International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Assessment of Red Blood Cell Indices, White Blood Cells, Platelet Indices and Procalcitonin of Chronic Kidney Disease Patients under Hemodialysis

Mohammad Asaduzzaman[1], Asmini Shobnam[1], Md. Farukuzzaman[1], Abdul Gaffar[1], Farha Matin Juliana[2], Tanima Sharker[3], Khokon Kumar Dutta[4], Mohammod Johirul Islam[5]

[1]Department of Biochemistry, Primeasia University, Banani, Dhaka, Bangladesh
[2]Department of Biochemistry and Molecular Biochemistry, Jahangirnagar University, Savar, Dhaka, Bangladesh
[3]Department of Biochemistry and Molecular Biology, Noakhali Science and Technology University, Noakhali, Bangladesh
[4]Department of Biochemistry and Molecular Biology, Bangabandhu Sheikh Mujibur Rahman Science & Technology University, Gopalganj, Bangladesh
[5]Department of Biochemistry and Molecular Biology, Mawlana Bhashani Science & Technology University, Tangail, Bangladesh

Corresponding Author: Mohammad Asaduzzaman

ABSTRACT

Introduction: This study aimed to detect the effects of renal HD on some blood parameters in CKD patients using RBC indices (T-RBC, Hb, MCV, MCH, HCT/PCV), WBC (T-WBC, Neutrophil, Eosinophil, Lymphocytes, Monocytes) and Platelet indices (Platelet, MPV, PDW).
Methods: The patients were divided into two groups according to their sex. Most of the patients were above 40 years. For male highest number of patients found in the 60-70 years age group and then 50-60, 70-80 years age group. For female highest number of patients found in the 60-70 years age group and then 40-50 years age group. Seventy six chronic renal failure patients under HD attending Dhaka International Hospital, Bangladesh were selected for this study. A specimen of 2.5 ml of blood was collected from each patient in EDTA container. Automated hematological analyzer (Sysmex XT-2000i) was used to measure the parameters. Data were analyzed statistically by using IBM SPSS Statistics, version 18.
Results: Percentile results showed highly decrease in RBC count, Hb content, HCT and lymphocytes count 83.46%, 91.50%, 93.40% and 76.17% of the respondents consecutively, moderately decrease in PCT level and it was 40.20%, lightly decrease in eosinophils 19.93%, platelets 6.28% of the subjects. RDW for 83.90%, neutrophils for 78.61%, PCT for 49.29%, T-WBC for 48.73% respondents found with increased level. Monocytes, platelet, MPV and PDW found standard for 96.34%, 87.18%, 92.52% and 91.10% of the dialysis patients consecutively.
Conclusion: In conclusion CKD patients under HD are at risk of anemia, thrombocytopenia, septicemia, bacteremia and inflammatory tendency.

Key Words: HD, RBC Indices, WBC, Platelet Indices, CKD

I. INTRODUCTION

Kidney Failure

Kidney failure, also known as end-stage kidney disease (ESKD), is a medical condition in which the kidneys no longer work to filter wastes and water from blood. It is divided into acute kidney failure (cases that develop rapidly) and chronic kidney

disease (CKD) (those that are long term). Symptoms may include leg swelling, feeling tired, vomiting, loss of appetite, or confusion. Complications of acute disease may include uremia, high blood potassium, or volume overload. Complications of chronic disease may include heart disease, high blood pressure, or anemia. [(1)]

Hemodialysis (HD)

HD is a treatment to filter wastes and water from blood, as kidneys did when they were healthy. HD helps control blood pressure and balance important minerals, such as potassium, sodium, and calcium, in your blood. HD can help to feel better and live longer, but it's not a cure for kidney failure. [(2)]

Total Red Blood Cell (T-RBC)

Shortening of RBC survival contributes to the anemia of CKD. The toxic uremic environment accounts for the decreased RBC life span. The contribution of mechanical damage caused by HD to the shortened life span is unclear. Reductions up to 70% in T-RBC survival have been reported in uremic patients. [(3)]

Hemoglobin (Hb)

Naturally occurring high Hb levels are safe for kidney disease patients on HD, according to a study appearing in an upcoming issue of the Journal of the American Society Nephrology (JASN). The results suggest that there is no need to lower these levels to protect patients' health. [(4)]

The vast majority of individuals who develop advanced CKD also develop progressive anemia, or RBC deficiency, that must be treated with medication. Prior to the approval of such erythropoiesis-stimulating agents in 1989, many dialysis patients maintained Hb concentrations < 10 g/dl, with attendant fatigue and the need for repeated blood transfusions. Treatment is controversial, though, because correcting CKD patients' anemia so their target level of Hb, which carries oxygen, is towards the normal range of ~14 g/dl may lead to serious thrombotic complications or even increased risk of death. Researchers have wondered: are dialysis patients whose Hb levels remain high naturally also at risk? studying these patients provides a natural opportunity to investigate the clinical outcomes associated with higher Hb concentrations in the absence of effects of prescribed drugs. [(4)]

David Goodkin, MD (Arbor Research Collaborative for Health) and his colleagues studied the health of patients enrolled in the Dialysis Outcomes and Practice Patterns Study (DOPPS), which follows thousands of dialysis patients in 12 countries. Of 29,796 dialysis patients enrolled in the DOPPS with information on Hb levels and medication dose over a 4 month period, 545 (1.8%) maintained Hb concentrations >12 g/dL without medication to stimulate RBC production by the bone marrow. [(4)]

