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# Study of hematological and coagulation parameters in renal failure patients undergoing hemodialysis

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**Abstract**
**Background and Introduction:** Chronic kidney disease (CKD) is a global public health problem. End-Stage renal disease (ESRD) is the final stage of chronic renal failure where there is a progressive, irreversible deterioration in renal function. Dialysis involves removal of urea and other toxic substances from plasma as well as correction of electrolyte imbalance. Out of the two types of dialysis, hemodialysis (HD) is the most commonly practiced. Changes in hematological parameters are noted both due to CKD and also due to effect of hemodialysis.
**Objectives:** To analyze Complete Blood Count (CBC), coagulation (PT, APTT) and biochemical (urea, creatinine) parameters in hemodialysis patients before and after hemodialysis.
**Material and Methods:** A prospective study was conducted in the Department of Pathology at Subharti Medical College, and associated Chhatrapati Shivaji Subharti Hospital (CSSH), Meerut in IPD patients undergoing Hemodialysis for a period of 2 years. Various hematological, coagulation and biochemical parameters were analyzed pre and post dialysis in 100 patients.
**Results:** It was observed that parameters like RBC count, hemoglobin level, hematocrit, MCV, MCH, APTT showed a significant increase in post dialysis period(p value <0.01),whereas platelet count, serum urea and creatinine decreased significantly following dialysis (p value<0.01). Other parameters like MCHC, TLC, DLC, PT showed no significant difference in pre or post dialysis period.
**Conclusion:** Dialysis causes a visible and significant change in various hematological and biochemical parameters, and to the coagulation profile as well, so it is important for a clinician/nephrologist to keep these factors in mind while dealing with such patients, to know the efficacy and undesirable effects of hemodialysis and further planning the necessary treatment.

**Keywords:** hemodialysis; chronic kidney disease; hematological, coagulation and biochemical parameters

## 1. Introduction
The National Kidney Foundation in India states that, kidney diseases rank 3rd amongst the life-threatening diseases after cancer and heart disease [1]. Renal failure is a situation in which kidney fails to function adequately. There are two forms of renal failure: acute and chronic [2]. Chronic kidney disease (CKD) is a global public health problem, with greater burden and very high cost of care especially in developing countries like India [1].
Chronic kidney disease (CKD) describes abnormal kidney function and/or structure. There is evidence that treatment can prevent or delay the progression of CKD, reduce or prevent the development of complications, and reduce the risk of cardiovascular disease (CVD) [3]. End-Stage renal disease (ESRD) is the final stage of chronic renal failure where there is a progressive, irreversible deterioration in renal function [2].
Kidney failure is defined as a Glomerular Filtration Rate (GFR) of less than 15 ml/minute per 1.73 meter square, or the need for treatment with dialysis or transplantation [4]. Uremia is characterized by very high blood urea and creatinine levels and accumulation of metabolic waste products [5]. ESRD is characterized by a decrease in GFR and evidence of less than 10% nephron function remaining [1]. CRF is a growing problem worldwide leading to increasing incidence of life-threatening complications or death [6].
The mainstay of treatment in this condition is renal replacement therapy which includes both kidney transplantation and dialysis. Kidney transplantation remains the gold standard for the treatment of this condition, but dialysis (Both hemo and peritoneal) is the most common and most practical modality of treatment because of high cost of renal transplantation. Out of the two types of dialysis, hemodialysis (HD) is the most commonly practiced. Changes in

hematological parameters are noted both due to CKD and also due to effect of hemodialysis [6].

Hypotension is the most common acute complication of hemodialysis particularly among patients with diabetes mellitus. Patients with arteriovenous (AV) fistulas and grafts may develop high-output cardiac failure due to shunting of blood through the dialysis access; on rare occasions, this may necessitate ligation of fistula or graft. Muscle cramps during dialysis are also a common complication. Strategies that may be used to prevent cramps include reducing volume removal during dialysis, ultra-filtration profiling and the use of sodium modeling [7]. Patients undergoing chronic hemodialysis treatment represent a high risk group for thromboembolic complications [8]. The objective of this study is to assess the clinic pathological correlation in patients undergoing hemodialysis and to study the effect of dialysis on coagulation and hematological parameters in post-dialysis patients.

