

C-reactive Protein and Tumour Marker (Ferritin) Levels in Chronic Myeloid Leukaemia Patients

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Abstract: C-reactive protein and tumour marker (ferritin) levels with haematological parameters in chronic myeloid leukaemia patients were estimated. Thirty three (33) leukaemic patients and 20 apparently healthy control subjects were evaluated in this study. Haematological parameters were estimated by automation SYSMEX KX-21N. C-Reactive protein (CRP) was estimated by semi-quantitative Latex agglutination method. Serum ferritin was also estimated using Atomic absorption spectrophotometry. There is significant difference ($p < 0.05$) between the markers, CRP and ferritin levels between the control subjects and leukaemia patients. Significant difference ($p < 0.05$) also exists between the patients and controls in the Haematological parameters such as: PCV, MCV, MCHC, RDW-SD, e.t.c. The study reveals that both CRP and ferritin (tumour marker) levels could be useful factors in determining disease progression or monitor the effectiveness of treatment in the leukaemic patients. The need for baseline determination of the markers cannot be under estimated.

Key words: C-reactive protein • Tumour marker • Ferritin • Leukaemia • Haematological parameters

INTRODUCTION

Leukaemia is the 6th leading cause of cancer death among men and the 7th leading cause of cancer death among women. As of 1998, it was estimated that each year, approximately 30,800 individuals will be diagnosed with leukaemia in the US and 21,700 individuals will die of the disease. This represents about 2% of all forms of cancer [1, 2].

Leukaemia is a cancer of the blood or bone marrow and is characterized by an abnormal uncontrolled proliferation (production by multiplication) of blood cells, usually white blood cells, (Leukocytes). It is part of the blood group of diseases called haematological neoplasms [3]. The abnormal proliferation of haemopoietic cells causes progressive infiltration of bone marrow although in certain forms the lymphatic tissues are particularly affected. The process of differentiation of leukaemic cells is often abnormal and this commonly results in an

immature morphological appearance. The progression varies considerably in different types of leukaemia which could be acute or chronic, but death is the usual outcome in untreated disease as a result of compromised production of mature blood cells [4].

Leukaemia like other cancers results from somatic mutations in the DNA which activates oncogenes or deactivates tumor suppressor genes and disrupt the regulation of cell death, differentiation or division. These mutations may occur spontaneously or as a result of exposure to radiation or carcinogenic substances and are likely to be influenced by genetic factors [5].

Leukaemia is classified into several ways: according to cell population which is considered aleukaemia when the white blood cell count is usually below normal range ($4-11 \times 10^9/L$) [6]. Leukaemic leukaemia when the white blood cells count can be up to a million/cumm, leukaemia when the white blood cell count is between $15-20 \times 10^9/L$ [7].

Disease classification depends on acute or chronic course of leukaemia. The acute leukaemia is characterized by the rapid increase of immature blood cells (blast cell). These disorders are characterized by a maturation defect (arrest) of the blast cells as a result of failure of bone marrow to produce normal cellular element of the blood resulting in anemia, haemorrhagic state due to thrombocytopenia and infections due to neutropenia [8]. Acute leukaemia is further classified into acute lymphoblastic most in children and acute myeloblastic leukaemia occurs mostly in adult than in children [9].

Chronic leukaemia is distinguished by the excessive build up of relatively matured, but still abnormal blood cells which takes months or years in progress. Cells are produced at a much higher rate than normal cells. Chronic leukaemia mostly occurs in older people. Acute leukaemia could be treated immediately; chronic forms are sometimes monitored for sometime before treatment to ensure maximum effectiveness of therapy. Chronic leukaemia is classified into two: Chronic lymphocytic leukaemia (CLL) and chronic myelogenous leukaemia [10, 11].

CLL are the commonest form of adult leukaemia, most are due to B-cell clonal abnormal proliferation while a few may be due to T-cell. CLL is most common in the Caucasian; it is rare in people below 30 years [12]. There is a male to female ratio of 2: 1 [13]. Incidence increases rapidly with increasing age. It is estimated that 15,110 cases of CLL was diagnosed in 2008, 8,750 in males and 6,360 in female.