These patients were more likely to be men, to have been receiving dialysis for more years, and to have underlying cystic kidney disease. Conditions that lower oxygen levels in the blood, such as lung disease, cardiovascular disease, and smoking, were also associated with an increased likelihood of manifesting higher hemoglobin concentrations. The investigators discovered that these patients did not have an elevated risk of dying compared with patients who had lower Hb levels, after adjusting for age, sex, and concomitant diagnoses. Also, there were no differences in mortality between these patients and the subset of other patients who were taking medications to achieve Hb concentrations >12 g/dL. [(4)]

While current guidelines caution against prescribing drugs to achieve Hb concentrations >12 g/dL in kidney disease patients, these findings suggest there is no need to remove blood, or phlebotomize, patients whose Hb levels naturally reach this level without medication. The authors added that "determining the appropriate Hb target range and pharmacological management strategy for dialysis patients is a very complex endeavor and the solution remains a work in progress." [(4)]

MCV, MCH, HCT/PCV

Intradialytic hypotension remains the commonest complication for outpatient HD. The majority of relative blood volume (RBV) monitoring techniques monitor changes in hematocrit (hematocrit or HCT and other name packed cell volume or PCV is defined as the volume percentage of RBCs in Blood). As HCT can potentially be affected by changes in RBC size and hemolysis John B et al. studied the change in RBC size (Mean corpuscular volume, MCV) during HD and hemolysis. [(5)]

CKD has evolved as a silent killer if not managed in its early stage. HD influences the transport of water through the erythrocyte membrane and induces morphologic and functional modifications. HD is one of the most popular form of renal replacement therapy. Considering the nature of HD process we designed the present cross-sectional, comparative study to observe the effects of HD on RBC indices and HCT/PCV in CKD patients of both sexes and to compare the changes in pre-dialysis and postdialysis blood samples. In the light of results of study of Mohammed NUC et al. it can be concluded that significant changes in MCV (MCV is the average mass of hemoglobin per red blood cell in a sample of blood) and MCHC (MCHC stands for mean corpuscular hemoglobin concentration. It's a measure of the average concentration of Hb inside a single RBC) occurs in patients during HD process in their post-dialysis blood samples along with no significant changes in MCH (The mean corpuscular hemoglobin (MCH), or "mean cell Hb" (MCH), is the average mass of Hb per RBC in a sample of blood) and HCT/PCV and all these findings are consistent with each other. [(6)]

Total White Blood Cell (T-WBC)

The Total white Blood cell (TWBC) count had been reported to be high in cases of acute renal failure and high or normal in cases of CKD; neutrophil leucocytosis and lymphopenia is common to both. The cause of lymphopenia in uraemia is obscure, as is also neutrophil leucocytosis in the absence of infection. It may be that substances retained in the body because of renal failure depress lymphopoiesis and stimulate granulopoiesis, though the identity of such substances is unknown. Little is known of the behavior of the white cells in patients on regular HD, where uraemia is well controlled, though infections are common in such patients. [(7)]

WBC: Neutrophil

Patients undergoing HD manifest marked temporary neutropenia occurring 2 to 15 minutes after the start of HD, followed by an increase in band neutrophils. Total leukocyte counts return to near normal levels approximately one hour later. The phenomenon is not due to simple filtration of leukocytes by the dialyzer nor to heparin sodium administration, and is independent of the administration set or the infusion pump mechanism. Rebound leukocytosis is not observed, and the neutropenia is unaccompanied by chills, fever, or other symptoms usually associated with intravenous infusions of pyrogenic substances. [(8)]

WBC: Eosinophil

Michael F *et al*. showed that thirteen percent of 99 patients undergoing maintenance HD showed an increased predialysis peripheral blood eosinophil count (mean value of 828cells/mm3, range 410-2, 710). Patients with eosinophilia were predominantly male and evidenced more frequent elevation of total plasma IgE levels. Otherwise, no differences were found between patients with and without eosinophilia. [(9)]

WBC: Lymphocytes

Lymphopenia of a group of uremic patients was associated with normal percentages of T cells but reduced percentages of B cells. Lymphocyte counts improved after a period of maintenance HD, although not to control levels, and B cell percentages returned towards normal. Uremia is therefore associated with depression of total T and B cell numbers, with a relatively more pronounced effect on B cells. A period of maintenance HD produces increase in numbers of both cell

types and depression becomes nonselective. [10]

WBC: Monocytes

Infections are frequent complications in end-stage renal failure patients undergoing HD, and peripheral blood monocytes are important cells in host defense against infections. [23] An increase in WBC count is an independent predictor of mortality in HD patients. However, few studies have assessed the association of specific WBC subtypes with mortality. In contrast, neutrophil and lymphocyte counts were not associated with mortality. Kato A *et al.* suggest that an increased blood monocyte count is an independent predictor of long-term mortality in chronic HD patients. [11]

Platelet

Typically, the platelet count decreases slightly during the first hour of dialysis, but mostly returns to initial values by the end of dialysis. A number of chronic HD patient cases have been reported in which a marked decrease in platelet count (50% or more) during dialysis was observed, resulting in mild degrees of predialysis thrombocytopenia. [12]

