and CKD patients. Haemodialysis results in a notable reduction in blood urea and serum creatinine levels, as well as a substantial rise in serum calcium & sodium concentrations. Additionally, it facilitates the restoration of serum potassium levels. Dyselectrolytemia, whether it is disease-associated or a consequence of dialysis, has immediate as well as long-term consequences, ultimately leading to heightened mortality rates in those undergoing haemodialysis, primarily due to cardiovascular problems. It is important to closely monitor the electrolyte profile for dialysis patients and tailor the treatment to their specific needs.

References

1. Harrison's Principles of Internal Medicine; 21st edition. Loscalzo, Fauci, Kasper, Hauser, Longo, Jameson, volume 2; chapter 312, Dialysis in the treatment of renal failure. Pages 2320 to 2324.
2. Zilva, F., Pannall, P.R. and Mayne, P. Clinical chemistry in diagnosis and treatment, 6th ed., London, Arnold. 1994.
3. Uchida, S. Differential Diagnosis of Chronic Kidney Disease (CKD): By primary diseases. JMAJ, 2011;54(1): 22–26.
4. Flanigan MJ. Role of sodium in hemodialysis. Kidney Int Suppl. 2000; 58 (Suppl 76):S72–S78.
5. Nisha, R., Srinivasa Kannan, S. R., Thanga Mariappan, K., & Jagatha, P. Biochemical evaluation of creatinine and urea in patients with renal failure undergoing hemodialysis. Journal of Clinical Pathology and Laboratory Medicine, 2017;1(2): 1-5.
6. Amin, N., Mahmood, R. T., Asad, M. J., Zafar, M., & Raja, A. M. Evaluating urea and creatinine levels in chronic renal failure pre andpost dialysis: a prospective study. Journal of cardiovascular disease, 2014;2(2): 1-4.
7. Hassen, Hussein Faleh, Makarim Qassim Dawood Al-Lami, and Ali J. Hashim Al-Saedi. Evaluation some Biochemical Levels in Patients undergoing Hemodialysis in Baghdad Governorate. Journal of Advanced Laboratory Research in Biology. 2018;9(2): 50-57.
8. Shekhar S, Singh RR, Sinha R, Tripathy S. Effect of hemodialysis on renal profile in chronic renal failure patients at a tertiary care centre. Int J ClinBiochem Res. 2021; 8: 57-61.
9. Nisha, R., Srinivasa Kannan, S. R., Thanga Mariappan, K., & Jagatha, P. Biochemical evaluation of creatinine and urea in patients with renal failure undergoing hemodialysis. J Clin Path Lab Med, 2017;1.2:1-5.
10. Meenakshi, Gonella Geetha. Effect of dialysis on certain biochemical parameters in chronic renal failure patients. International Journal of Contemporary Medical Research. 2016; 3(10): 2869-2871.
11. Owen WF, Lew NL, Liu Y, Lowrie EG, Lazarus JM. The urea reduction ratio and serum albumin concentration as predictors of mortality in patients undergoing hemodialysis. N. Engl. J. Med. 1993; 329: 1001–1006.
12. Lowrie EG, Lew NL. The urea reduction ratio (URR): a simple method for evaluating hemodialysis treatment. Contemp Dial Nephrol 1991; 12:11-20.
13. Jindal KK, Manuel A, Goldstein MB. Percent reduction in blood urea concentration during hemodialysis (PRU): a simple and accurate method to estimate Kt/V urea. ASAIO Trans 1987; 33:286-288.
14. Daugirdas JT. Bedside formulas for Kt/V: a kinder, gentler approach to urea kinetic modelling. ASAIO Trans 1989; 35:336-338.
15. Basile C, Casino F, Lopez T. Percent reduction in blood urea concentration during dialysis estimates Kt/V in a simple and accurate way. Am J Kidney Dis 1990; 15:40-45.
16. Gotch FA, Sargent JA. A mechanistic analysis of the National Cooperative Dialysis Study (NCDS) Kidney Int. 1985; 28:526–534.
17. Daugirdas JT. Second generation logarithmic estimates of single-pool variable volume Kt/V: An analysis of error. J. Am. Soc. Nephrol. 1993; 4:1205–1213.
18. Daugirdas JT, et al. KDOQI clinical practice guideline for hemodialysis adequacy: 2015 update. Am. J. Kidney Dis. 2015;66:884–930.
19. Peritoneal Dialysis Adequacy 2006 Work Group Clinical practice guidelines for hemodialysis adequacy, update 2006. Am. J. Kidney Dis. 2006; 48:S2–S90.
20. Eknoyan G, et al. Effect of dialysis dose and membrane flux in maintenance hemodialysis. N. Engl. J. Med. 2002; 347:2010–2019.
21. Zemaitis MR, Foris LA, Katta S, Bashir K. Uremia. 2021 Jan.
22. Raghavan R, Eknoyan G. Uremia: A historical reappraisal of what happened. Clin Nephrol. 2018 May. 89 (5):305-313.
23. Piorry PA, Heritier D. Traite des Alterations du Sang. Paris, France: Bury & JB Bailliere; 1840.
24. DeepikaModi, JayeshModi, Premaram Chaudhary, SunitaDinkar, Evaluation of haematological parameters and hemodialysis outcomes in patients with chronic kidney disease from north Gujarat: A prospective study. Trop J Pathol Microbiol. 2021; 7(5):266-271.
25. Gonella Geetha Meenakshi. Effect of dialysis on certain biochemical parameters in chronic renal failure patients. International Journal of Contemporary Medical Research 2016; 3(10):2869-2871.
26. Putra, R. N., Valentine Athania Br Perangin-angin, Sahna Ferdinand, &ErnyTandanu. (2021). Description of Serum Urea and Creatinine Levels Pre-Heodialysis and Post-