C-reactive protein (CRP) is a plasma protein, an acute phase protein produced by liver [14] and by adipocytes [15]. It is a member of the pentraxin family of proteins. It is not related to C-peptide or protein C.

C-reactive protein was originally discovered by Tillet and Francis in 1930 as a substance in the serum of patients with acute inflammation that reacted with the C polysaccharide of *Streptococcus pneumoniae*. Initially it was thought that CRP might be a pathogenic secretion, as it was elevated in people with a variety of illness, including carcinomas. The debate was closed by the discovery of hepatic synthesis and secretion of CRP. It is thought to bind to phosphocholine, thus initiating recognition and phagocytosis of damage cells [14].

The CRP gene is located on the first chromosome (1q 21-q23). CRP is a 224 residue protein with a monomer molar mass of 25106 Da. The protein is an annular pentameric disc in shape. CRP levels rise dramatically during inflammatory processes occurring in the body. The increment is due to rise in the plasma concentration of interleukin-6 (IL-6), which is produced predominantly

by macrophages [14]. Cytokines derived from macrophages and monocytes include tumour necrosis factor alpha (TNF- α), interleukin-1 and interleukin-6. These cytokines are primarily responsible for mediating in acute phase response [16].

CRP is used mainly as a marker of inflammation [17]. A lack of elevation of CRP may be seen in hepatic failure, during flares condition such as systemic lupus erythematosus. Elevated concentration is associated with microbes, autoimmune disease and drug allergies (especially to antibiotics). Normal reference ranges for blood tests are less than 5-6 mg/L [17]. The median normal concentration CRP is 0.8mg/L, with 90% of apparently healthy individuals having a value less than 3mg/L and 99% less than 12mg/L [18].

Tumour markers are usually proteins associated with a malignancy and might be clinically usable in patients with cancer. A tumour marker can be detected in a solid tumour, in circulating tumour cells in peripheral blood, in lymph nodes, in bone marrow, or in other body fluids (ascites, urine and stool). A tumour marker may be used to define a particular disease entity, in which case it may be used for diagnosis, staging, or population screening. Markers may also be used to detect the presence of occult metastatic disease, to monitor response to treatment, or to detect recurrent disease. Recently they have even been used as targets for therapeutic intervention in clinical trials [19].

Tumour markers are mainly used to diagnose specific malignancies. The methods commonly involve immunohistochemistry and cytogenetics, including fluorescent in situ hybridisation (FISH) and reversed transcriptase and polymerase chain reaction. Markers to be used in population based screening for early diagnosis such as screening for early colorectal cancer in stool is needed. The only marker that is sometimes used for screening is prostate specific antigen (PSA). Markers used for staging are also needed to optimise treatment; the oestrogen receptor is an important marker for this purpose in breast cancer and the carcinoembryonic antigen marker looks similarly promising for improved staging of colorectal cancer. The sentinel node technique can improve staging, but more and better markers and techniques are needed in screening, staging and follow up of malignant disease [20].

Serum ferritin, one of the acute phase reactant is a cellular protein playing a role in sequestration and storage iron. Increased level of serum ferritin is reported in cancer patients in the absence of iron overload. Ferritin levels are increased in advanced cancers of breast, ovaries, lungs

and oesophagus. Elevated levels are also reported in acute myelocytic leukaemia and tetratoblastoma.

There is dearth of information about CRP and tumour marker (ferritin) levels in chronic myeloid leukaemia patients. This study therefore aimed at determining variations of CRP and ferritin as tumour markers in leukaemic patients.

MATERIALS AND METHOD

Subjects: Thirty-three (33) subjects diagnosed with chronic myeloid leukemia (CML) Ladoke Akintola University Teaching Hospital, Osogbo Osun state and 20 apparently healthy individuals served as control. Informed consent was obtained from the subjects with those that refused excluded from the study.