Mean platelet volume (MPV)

MPV is a machine-calculated measurement of the average size of platelets found in blood and is typically included in blood tests as part of the complete blood count (CBC). Since the average platelet size is larger when the body is producing increased numbers of platelets, the MPV test results can be used to make inferences about platelet production in bone marrow or platelet destruction problems. MPV is higher when there is destruction of platelets. [13]

Platelet Distribution Width (PDW)

Platelet indices are potentially useful markers for the early diagnosis of thromboembolic diseases (formation in a blood vessel of a clot (thrombus) that breaks loose and is carried by the blood stream to plug another vessel. [18] An increase in both MPV and PDW due to platelet activation, resulting from platelet swelling and pseudopodia formation was hypothesized. [14]

Abnormalities in platelet parameters like mean MPV, PDW, platelet count, plateletcrit and platelet large cell ratio (PLCR) are studied extensively in patients with coronary artery disease (CAD) and CVD, both in general population as well as patients with risk factors like diabetes mellitus (DM), hypertension and CKD. The abnormal values are associated with increased risk of thrombotic events among patients with above said risk factors. HD patients behave in a distinct way where they tend to develop higher bleeding manifestations than thrombotic complications when compared to other high risk patients. [15]

Procalcitonin (PCT)

PCT is the precursor of calcitonin, is a new diagnostic parameter for infections. There is evidence for PCT being a more specific parameter indicating systemic bacterial and fungal infections than the nonspecific acute-phase markers C-reactive protein (CRP) or apoferritin. Experimental data and clinical observations have shown that the main stimuli for PCT release are bacterial endotoxins and proinflammatory cytokines as seen in septicemia and bacteremia. Both uremia and bioincompatibility of HD result in a chronic systemic inflammatory syndrome. [16] In this study our aim is to find out the effect of HD on RBC indices, WBC, platelet indices and PCT.

II. MATERIALS AND METHODS

Materials

Location: Dhaka International Hospital, Bangladesh.

Study Population: 76 HD patients.

Study Time: May 2017 to May 2018.

Samples: Whole blood from participants is drawn by venipuncture into dipotassium ethylenediamine-tetraacetate (K2-EDTA)-containing evacuated Vacutainer tubes (Becton Dickinson, Franklin Lakes, NJ) after informed consent was obtained. Samples were packaged according to CDC

guidelines and transported by courier in insulated containers to this CLIA-certified laboratory. Most samples are delivered within 4 hours of collection. Samples held overnight before delivery are kept at room temperature (65-76°F). [17]

Methods

RBC (indices), WBC, Platelet (indices) test method:

The Sysmex XT-2000i uses the electric resistance detecting method (impedance technology) with hydro dynamic focusing to measure RBC, PLT, MPV, MCV write out on first reference, and HCT. Fluorescence flow cytometry is used to measure WBC, Diff, the optical PLT count, and the reticulocyte count. The system employs a 633nm semi-conductor laser for flow cytometry analysis. For the measurement by flow cytometry of the proportional count, expressed as percent of the total WBC, of neutrophils (NEUT), lymphocytes (LYMPH), monocytes (MONO), and eosinophils (EOS), white cells are stained with fluorescent dyes that bind to both DNA and RNA. Side Scatter (SSC) is employed to determine the internal complexity of the cell-the size, shape, and density of the nucleus and granules of the cell. Fluorescence and scatter measurements are combined to characterize white cell populations. Basophils (BASO) are measured separately using cell size and SSC properties. Hb is measured photocolorimetrically using SLS-HGB, a cyanide-free method. [17]

The reagents required for the operation of the Sysmex XT-2000i are supplied by Sysmex America (Mundelein, IL) and are listed as follows: [17]

Reagent[17]	**Function**[17]
Cellpack	RBC/PLT and Hb Diluent; rinsing of instrument; hydrodynamic focusing
Stromatolyser-4DL	Diff lysing reagent
Stromatolyser-4DS	Diff stain
Stromatolyser-FB	Diluent for WBC count and lyses all cells except BASO
Sulfolyser	Non-cyanide Hb lyse (sodium lauryl sulphate)
Ret-Search (II)	Dilutes sample for reticulocyte analysis
Ret-Search (II) Dye	Stains reticulocytes and platelets for analysis

HCT and MCV are direct measurements on the Sysmex XT-2000i. The MCV is an average of all RBC size measurements collected in the impedance counter. The HCT is the sum of all the RBC size measurements and reported in proportion to the total volume of the analysis sample. Calculated red cell indices are MCH write out first reference, MCHC write out first reference, and RDW. RDW is reported on the Sysmex XT as both standard deviation from the mean red cell size (RDW-SD) and as coefficient of variation from the mean (RDW-CV). [17]

The Sysmex XT-2000i provides 2 PLT counts. One is an impedance count that both enumerates the platelets (I-PLT) and estimates MPV. The other is an optional optical count obtained in 1 of the flow analysis channels (O-PLT). The instrument also performs an optional reticulocyte count in 1 of the flow analysis channels. RBCs are stained, counted, and measured for size and fluorescence. Counts are expressed as percent of RBC (RET%). [17]

This laboratory operates under Clinical Laboratory Improvement Act (CLIA) certification. Calibration of the instrument is confirmed each day using 2 levels of controls (Sysmex e-Check Hematology Control for Sysmex X-Series Analyzers, Sysmex America), according to the manufacturer's recommendations. These recommendations are consistent with CLIA Interpretive Guidelines 493.1256(a)-(c) and 493.1256(d), Standard: Control procedures. Repeated analysis of a sample obtained from a healthy donor is used daily to confirm instrument precision, as per CLIA

Interpretive Guideline 493.1253(b) (1) (i) (B), Precision (Reproducibility). [17]

Statistical Analysis

Data were assessed using the Statistical Package for Social Science (IBM SPSS Statistics, version 18, IBM Corporation, SPSS Inc. Chicago, III, USA) and Microsoft Office Excel 2007.