## 2. Material and Methods

A prospective study was conducted from August 2016 to July 2018 in the Department of Pathology at Subharti Medical College, and associated Chhatrapati Shivaji Subharti Hospital (CSSH), Meerut in 100 IPD patients undergoing hemodialysis before and after dialysis sessions and received in the laboratory for hematological and biochemical parameters.

### Inclusion criteria

All patients who came for hemodialysis in the dialysis unit were included in the study.

### Exclusion criteria

Patients with chronic liver disease (CLD), hemorrhagic disorder and patients on oral anticoagulants were excluded from the study.

Detailed clinical data was recorded including history and physical examination of the patient.

Data were analysed to assess any correlation between changes in hematological parameters and biochemical parameters.

All the statistical analysis was done by using S.P.S.S. (statistical package for social sciences) software version 22.0.

All the values of different hematological parameters under study for pre & post hemodialysis observations were expressed in terms of mean & standard deviation respectively. Also the difference between pre & post hemodialysis values for different hematological parameters was expressed. The significant difference between pre-HD and post-HD was calculated by Paired "t" test at 0.01 level of significance. P value<0.01.was considered indicative of statistically significant difference.

## 3. Results

A total of 100 cases of renal failure who underwent hemodialysis, were enrolled for the study. Among the study population, 59(59%) of the patients were males and 41(41%) of the patients were females. The maximum number of patients were from the age group category 41-60 years as shown in Table 1.

**Table 1:** Age wise distribution of hemodialysis patients

| Age (year) | Total no. |
|---|---|
| 0-20 | 02 |
| 21- 40 | 30 |
| 41-60 | 47 |
| >60 | 21 |
| Total | 100 |

### Primary cause of ESRD leading to dialysis

The most common primary etiology for ESRD leading to dialysis was patient suffering from both diabetes and hypertension accounting for 35%, followed by hypertension alone being 26% and diabetes mellitus alone being 20%. (Table 2).

**Table 2:** Primary cause of ESRD leading to dialysis

| Primary cause | No. of patients | % of patient |
|---|---|---|
| Diabetes with hypertension | 35 | 35 |
| Hypertension | 26 | 26 |
| Diabetes | 20 | 20 |
| Drug intake | 08 | 08 |
| Kidney stone | 06 | 06 |
| Chronic Glomerulonephritis | 03 | 03 |
| Polycystic Kidney Disease(PKD) | 02 | 02 |

### Erythrocytes: Pre-hemodialysis v/s Post-hemodialysis

The difference between the mean of RBC count, Hb, Hct, MCV, MCH and MCHC in renal failure patients pre and post-HD sessions was calculated as shown in Table 3. RBC count, Hb, Hct, MCV and MCH showed a statistically significant increase in values post-HD ($p<0.01$) while MCHC did not show any significant difference in values post-HD as shown in Table 3.

**Table 3:** Difference between mean of RBCs, Hb, Hct, MCV, MCH, MCHC in renal failure patients pre and post hemodialysis

| S. No. | Parameters | Pre-HD Values | Post-HD Values | Difference | P-value |
|---|---|---|---|---|---|
| 1 | RBCs $x10^{6}/\mu l$ | 3.05±.82 | 3.33±.84 | 0.279±0.78 | 0.0006 P<0.01 (Significant) |
| 2 | Hb (g/dl) | 8.91±2.45 | 9.64±2.34 | 0.728±2.19 | 0.0013 P<0.01 (Significant) |
| 3 | Hct (%) | 27.48±7.14 | 29.5±6.77 | 2.037±6.65 | 0.0028 P<0.01 (Significant) |
| 4 | MCV (fl) | 89.92±8.43 | 91.74±8.19 | 1.82±4.39 | 0.0000 P<0.01 (Significant) |
| 5 | MCH (pg) | 29.06±2.98 | 29.52±2.71 | 0.46±1.274 | 0.0005 P<0.01 (Significant) |
| 6 | MCHC (g/dl) | 32.03±1.31 | 32.29±1.24 | 0.241±1.311 | 0.0690 P>0.01(Not Significant) |

### Red Cell Morphology

In the present study, all patients were divided into 4 groups namely normocytic normochromic, microcytic hypochromic, macrocytic and dimorphic as shown in Table 4.