Blood Samples Collection: 5ml of venous blood was collected from each subject from an antecubital vein with the subjects comfortably seated. 3ml of the blood was immediately transferred into EDTA specimen bottles and was carefully mixed and was used for the estimation of haematological parameters. The remaining 2ml was put into a dry tube for serum extraction which when separated were stored frozen until analyzed for serum ferritin estimation as a tumour marker.

C-Reactive protein Estimation: CRP was estimated with the use of Latex agglutination kit. The method used is semi quantitative. Latex agglutination kit contains wells; pipette the test, positive and negative control.

Principle: Antigen reacts with its corresponding antibody to form observable agglutination.

Procedure: A drop of the positive, negative control was placed on the well and a drop of CRP reagent was added. It was mixed and was rocked for 2 minutes for observable agglutination. The positive control was quantified with using several doubling dilutions. All samples were doubly diluted and analyzed as the positive and negative controls. The result of samples was determined as the reciprocal of the last tube that gave agglutination.

Estimation of Serum Ferritin: Serum ferritin was estimated using advanced instrumentation of Atomic Absorption Spectrophotometry method, Buck 200 model [21].

Preparation of Iron standard: Iron Standard was prepared at 4 parts per million (4ppm) equivalents to mg/l with sensitivity test of 0.2ppm for the machine. Iron

absorption standard is 3.99 approximately to 4ppm which give 4.00 on meter reading.

Since 4ppm = 4.00

Slope = $4/4 = 1$

Calculation: Meter reading (mg/l) x Dilution factor x slope
Stock iron standard solution was prepared by dissolving 3.04g of ammonium ferrous sulphate (FENH_4SO_4) salt was dissolved in 1000ml of distilled water i.e 3.04g/1000ml of stock standard solution (1000ppm), 10ml of stock standard solution (1000ppm) was dissolved into 100ml of distilled water to give 100ppm of standard solution, 4ml from 100ppm standard solution was dissolved into 100ml of distilled water to give 4ppm of standard solution which was used for serum ferritin estimation.

Procedure: Serum sample was centrifuged at 3000rpm for 30 minutes to obtain supernatant from the sample. 1 in 10 dilution of sample was made with distilled water, before the sample was read on the atomic absorption spectrophotometry machine. Normal wavelength for Iron is 248.3nm. Sample was poured into sample cup and it was aspirated into the machine at the preset wave length for Iron and sensitivity of 0.2ppm. Values for serum ferritin were read at concentration level. Serum iron concentration determines the level or concentration of serum iron ferritin in the body. Hence, serum iron ferritin = meter concentration reading (mg/l) x slope x dilution factor.

Estimation Haematological parameters and

Hematological indices: The methodology is by flow cytometry (direct current method) using suitable cell packs according to manufacturer's specification for the desired cell population using SYMEX KX-21N auto-analyzer machine instrument [22].

Differential White cell Count: Leishman staining technique was used according to Dacie and Lewis [23].

Procedure: A thin film was made, dried and stained with Leishman stain. It was diluted with phosphate buffer at pH 7.4 Allowed to stain for 10 minutes and rinsed. The stained slide was allowed to dry and examined using battlement method with oil immersion objective (x 100). 100 consecutive white blood cells were counted in all, indicating various types of leukocytes encountered recorded.

Statistical analysis: Student 't' test and ANOVA were used to analyze the differences between the results.

RESULTS

Results of the C-reactive protein level, tumor marker (ferritin) and haematological parameters in chronic myeloid leukaemia (CML) patients attending Ladoke Akintola University Teaching Hospital, Osogbo, Osun State, Nigeria are shown in Figure 1 and Tables (1-3) below. The haematological parameters estimated are: Packed cell volume (PCV), White blood cells (WBC), red cell indices (MCV, MCH and MCHC), red blood cell count (RBC count), red cell distributor width (RDW), haemoglobin concentration (Hb) and blood film appearance. These were used to diagnose leukaemia among the study population. C-reactive protein (CRP) level and serum ferritin was estimated.