The Chi-Square statistic is most commonly used to evaluate Tests of Independence when using a cross tabulation. It presents the distributions of two categorical variables simultaneously, with the intersections of the categories of the variables appearing in the cells of the table. The Test of Independence assesses whether an association exists between the two variables by comparing the observed pattern of responses in the cells to the pattern that would be expected if the variables were truly independent of each other. Calculating the Chi-Square statistic and comparing it against a critical value from the Chi-Square distribution allows the researcher to assess whether the observed cell counts are significantly different from the expected cell counts. The Chi-Square statistic appears as an option when requesting a cross tabulation in SPSS. The output is labeled Chi-Square Tests; the Chi-Square statistic used in the Test of Independence is labeled Pearson Chi-Square. It is easier to simply examine the p-value provided by SPSS. To make a conclusion about the hypothesis with 95% confidence, the value labeled Asymp. Sig. (which is the p-value of the Chi-Square statistic) should be less than 0.05 (which is the alpha level associated with a 95% confidence level).

If p-value is less than 0.05 than we can conclude that the variables are not independent of each other and that there is a statistical relationship between the categorical variables.

III. RESULTS

In this study 76 HD patients participated and among them 41 participants were male and 35 patients were female. In the male subjects 2.44% (1) were in the 10-20 years age group. 9.76% (4), 0.00% (0), 9.76% (4), 21.95% (9), 29.27% (12), 21.95% (9) and 4.88% (2) male participants were in the 20-30, 30-40, 40-50, 50-60, 60-70, 70-80 and 80-90 years age group consecutively. In the female subjects 5.71% (2) were in the 10-20years age group. 2.86% (1), 8.57% (3), 25.71% (9), 11.43% (4), 37.14% (13), 5.71% (2) and 3.95% (3) female participants were in the 20-30, 30-40, 40-50, 50-60, 60-70, 70-80 and 80-90 years age group consecutively. For male highest number of patients found in the 60-70 years age group and then 50-60, 70-80 years age group. For female highest number of patients found in the 60-70 years age group and then 40-50 years age group (Table-1).

Table-1: Distribution of dialysis patients among different age and sex groups (n=76)

Age (Years)	Sex				Total	%
	Male	%	Female	%		
10-20	1	2.44	2	5.71	3	3.95
20-30	4	9.76	1	2.86	5	6.58
30-40	0	0.00	3	8.57	3	3.95
40-50	4	9.76	9	25.71	13	17.11
50-60	9	21.95	4	11.43	13	17.11
60-70	12	29.27	13	37.14	25	32.89
70-80	9	21.95	2	5.71	11	14.47
80-90	2	4.88	1	2.86	3	3.95
Total	41	100.00	35	100.00	76	100.00

Among the male subjects 87.50% (35) were with less than standard RBC count, 7.50% (3) with standard and 5.00% (2) with above the standard count. Scenario was same for female subjects. 79.41% (27) with less than the standard count; and 20.59% (7) with standard and 0.00% (0) with above the standard count (Table-2). P-value for male=0.395 and for female=0.140.

In respect of the male subjects 87.80% (36) were with less than standard Hb content, 9.76% (4) with standard and 2.44% (1) with above the standard content. Scenario was same for female subjects. 94.29% (33) with less than the standard content; and 5.71% (2) with standard and 0.00% (0) with above the standard content (Table-3). P-value for male=0.310 and for female=0.190.

Table-2: RBC count between different sex of the dialysis patients (Male=40, Female=34)

RBC (millions/µL)		Male	%	RBC (millions/µL)		Female	%	Average %
Below	4.5	35	87.50	Below	4	27	79.41	83.46
Standard	4.5-5.5	3	7.50	Standard	4-5	7	20.59	14.05
Above	5.5	2	5.00	Above	5	0	0.00	2.50

Table-3: Hb content between different sex of the dialysis patients (Male=41, Female=35)

Hb (grams/dL)		Male	Percentage	Hb (grams/dL)		Female	Percentage	Average %
Below	13	36	87.80%	Below	12	33	94.29%	91.05
Standard	13-17	4	9.76%	Standard	12-15	2	5.71%	7.74
Above	17	1	2.44%	Above	15	0	0.00%	1.22

MCV was measured for both types of sex group. Here standard range for both the sexes are same and is 79-96 femtoliters/cell. For male 70.00% and female 71.43% subjects were in standard range; 27.50% male and 28.57% female were in the below the standard range (Table-4). P-value for MCV=0.641.