Heodialysis at Royal Prima Hospital in Chronic Kidney Disease. Archives of the Medicine and Case Reports, 2(2): 118-122.

27. Yasir A.H. Hakim1, A. A. Abbas1, Adil Khalil2 and Technologist. Hameeda Ibrahim Ahmed Mustafa. The Effect of Hemodialysis on Hemoglobin Concentration, Platelets count and White Blood Cells Count in End Stage Renal Failure. International Journal of Medical Research & Health Sciences, 2016; 5:5:22-35 22
28. Seethalakshmi C, Kodeeswaran D, Chiranjeevi V; Correlation of serum and salivary biochemical parameters in end stage disease patients undergoing hemodialysis in pre and post-dialysis state. Jclindign res. 2014; 8(12):12-14
29. Tarif N, Yamini H, Bakhsh AJ, et al; Electrocardiography and serum potassium before and after hemodialysis sessions. Saudi j kidney dis transpl, 2008; 19(1):47-53.
30. Gouri A, Vinod V, Vimmi Kishore; A comparative study of pre and post-dialysis biochemical parameters in chronic renal failure patients; International Journal of Clinical Biochemistry and Research, 2020;204-206
31. Liggy Andrews1, Bhavisha N. Vegada, Hiteshbharthi Anand Bharti Gosai; Evaluating Levels of Urea, Creatinine and Electrolytes in Patients with Chronic Kidney Failure Pre and Post Dialysis: A Retrospective Analysis; SchInt J Biochem, March 2019; 2(3): 79-82
32. Bhagat, Swati & Bhougal, Badrinath &Chandel, Vijant & Kumari, Rashmi & Bhagat, Shweta & Bali, S & Kashmir, India & Student, P. Effect of Dialysis on Upper Gastrointestinal Symptoms and Endoscopic Findings Along with Biochemical Parameters in Patients of Chronic Renal Failure: A Cross-sectional Study in Tertiary Care Settings in North India. 2018.