**Table 4:** Showing type of anemia in renal failure patients pre and post hemodialysis

| Type of Anemia | Pre-HD | Post-HD |
|---|---|---|
| Normocytic Normochromic Anemia | 69% | 66% |
| Dimorphic Anemia | 12% | 14% |
| Macrocytic Anemia | 06% | 06% |
| Microcytic Hypochromic Anemia | 02% | 01% |

**Leukocytes and differential count: pre-hemodialysis v/s post-hemodialysis**

The differences between the mean of total leucocytes count and differential counts in renal failure patients pre and post-HD sessions were calculated as shown in Table 5.

**Table 5:** Difference between mean of leukocytes and differential counts in renal failure patient's pre and post hemodialysis

| S. No. | Parameters | Pre-Hd Values | Post-HD Values | Difference | P-Value |
|---|---|---|---|---|---|
| 1. | TLC(WBCs) $x10^3/\mu l$ | 13.85±9.41 | 15.19±8.83 | 1.34±5.55 | 0.0175 p>0.01(Not Significant) |
| 2. | NEUTROPHIL $x\ 10^3/\mu l$ | 80.83±8.11 | 81.71±8.18 | 0.88±6.70 | 0.1919 p>0.01 (Not Significant) |
| 3. | LYMPHOCYTE $x10^3/\mu l$ | 16.85±7.08 | 16.16±7.43 | -0.69±5.41 | 0.2050 p>0.01 (Not Significant) |
| 4. | MONOCYTE $x10^3/\mu l$ | 0.06±0.278 | 0.12±0.477 | 0.06±0.49 | 0.2224 p>0.01 (Not Significant) |
| 5. | EOSINOPHIL $x10^3/\mu l$ | 2.16±2.04 | 1.79±1.52 | -0.37±1.94 | 0.0596 p>0.01 (Not Significant) |
| 6. | BASOPHIL $x10^3/\mu l$ | 0±0 | 0±0 | 0±0 | ------- |

**Platelet count and coagulation profile (PT, APTT): Pre-hemodialysis v/s Post-hemodialysis**

The differences between the mean of platelet count and coagulation profile (PT, APTT) that occurred in renal failure patients pre and post-HD sessions were calculated as shown in Table 6. The platelets count showed statistically significant decrease post-HD when compared to that of the pre-HD. The APTT levels increased significantly post-HD when compared to the pre-HD levels. The PT levels on the other hand did not show any statistically significant difference post-HD when compared to the pre-HD levels.

**Table 6:** Difference between mean of platelet counts and coagulation profile (PT, APTT) in renal failure patients pre and post hemodialysis

| S. No. | Parameters | Pre-HD Values | Post-HD Values | Difference | P-Value |
|---|---|---|---|---|---|
| 1. | PLT $x\ 10^3/\mu l$ | 234.1±84.39 | 202.71±73.45 | -31.38±58.174 | 0.0000 p <0.01 (Significant) |
| 2. | PT (second) | 14.38±5.54 | 14.72±4.62 | 0.343±3.51 | 0.3306 p >0.01 (Not Significant) |
| 3. | APTT (second) | 33.39±13.61 | 38.36±14.97 | 4.96±10.39 | 0.0000 p<0.01 (Significant) |

**Urea and creatinine: pre-hemodialysis v/s post-hemodialysis**

The differences between the mean of blood urea and creatinine levels that occurred in renal failure patients pre and post-HD sessions were calculated as shown in Table 7.Both urea and creatinine showed statistically significant decrease in post-HD patients with p-value<0.01 as shown in Table 7.

**Table 7:** Difference between mean of urea and creatinine in renal failure patient's pre and post hemodialysis

| No. | Parameters | Pre-HD Values | Post-HD Values | Difference | P-Value |
|---|---|---|---|---|---|
| 1. | Urea | 212.08±77.99 | 104±45.31 | 108.09±47.39 | 0.0000 P<0.01 (Significant) |
| 2. | Creatinine | 8.72±3.97 | 5.04±3.22 | 3.69±1.58 | 0.0000 P<0.01 (Significant) |

## 4. Discussion

The results of our study show that the patients with renal failure on hemodialysis display various degrees of changes of hematological, coagulation and biochemical parameters.

In our study, a male predominance was noted with male patients being 59% and female patients being 41%.The maximum number of the patients in our study belonged to the age group category of 41-60 yrs (47%) followed by 21-40 yrs(30%). Similar observation was reported by Habib A, Ahmad R and Rehman S [1].