Table-4: MCV of RBC between different sex group of the dialysis patients (Male=40, Female=35)

MCV (femtoliters/cell)		Male	Percentage	MCV (femtoliters/cell)		Female	Percentage	Average %
Below	79	11	27.50%	Below	79	10	28.57%	28.04
Standard	79-96	28	70.00%	Standard	79-96	25	71.43%	70.72
Above	96	1	2.50%	Above	96	0	0.00%	1.25

The MCH is the average mass of Hb per RBC in a sample of blood. It is reported as part of a standard complete blood count. MCH value is diminished in hypochromic anemias. MCH was measured for both types of sex group. Here standard range for both the sexes are same and is 27-32 picograms/cell. For male 67.50% and female 54.29% subjects were in standard range; 32.50% male and 40.00% female were in the below the standard range (Table-5). P-value for MCH=0.641.

Table-5: MCH content of RBC between different sex group of the dialysis patients (Male=40, Female=35)

MCH (picograms/cell)		Male	Percentage	MCH (picograms/cell)		Female	Percentage	Average %
Below	27	13	32.50%	Below	27	14	40.00%	36.25
Standard	27-32	27	67.50%	Standard	27-32	19	54.29%	60.90
Above	32	0	0.00%	Above	32	2	5.71%	2.86

The HCT, also known by several other names such packed cell volume (PCV), is the volume percentage of red blood cells in blood. It is normally 40-54% for men and 37-47% for women. For male 92.50% and female 94.29% subjects were in below the standard range; 7.50% male and 5.71% female were in the standard range (Table-6). P-value for HCT/PCV, male=0.641 and female=0.497.

Table-6: HCT/PCV Percentage between different sex of the dialysis patients (Male=40, Female=35)

HCT/PCV (%)		Male	Percentage	HCT/PCV (%)		Female	Percentage	Average %
Below	40	37	92.50%	Below	37	33	94.29%	93.40
Standard	40-54	3	7.50%	Standard	37-47	2	5.71%	6.61
Above	54	0	0.00%	Above	47	0	0.00%	0.00

RDW is a measure of the range of variation of RBC volume that is reported as part of a standard complete blood count.

Both male and female subjects showed that their RDW were maximum for beyond the standard range and 82.50% and

85.29% respectively (Table-7). P-value for RDW=0.641.

Table-7: RDW Percentage between different sex of the dialysis patients (Male=40, Female=34)

RDW (%)		Male	Percentage	RDW (%)		Female	Percentage	Average %
Below	11.6	0	0.00%	Below	11.6	0	0.00%	0.00
Standard	11.6-14	7	17.50%	Standard	11.6-14	5	14.71%	16.11
Above	14	33	82.50%	Above	14	29	85.29%	83.90

How many WBCs someone has varies, but the normal range is usually between 4,000 and 11,000 per microliter of blood. A blood test that shows a WBC count of less than 4,000 per microliter (some labs say less than 4,500) could mean your body may not be able to fight infection the way it should. Among the male participants 48.00% were counted with standard range and 52.00% were with above the standard range. 45.45% female subjects WBC count found within the standard range, 45.45% were with above the standard count and 9.09% found with less than 4000cells/μL (Table-8). P-value for total WBC=0.302.

Table-8: T-WBC count between different sex group of the dialysis patients (Male=25, Female=22)

T-WBC (Cells/μL)		Male	Percentage	TWBC (Cells/μL)		Female	Percentage	Average %
Below	4500	0	0.00%	Below	4500	2	9.09%	4.55
Standard	4500-11000	12	48.00%	Standard	4500-11000	10	45.45%	46.73
Above	11000	13	52.00%	Above	11000	10	45.45%	48.73

Neutrophils count is derived by multiplying the WBC count times the percent of neutrophils in the differential WBC count. The percent of neutrophils consists of the segmented (fully mature) neutrophils) + the bands (almost mature neutrophils). The normal range is 40-75% of the WBC. Both male and female (82.93% and 74.29%) dialysis subjects showed more neutrophils count those were higher than 75%. 17.07% male and 25.71% female subjects neutrophils count were within the 40-75% range (Table-9). P-value for neutrophils=0.226.

Table-9: Neutrophil count between different sex group of the dialysis patients (Male=41, Female=35)

Neutrophil (%)		Male	Percentage	Neutrophil (%)		Female	Percentage	Average %
Below	40	0	0.00%	Below	40	0	9.09%	4.55
Standard	40-75	7	17.07%	Standard	40-75	9	25.71%	21.39
Above	75	34	82.93%	Above	75	26	74.29%	78.61

In this study most of the male and female (65.85% and 74.29%) subjects eisinophils count were within the standard range (2-6%). 34.15% male respondents showed count below the standard limit and for female it was only 5.71% (Table-10). P-value for eosinophils=0.425.

Table-10: Eosinophil count between different sex group of the dialysis patients (Male=41, Female=35)

Eosinophil (%)		Male	Percentage	Eosinophil (%)		Female	Percentage	Average %
Below	2	14	34.15%	Below	2	9	5.71%	19.93
Standard	2-6	27	65.85%	Standard	2-6	26	74.29%	70.07
Above	6	0	0.00%	Above	6	0	0.00%	0.00

Lymphocytes count showed that most of the male and female (78.05% and 74.29%) subjects were with lower number (Less than 20%). In case of standard count 21.95% were male and 25.71% were female subjects (Table-11). P-value for lymphocytes=0.701.