A total of 53 subjects were used for the study which consists of 33 leukaemia subjects. Out of the 33, 18 (54.5%) were males and 15 (45.3%) were females. Twenty apparently healthy individuals were used as control which consists of 10 (50%) females and 10 (50%) males. All the subjects were between 12 and 90 years.

33 CML patients were used. This consists of 18(54.5%) male subjects. 15(45%) female subjects. 20 apparently healthy individual that served as controls consist of 10(50%) male and 10(50%) female.

The mean and standard deviation of WBC count (21.07 ± 41.56) for the test subject is higher compared to the control subjects (6.86 ± 1.41), haemoglobin mean and standard deviation of test (11.29 ± 2.22) is lower

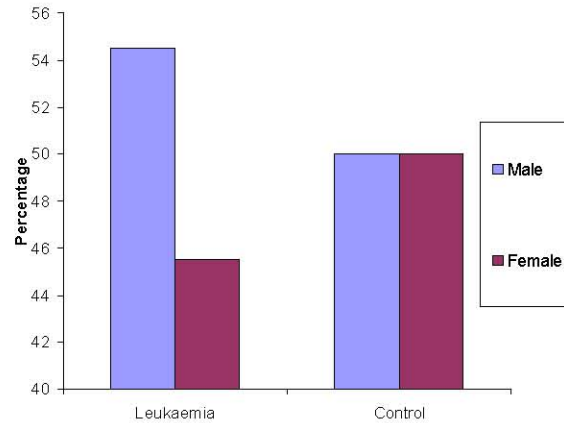


Fig. 1: Shows the frequency distribution for the total population of samples.

compared to the control subjects (13.62 ± 1.12). Also the MCV of the test subject (90.35 ± 7.82) is higher compared to the control subject (85.77 ± 5.78) while platelet mean and standard deviation (254.81 ± 311.77) is high compared to the control subjects (226.00 ± 42.64).

The mean \pm standard deviation (SD) of leukaemia patient sex group, the female mean standard deviation Age (45.47 ± 13.98) lower than that of the male (49.50 ± 17.67), WBC count (16.59 ± 33.97) female lower compared with the male (24.80 ± 47.64), PCV (33.65 ± 8.02) female is also lower and the platelet (224.98 ± 181.17) female compared to the male (274.67 ± 393.05).

Table 1: Shows the mean and standard deviation of haematological parameters, CRP level and ferritin level in leukaemia (CML) patients and control subjects

Parameters	Leukemia patients n = 33 ($\bar{x} \pm S.D.$)	Control Subjects n = 20 ($\bar{x} \pm S.D.$)	ANOVA	p-value
Age (years)	47.67 \pm 15.990	38.80 \pm 8.67	5.20	0.027
CRP estimation	2.36 \pm 4.23	0.00 \pm 0.00	6.21	0.016
Ferritin ($\mu\text{mol/L}$)	22.69 \pm 1.35	25.36 \pm 2.21	29.19	0.000
WBC count ($\times 10^3/\mu\text{L}$)	21.07 \pm 41.56	6.86 \pm 1.41	2.32	0.134
RBC count ($\times 10^6/\mu\text{L}$)	3.97 \pm .86	4.68 \pm .49	11.12	0.002
Haemoglobin (g/dl)	11.29 \pm 2.22	13.62 \pm 1.12	18.95	0.000
PCV (%)	35.58 \pm 6.76	39.70 \pm 3.36	6.43	0.014
MCV (fL)	90.35 \pm 7.82	85.77 \pm 5.78	5.15	0.027
MCH (Pg)	28.72 \pm 3.01	28.85 \pm 2.37	0.03	0.867
MCHC (g/dl)	31.74 \pm 1.21	34.20 \pm 2.46	23.78	0.000
Platelets ($\times 10^3/\mu\text{L}$)	254.81 \pm 311.77	226.00 \pm 42.64	0.17	0.684
RDW-SD (fL)	53.72 \pm 11.58	45.22 \pm 1.88	10.51	0.002
RDW-CD (%)	16.81 \pm 2.71	14.07 \pm 0.58	19.70	0.000
Neutrophil (%)	44.45 \pm 20.01	64.65 \pm 5.86	19.24	0.000
Lymphocyte (%)	52.82 \pm 20.42	35.20 \pm 5.83	14.09	0.000
Eosinophil (%)	1.71 \pm .76	1.00 \pm 0.00	2.50	0.153