The most common primary etiology for ESRD heading to dialysis in our study were patient suffering from both diabetes and hypertension (38%) followed by hypertension alone (23%) and diabetes mellitus alone (20%). Similar observations were reported by HabibA, Ahmad R and Rehman S[1], Bhattacharjee K *et al* [9].

**Red blood cell (RBC) and Its Indices**

The mean of each of RBC count, Hb, Hct, MCV,MCH as measured in our study show a statistically significant (p<0.01) increase in renal failure patients post-HD as compared to pre-HD. There was no statistically significant change between mean of MCHC pre and post-HD. The increase of each RBC counts, Hb, Hct levels post-HD can be attributed to the fact that before HD, patients are usually hypervolemic and that's why the values of each RBC count, Hb and Hct levels are also lower [2]. Similar results were observed by Alghythan AK and Alsaeed AH [2]. Pereira R *et al* [10] also observed increase in HB, HCT, RBC count post-HD though they showed decrease in MCV and no change in MCH. Studies reported by Mohammad DK [11] and Butt ML *et al* [12] have also reported increase in HB, HCT and RBC count post-HD in renal failure patients. It was hypothesized that the HB values were significantly higher after hemodialysis sessions as compared to pre-dialysis as a result of ultrafiltration of plasma volume during dialysis [13].

In our study, the peripheral blood smear examination showed that the normocytic normochromic anemia was the most frequent (69% in pre-HD and 66% in post-HD) followed by dimorphic (12% in pre-HD and 14% in post-HD), macrocytic (6% in both pre-HD and post-HD) and microcytic (2 % in pre-HD and 1 % in post-HD**).**Similar result was reported by Bhatta S, Aryal G and Kafle RK [14].

**Leucocytes and Differential Counts**

In our study, there were statistically insignificant differences between the total leukocyte and differential counts (neutrophil count, lymphocyte count, monocyte count, eosinophil count, basophil count) in renal failure patients post-HD when compared to pre-HD. Similar observation was reported by Pariera R *et al* [10] though they showed that monocyte and eosinophil counts significantly decreased.

**Platelets and coagulation profile (PT, APTT)**

In our study, there was a significant decrease in the mean platelet counts of renal failure patients post-HD when

compared to pre-HD counts. Similar observation was reported by Yenicerioglu Y [15], Alghythan AK and Alsaeed AH[2], Algader AABD [16] and Khan MZ [17]. The decrease in platelet counts post-HD may be due to either the HD procedure through the interaction of blood with membranes that may activate complement or from heparin (used as anticoagulant to inhibit clotting) that may occasionally induce thrombocytopenia through immunological mechanism [18].

In our study, APTT was significantly increased in renal failure patient's post-HD when compared to pre-HD levels while there was insignificant difference in PT levels pre and post-HD. Similar results were reported by Sana EA and Emad MA 8 [8] in 2014.

**Urea and Creatinine**

The present study shows a significant decrease in the urea and creatinine values post-HD compared to pre-HD values. Similar results were reported by Amin NU *et al* [19] in 2014, Meenakshi GG [20] in 2016. Hemodialysis is one of the renal replacement therapy during which body waste product like urea and creatinine and free water are removed from the blood when the kidneys are impaired [19].

After comparing our findings with available literature, we conclude that:

1. Haemostasis disturbance is a common complication in CKD.[5] Abnormal hemostasis in CRF is characterized by tendency of abnormal bleeding and bruising [1].
2. Anemia is a common and often early complication of CKD. In addition to anemia, patients with CRF are more prone to develop infections and hemorrhagic diathesis. Most common type of anemia in CKD patients is normocytic normochromic type [14].
3. Globally the dialysis monitoring strategy is principally based on measurement of hematological parameters before and after each session of dialysis. Thus, monitoring various hematological parameters, especially before dialysis, may help in preventing complications and consequently mortality rate [21].
4. Marked elevation of APTT is usually suggestive of bleeding and thrombosis tendency. Thus, monitoring of coagulation parameters may help in determining the risk of development of bleeding complications and the consequent increasing morbidity rate 6 [6].

Patients undergoing chronic hemodialysis treatment represent high risk group for thromboembolic complications [8].

## 5. Conclusion

Dialysis causes a visible and significant change in various hematological and biochemical parameters, and to the coagulation profile as well, so it is important for a clinician/nephrologist to keep these factors in mind while dealing with such patients, to know the efficacy and adverse effects of hemodialysis and further planning the necessary treatment.

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