Table-11: Lymphocytes count between different sex group of the dialysis patients (Male=41, Female=35)

Lymphocyte (%)		Male	Percentage	Lymphocytes (%)		Female	Percentage	Average %
Below	20	32	78.05%	Below	20	26	74.29%	76.17
Standard	20-40	9	21.95%	Standard	20-40	9	25.71%	23.82
Above	40	0	0.00%	Above	40	0	0.00%	0.00

A low number of monocytes in the blood (monocytopenia) can be caused by anything that decreases the overall white blood cell count, such as a bloodstream infection, chemotherapy, or a bone marrow disorder. In our study for male only 7.32% were found with low number of monocyte and for female no subject was found with low monocytes. 92.68% male and 100.00% female subjects' monocytes counts were within the standard range (2-10%) (Table-12). P-value for monocytes=0.102.

Table-12: Monocytes count between different sex group of the dialysis patients (Male=41, Female=35)

Monocytes (%)		Male	Percentage	Monocytes (%)		Female	Percentage	Average %
Below	2	3	7.32%	Below	2	0	0.00%	3.66
Standard	2-10	38	92.68%	Standard	2-10	35	100.00%	96.34
Above	10	0	0.00%	Above	10	0	0.00%	0.00

A low platelet count is below 150,000. If platelet count is below 50,000, risk of bleeding is high. Even every day activities can cause bleeding. A lower-than-normal platelet count is called thrombocytopenia. Only 8.00% male and 4.55% female respondents were found with thrombocytopenia. 88.00% male and 86.36% respondents were fit with standard platelet count. 4.00% male and 9.09% female precipitants platelet count found above the standard limit (Table-13). P-value for platelets=0.706.

Table-13: Platelets count between different sex of the dialysis patients (Male=25, Female=22)

PL (Cells/µL)		Male	Percentage	PL (Cells/µL)		Female	Percentage	Average %
Below	150,000	2	8.00%	Below	150,000	1	4.55%	6.28
Standard	150,000-450,000	22	88.00%	Standard	150,000-450,000	19	86.36%	87.18
Above	450,000	1	4.00%	Above	450,000	2	9.09%	6.55

MPV is a machine-calculated measurement of the average size of platelets found in blood and is typically included in blood tests as part of the CBC. Regarding average size of platelet 94.12% male and 90.91% female subjects showed standard phenomena. Only 5.88% male and 9.09% female showed substandard phenomena (Table-14). P-value for MPV=0.617.

Table-14: MPV of platelet cell between different sex of the dialysis patients (Male=34, Female=33)

MPV (femtoliters)		Male	Percentage	MPV (femtoliters)		Female	Percentage	Average %
Below	9	2	5.88%	Below	9	3	9.09%	7.49
Standard	9-13	32	94.12%	Standard	9-13	30	90.91%	92.52
Above	13	0	0.00%	Above	13	0	0.00%	0.00

Platelet Distribution Width (PDW) is a measure of the variation in the size of platelets found in the circulating blood. Platelets recently released from bone marrow tend to be larger and to contain more RNA than older, smaller platelets, which discard their endoplasmic reticulum as they mature. 94.12% male 87.88% female subjects' PDW were standard. PDW of the 6.06% female were substandard and 6.06% were above the standard (Table-15). P-value for PDW=0.112.

Table-15: PDW of platelet cell between different sex of the dialysis patients (Male=34, Female=33)

PDW (femtoliters)		Male	Percentage	PDW (femtoliters)		Female	Percentage	Average %
Below	9	0	0.00%	Below	9	2	6.06%	3.03
Standard	9-17	34	94.12%	Standard	9-17	29	87.88%	91.00
Above	17	0	0.00%	Above	17	2	6.06%	3.03

PCT is a biomarker that exhibits greater specificity than other proinflammatory markers (eg, cytokines) in identifying patients with sepsis and can be used in the diagnosis of bacterial infections. Increased PCT level found for 47.06% male and 51.52% female respondents. It was found below the standard limit for 47.06%

male and 33.33% female. Standard amount of PCT found in 5.88% male and 15.15% female dialysis patients (Table-16). P-value for PCT=0.321.

Table-16: PCT Percentage between different sex of the dialysis patients (Male=34, Female=33)

PCT (%)		Male	Percentage	PCT (%)		Female	Percentage	Average %
Below	0.22	16	47.06%	Below	0.22	11	33.33%	40.20
Standard	0.22-0.24	2	5.88%	Standard	0.22-0.24	5	15.15%	10.52
Above	0.24	16	47.06%	Above	0.24	17	51.52%	49.29

IV. DISCUSSION

Vos FE *et al.* showed that more than 85% of dialysis patients were anemic (Hb, 12.0±1.1g/dL); Hb concentrations were not significantly different between HD and peritoneal dialysis (PD) patients. Median RBC survival was significantly decreased by 20% in HD patients compared with healthy controls: 58.1 (25th-75th percentile, 54.6-71.2) versus 72.9 (25th-75th percentile, 63.4-87.8) days (P=0.02). No difference was shown between the PD and HD groups: 55.3 (25th-75th percentile, 49.0-60.2) versus 58.1 (25th-75th percentile, 54.6-71.2) days (P=0.2). [(18)] RBC evidence supports our findings.