p-value $p < 0.05$ is assigned significant and $p > 0.05$ as not significant.

Table 2: Shows the sex distribution of the estimated parameters in the test subjects

Parameters	Female n = 15, $\bar{x} \pm S.D.$	Male n = 18, $\bar{x} \pm S.D.$	ANOVA(F)	p-value
Age (years)	45.47 \pm 13.980	49.50 \pm 17.670	0.892	0.349
CRP estimation	1.60 \pm 4.2200	3.00 \pm 4.2400	1.005	0.321
Ferritin ($\mu\text{mol/L}$)	22.49 \pm 1.3100	22.87 \pm 1.390	0.265	0.609
WBC count ($\times 10^3/\mu\text{L}$)	16.59 \pm 33.970	4.80 \pm 47.640	0.396	0.532
RBC count ($\times 10^6/\mu\text{L}$)	3.74 \pm 1.0100	4.16 \pm .6700	3.068	0.086
Haemoglobin (g/dl)	10.58 \pm 2.5400	11.88 \pm 1.7600	4.376	0.041
PCV (%)	33.65 \pm 2.5400	37.18 \pm 5.2000	4.562	0.038
MCV (fL)	0.85 \pm 8.0700	89.95 \pm 7.8100	0.002	0.969
MCH (Pg)	28.61 \pm 2.9200	28.80 \pm 3.1600	0.347	0.558
MCHC (g/dl)	31.47 \pm 1.1600	31.96 \pm 1.2300	0.110	0.741
Platelets ($\times 10^3/\mu\text{L}$)	224.98 \pm 181.17	279.67 \pm 393.05	0.333	0.567
RDW-SD (fL)	55.76 \pm 8.9200	562.01 \pm 13.420	0.489	0.488
RDW-CD (%)	16.84 \pm 2.9800	16.78 \pm 2.5400	0.037	0.849
Neutrophil (%)	44.27 \pm 20.450	44.61 \pm 20.220	0.053	0.819
Lymphocyte (%)	56.13 \pm 20.140	50.06 \pm 20.710	0.923	0.341
Eosinophil (%)	2.00 \pm 0.0000	1.67 \pm .8260	0.000	1.000

At p-value ($p < 0.05$) is significant, p-value i.e ($p > 0.05$) is not significant. The level of significance between the sex in haemoglobin ($p = 0.041$) and PCV ($p = 0.038$) are significant

Table 3: Shows the mean and standard deviation of the sex in both patients and control samples