Hala OA *et al.* aimed to detect the effects of renal HD on some blood parameters in CKD patients using complete blood count (CBC) Hb, HCT, RBC, MCV, MCH, MCHC, WBC and blood platelets. [(19)] The patients were divided into two groups according to their age. Group (A) patients bellow 16 years, group (B) patients with age ranged between 40-55 years. Eighty chronic renal failure patients under HD attending Khartoum North Dialysis Center, Selma Dialysis Center and Soba Hospital, were enrolled (group A). Twenty control individuals were selected for the study. Fifty patients with chronic renal failure under HD attending Alnaw Hospital were selected for the study, their age ranged between 40-55 years (Group B). Twenty individuals who were matched as a control. A specimen of 2.5 ml of blood was collected from each patient in EDTA container. Automated hematological analyzer (Sysmex KX-21N) was used to measure the parameters. The results showed a significant decrease in Hb, HCT and RBC in both groups compared to control group. Hb of group A is 9.6±2.2 g/dl and that of control is 13.4±0.89 g/dl. In group B, Hb is 8.8±2.1g/dl compared to 15.1±1.5g/dl of control group. MCV, MCH and MCHC of group A significantly decreased compared to control MCV=83.1±5.4fl, MCH=27.3±2.2pg, MCHC=32.7±1.4g/dl. No significant change was observed in MCV, MCH and MCHC of group (B). TWBC of group B increased insignificantly, from 5.00±1.0cell/cmm (control level) to 6.4±2.6cell/cmm. Platelets of group B decreased significantly from control level but within range of 314.3±52.6 cell/cmm to 209.4±79.2cell/cmm. In conclusion CKD patients under HD are at risk of anemia, thrombocytopenia and bleeding tendency. [(15)] Our study matched with Hala OA *et al.* in respect of RBC (decreased), Hb (decreased), HCT (Decreased), TWBC (increased). They showed no significant change of MCV but our observation found that ~28% patient showed decreased MCV. R Gellert and Z Billip-Tomecka also mentioned in their book MCV increased for HD patients. Hala OA *et al.* showed significant change in the platelet count (decreased) but our observation found no significant change.

David L *et al.* studied on forty patients on maintenance HD were studied to determine the usefulness of the RDW in screening these patients for iron deficiency. Serum ferritin was used as the indicator of body iron stores. The sensitivity of RDW elevation in determining the likelihood of iron store depletion was 89%; and the negative predictive value of a normal RDW was 93%. The specificity of RDW elevation for iron deficiency was only 45%, and the positive predictive value was 32%. This study has confirmed the usefulness of the RDW as a screening test for iron deficiency in chronic HD patients. [(20)] Our study found highly significant increased value for RDW.

Kato A *et al.* prospectively studied the predictive value of WBC subtypes for total and cardiovascular death in 333 HD patients (age 63±12years; HD duration 129±109months) during a 40-month of follow-up. There was a significant and positive correlation between highly sensitive C-reactive protein and neutrophil ($r=0.28$, $p<0.01$) and monocyte ($r=0.20$, $p<0.01$) counts by a non-parametric Spearman rank analysis. Blood monocyte counts were significantly correlated inversely with ankle-brachial pressure index ($r=–0.24$, $p<0.01$). Kaplan-Meier analysis revealed that basal neutrophil (>4,060/µl) and monocyte (>270/µl) counts in the highest tertiles had a significantly lower survival rate compared to the middle and the lowest tertiles, respectively ($p<0.03$). Cox hazards analysis after adjustment for other conventional risk factors revealed that monocyte counts of >270/µl became a determinant of total death compared with those of <180/µl (hazards ratio 1.98 [1.10-3.57], $p=0.02$). [(11)] We found highly decreased neutrophils count among dialysis patients and it matched with the findings of Kato A *et al.* and found no significant change in the monocytes count.

The mean levels of lymphocyte count, packed cell volume, hemoglobin and serum calcium levels were significantly lower. [(21)] In our findings we also found low lymphocytes count, low PCV, low Hb and moderately more PCT. More PCT leaded low serum calcium level and was the indication for infection.

The mean values of PDW, MPV, platelet count, plateletcrit ratio (PCT) and platelet large cell ratio (P-LCR) were found to be higher in CKD and ESRD patients when compared to healthy controls. PDW, PCT and L-PCR attained statistical significance, while MPV did not. [(22)] MPV and PDW found approximately normal in our findings. Finally, large sample size is required to get statistically significant data to make a conclusion.

V. CONCLUSION

In conclusion we found a significant decrease in RBC, Hb, HCT and lymphocytes among the respondents, moderately decrease in procalcitonin level, lightly decrease in eosinophils and platelets of the subjects. RDW, neutrophils, moderately PCT and T-WBC found with increased level among the respondents. Monocytes, platelet, MPV and PDW found highly standard for the HD patients. In conclusion CKD patients under HD are at risk of anemia, thrombocytopenia, septicemia, bacteremia and inflammatory tendency.

VI. REFERENCES

1. Kidney failure [Internet]. Wikimedia Foundation, Inc., [Updated 2018, June 13; cited 2018 July 9]. Available from https://en.wikipedia.org/wiki/Kidney_failure
2. Singh AK. Hemoglobin level in dialysis patients: Revisiting the normal hematocrit study. Kidney International. 2007; 72 (9): 1161.
3. Vos FE, Schollum JB, Coulter CV, Doyle TC, Duffull SB, Walker RJ. Red Blood Cell Survival in Long-term Dialysis Patients. American Journal of Kidney Diseases. 2011; 58(4):591-598.
4. Naturally occurring high hemoglobin levels safe for kidney disease patients on dialysis [Internet]. Medical Daily © 2018 Newsweek Media Group [Updated 2010 December 20, cited 2018 July 9]. Available from https://www.medicaldaily.com/naturally-occurring-high-hemoglobin-levels-safe-kidney-disease-patients-dialysis-235564
5. John B, Jennifer P, Andrew D. Changes in Red Blood Cell Size and Red Cell Fragmentation during Hemodialysis. The International Journal of Artificial Organs. 2010; 33(12):900-905.
6. Mohammed NUC, Monira K, Pradip KD, Nayeema A. Effects of Haemodialysis on Red Cell Indices and Haematocrit in Chronic Kidney Disease Patients. Chattagram Maa-O-Shishu Hospital Medical College Journal. 2017; 16(1):15-18.
7. M Papadimitriou, LRI Baker, B Seitanidis, LH Sevitt, AE Kulatilakei. White Blood Count in Patients on Regular

Haemodialysis. British Medical Journal. 1969; 4:67-69.
8. Leonard SK, John AG. Profound Neutropenia During the Early Phase of Hemodialysis. JAMA. 1968; 203(13):1135-1137.
9. Michael F, Preben J, Bent N, Lars PN. Eosinophilia in Hemodialysis Patients. 1987; 11(2):90-92.
10. Hoy WE, Cestero RVM, Freeman RB. Deficiency of T and B Lymphocytes in Uremic Subjects and Partial Improvement with Maintenance Hemodialysis. Nephron. 1978; 20:182-188.
11. Kato A, Takita T, Furuhashi M, Maruyama Y, Kumagai H, Hishida A. Blood Monocyte Count Is a Predictor of Total and Cardiovascular Mortality in Hemodialysis Patients. Nephron Clin Pract. 2008; 110:c235-c243
12. John TD, Angelito AB. Hemodialysis effect on platelet count and function and hemodialysis-associated thrombocytopenia. Kidney Int. 2012; 82(2):147-157.
13. Mean platelet volume [Internet]. Wikimedia Foundation, Inc., [Updated 2018, May; cited 2018 July 9]. Available from https://en.wikipedia.org/wiki/Mean_platelet_volume
14. Vagdatli E, Gounari E, Lazaridou E, Katsibourlia E, Tsikopoulou F, Labrianou I. Platelet distribution width: a simple, practical and specific marker of activation of coagulation. Hippokratia. 2010; 14(1):28-32.
15. Lokesh S, Siva RG, Kadavanu TM, Hemachandar R, Kumar A, Tiwari SR, Lakshmi A, Ezhumalai G. A comparative study of platelet parameters in end stage renal disease patients undergoing haemodialysis and healthy individuals. Int J Adv Med. 2016; 3(3):559-63.
16. Martin S, Christian B, Thomas S, Eckhard H, Helmut S. Procalcitonin in Patients Undergoing Chronic Hemodialysis. Nephron. 2000; 84(2):187-188.
17. Hill VL, Simpson VZ, Higgins JM, Hu Z, Stevens RA, Metcalf JA, Baseler M. Evaluation of the Performance of the Sysmex XT-2000i Hematology Analyzer With Whole Bloods Stored at Room Temperature. Laboratory Medicine. 2009; 40(12):709-718.
18. Vos FE, Schollum JB, Coulter CV, Doyle TC, Duffull SB, Walker RJ. Red blood cell survival in long-term dialysis patients. Am J Kidney Dis. 2011; 58(4):591-8.
19. Hala OA, Zeinab HE, Khalda MH. Assessment of Complete Blood Count of Chronic Renal Failure Patients Under Hemodialysis. Journal of Science and Technology. 2014; 15(1):9-13.
20. David L, Morgan, MD, Sanford DP. The Use of Red Cell Distribution Width in the Detection of Iron Deficiency in Chronic Hemodialysis Patients. American Journal of Clinical Pathology. 1988; 89(4):513-515.
21. Emmanuel AE, Mathias AE, Jessy TM, Isaac FM. Correlation of lymphocyte count with serum calcium level and neutrophil-to-lymphocyte ratio in end stage renal disease patients undergoing hemodialysis in Adamawa State, Nigeria. 2017; 9(5):47-50.
22. Bazeed MM, Rasheed AM, Bakeer M, Abdel AA, Ali SA. A Comparative Study of Platelet Parameters in Chronic Kidney Disease, End Stage Renal Disease Patients Undergoing Hemodialysis and Healthy Individuals. Egyptian Journal of Hospital Medicine. 2018; 71(6):3429-3433.
23. Wolfgang AN, Jürgen ES. Expanded CD14+ CD16+Monocyte Subpopulation in Patients with Acute and Chronic Infections Undergoing Hemodialysis. Infect. Immun. 1998; 66(6):2782-2790.

How to cite this article: Asaduzzaman M, Shobnam A, Farukuzzaman et.al. Assessment of red blood cell indices, white blood cells, platelet indices and procalcitonin of chronic kidney disease patients under hemodialysis. Int J Health Sci Res. 2018; 8(8):98-109.

******