Parameters	Leukaemia Patients		Control Samples	
	Female n = 15 $\bar{x} \pm S.D.$	Male n = 18 $\bar{x} \pm S.D.$	Female n = 10 $\bar{x} \pm S.D.$	Male n = 10 $\bar{x} \pm S.D.$
Age (years)	45.47 \pm 13.98	49.50 \pm 17.67	37.70 \pm 7.850	39.90 \pm 9.710
CRP estimation	1.60 \pm 4.220	3.00 \pm 4.240	0.22 \pm 0.000	0.00 \pm 0.000
Ferritin ($\mu\text{mol/L}$)	22.49 \pm 1.31	22.87 \pm 1.39	25.17 \pm 2.36	25.56 \pm 2.16
WBC count ($\times 10^3/\mu\text{L}$)	16.59 \pm 33.970	24.80 \pm 47.64	6.71 \pm 1.510	7.00 \pm 1.37
RBC count ($\times 10^6/\mu\text{L}$)	3.74 \pm 1.0100	4.16 \pm .6700	4.47 \pm .380	4.88 \pm 0.510
Haemoglobin (g/dl)	10.58 \pm 2.5400	11.88 \pm 1.7600	12.94 \pm 830	14.29 \pm .960
PCV (%)	33.65 \pm 2.5400	37.18 \pm 5.2000	37.83 \pm 2.67	41.57 \pm 2.990
MCV (fL)	90.85 \pm 8.0700	89.95 \pm 7.8100	85.19 \pm 5.330	85.19 \pm 5.330
MCH (Pg)	28.61 \pm 2.9200	28.80 \pm 3.1600	28.40 \pm 2.170	29.30 \pm 2.580
MCHC (g/dl)	31.47 \pm 1.1600	31.96 \pm 1.2300	31.74 \pm 1.210	34.20 \pm 2.570
Platelets ($\times 10^3/\mu\text{L}$)	224.98 \pm 181.17	279.67 \pm 393.05	220.40 \pm 47.01	231.60 \pm 39.47
RDW-SD (fL)	55.76 \pm 8.9200	562.01 \pm 13.420	45.21 \pm 2.160	45.24 \pm 1.68
RDW-CD (%)	16.84 \pm 2.9800	16.78 \pm 2.5400	13.99 \pm .640	14.15 \pm .540
Neutrophil (%)	44.27 \pm 20.450	44.61 \pm 20.220	62.20 \pm 6.110	67.10 \pm 4.680
Lymphocyte (%)	56.13 \pm 20.140	50.06 \pm 20.710	37.70 \pm 6.110	32.70 \pm 4.520
Eosinophil (%)	2.00 \pm 0.0000	1.67 \pm .8260	1.00 \pm 0.000	1.00 \pm 0.000

The mean \pm S.D of the sex in both the patients and control samples as the Age, female (45.47 \pm 13.98) of the test is higher than the control (37.70 \pm 7.8). Also in the male (test) (49.50 \pm 17.6) compared to the control (39.92 \pm 9.71). Also the WBC count for the female (16.69 \pm 33.97) and the control (6.71 \pm 1.51) in females.

DISCUSSION AND CONCLUSION

C-reactive protein, serum ferritin levels and haematological parameters in chronic myeloid (CML) leukaemia patients were assessed in this study.

Figure 1. shows the frequency distribution for the total population of sample in chronic myeloid leukaemia when a total number of 33 patients consisting of 18 (54.5%) male and 15 (45%) female subjects. 20 apparently healthy individual that served as controls also consisted of 10 (50%) male and 10 (50%) female. The percentage of the male that are leukaemic in this study is high compare to the female. According to the American cancer society, Leukemia is the 6th leading cause of cancer death among men and the 7th leading cause of cancer death among women. Men are mostly affected [1]. This is due to the fact that men are more predisposed to ionizing radiation, chemicals and drugs e.g. exposure to benzene which is widely used in the industry, virus infection e.g. Human T-cell leukaemia (HTLV).

The result shown on Table 1, the mean and standard deviation of CRP (2.36 ± 4.23) at $n = 33$ (62.3%) of the test and control (0.00 ± 0.00) at $n = 20$ (37.7%) with p-value ($p = 0.016$) being significant. The result shows that CRP level is significantly high in the CML patients when compared with the controls ($p < 0.05$). This is due to rise in the plasma concentration of interleukin-6 which is produced predominantly by the macrophages [14]. CRP levels in CML male patients and CML female patients are significantly higher than their respective counterparts ($p < 0.05$). The above stated results agree with the report [24] who worked on C-reactive protein for rapid diagnosis of infection in Leukaemia. They reported that C-reactive protein was elevated to 100mg/L at the beginning of 32 of the 34 episodes of infection and subsequently rose above 100mg/L in all. The uninfected patients in leukaemic remission or, relapse, pyrexia or not had levels below 100mg/L.

Also, [25] carried out study on the use of CRP in the diagnosis and management of infecting in granulocytopenic and non-granulocytopenic patients. The serum levels of CRP were assayed in 64 non granulocytopenic and 35 granulocytopenic patients with or without fever and infection. The mean peak level of CRP in febrile patients with septicaemia was 207mg/L (median 214mg/L) in non granulocytopenic patients and 173mg/L (median 168mg/L) in granulocytopenic patients which differ significantly from that in febrile patients without positive blood culture. There is a significant difference between patients with major and minor infections were also found (less than 0.01).

A study on C-reactive protein concentration as a guide to antibiotic therapy in acute leukaemia was carried out [26]. The result shows a significant difference between neutropenic patients with acute leukaemia and

non neutropenic patients. The study provides on objective means of monitoring the response to antibiotic and granulocyte therapy the serum CRP dropped with half-life below the diagnostic level of 100mg/L in all 29 episodes.

According to a work carried out on serum C-reactive protein and neopterin concentrations in patient with viral and bacterial infection [27], He compared the concentrations with non-infective inflammatory condition. The result obtained confirmed that both markers were significantly raised in all categories of infection compared with the control.

Factors that brought about probably increased in CRP level due to inflammation of bone marrow, liver, lung, skin, kidney, kidney and bladder. CRP susceptible to multiple cardiovascular risk factors, including smoking, hypertension, obesity, lack of physical activity and low socio-economic status, all relate independently to elevated plasma level of the C-reactive protein, atherosclerosis may also trigger an elevation of CRP levels.

The mean and standard deviation of ferritin (22.69 ± 1.35) (at $n = 33$ (62.3%) for test subjects in table 2 is lower compared to the control (25.36 ± 2.21) at $n = 20$ (37.7%) at $p = .000$ which is significant. The result obtained agreed with that of work done [28] where they found that there is a significant difference on the work carried out on advanced cancers of the breast, ovaries, lungs and oesophagus. Elevated levels are also reported in acute myelocytic leukaemia.

[29] Indicates that myeloma, lymphoma and leukaemia synthesize β_2 microglobulin at higher rate compared to resting lymphoid cells. Serum β_2 microglobulin could be also used as a marker of both the malignant plasma cells mass and also the disease activity.

The result shows that RBC, Haemoglobin, PCV, MCV, MCHC RDW-S.D., RDW-CD, Neutrophil, lymphocyte, CRP estimation and ferritin levels were significantly high due to rise in the plasma concentration of interleukin-6 which is produced predominantly by macrophages. The mean and standard deviation of WBC count (21.07 ± 41.56) for the test subject as in table 2 is experimentally higher compared to the control subjects (6.86 ± 1.41) although not statistically significant ($p > 0.05$). MCH (28.72 ± 1.21) of test and control (28.85 ± 2.37) at $p = .867$, platelets count for test (254.81 ± 311.77) and control (226.00 ± 42.64) at $p = .684$ and Eosinophil ($1.71 \pm .76$) for test and control (1.00 ± 0.00) at $p = .153$ are not significant. The haemoglobin mean and standard deviation of test (1.00 ± 2.22) compared to control

(13.62±1.12) is low. PCV (35.53±6.76) test is lower compared to the control (39.70±3.36) at $p = .014$, neutrophil (44.45±20.01) test is lower, compared to control (64.65±5.86) at $p = 0.000$ are significant. Also, the MCV of the test subject (90.35±7.82) is higher compared to the control subject (85.77±5.78) at $p = 0.027$ is significant.

In conclusion, CRP can be useful in determining disease progression or monitor the effectiveness of treatment. Tumour marker levels may be used to follow the course of treatment, to measure the effect of treatment, as a part of follow-up care to check for recurrence.

Newly diagnosed Leukaemia patients should be screened for the tumour markers as baseline investigations before the commencement of treatment. Thus enable the efficient monitoring of the effect of chemotherapy on C-reactive protein level, ferritin and other tumour markers in Leukaemia patients.

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