Evaluation of Full Blood Count with the help of Total Leucocyte Count and Hemoglobin

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ABSTRACT

Introduction: One of the most frequently requested laboratory tests by the clinicians is full blood count (FBC). It is a group of tests to quantify the number of red blood cells (RBCs), white blood cells (WBCs) and platelets. In this study, we determine the effectiveness of the use of the total leucocyte count (TLC) in conjunction with the hemoglobin (Hb) value to determine the outcome of the FBC when the TLC and the Hb are: both within the normal reference range; beyond the reference range; Peripheral blood smear (PBS) examination in samples with both Hb and TLC beyond the reference range. **Materials and Methods:** Hospital based cross sectional study was conducted at Universal college of Medical Sciences and Teaching Hospital (UCMS-TH), Bhairahawa, Nepal. FBC data were collected for 6 months from September 2018 to February 2019. During the study period blood samples were collected from 502 patients who had the test requested by their clinicians. **Results:** A total of 171 (34.1%) FBC profiles were within the normal screened group where both the WBC and Hb values fell within the normal reference range: WBC = 4–11 x 10^9/L and Hb 13–17 g/dL (men), Hb 12–15 g/dL (women). There were 331 (65.9%) FBC profiles in the abnormal screened group in which 86 (17.1%) cases had both Hb and WBC abnormality. In 198 (39.4%) cases Hb was abnormal but TLC was within reference range and in 47(9.4%) cases Hb was normal but abnormal TLC. Neutrophil and Lymphocyte abnormality was significantly higher (p<0.05) in abnormal screened group compared to normal screened group. The red cell indices [Packed cell volume (PCV), RBC, mean cell volume (MCV), Mean cell hemoglobin (MCH), Mean cell hemoglobin concentration (MCHC)] and platelet abnormality is significantly higher (p<0.05) in abnormal screened group compared to normal screened group. Peripheral smear findings in the patients with both Hb and TLC abnormality showed normocytic normochromic anemia in 48 patients, microcytic hypochromic anemia in 36 patients and macrocytic anemia in 2 patients. **Conclusion:** We have found that majority of FBC parameters are out of normal reference range when both Hb and TLC are normal. Abnormality in both Hb and TLC can be used for screening of other FBC parameters.

Keywords: Total leucocyte count, Hemoglobin, White Blood Cells

INTRODUCTON

One of the most frequently requested laboratory tests by the clinicians is FBC.[1] It is a group of tests to quantify the number of RBCs, WBCs and platelets. This test also provides various information about the size, shape of blood cells, RBC indices, Hb concentrations, determine the percentage (relative) and absolute number of five white blood cell types. It also helps identifying abnormal blood cells in the circulation.[2]

The clinical utility of this test is vast; an increased or decreased TLC could be due to abnormal bone marrow pathology.[3] Increase in TLC with an associated neutrophilia or lymphocytosis indicate the presence of bacterial or viral infections.[4] Chemotherapy causes chemo toxic effect and can cause decrease in TLC. [5]

WBC parameters can be used as a tool to assess prognosis, need of urgent treatment and close follow up.[6] Hemoglobin is a substance which is found inside the RBCs and supply oxygen all over the body parts. The amount of oxygen that's delivered to body's tissues will depend on the number of red blood cells. Hemoglobin estimation and RBC count is usually carried out as part of a full blood cell FBC.[7] A decrease in RBCs or Hb may cause anemia and depending on the red cell indices, the etiology of anemia can be determined.[8] The rate of increase in Hb could be used to monitor the treatment of anemia and determine the amount of blood required for transfusion.[9] The platelet count and its size can also be used to determine the thrombopoietic activity of the bone marrow, and an increase or decrease in platelet numbers can also point to disorders of hemostasis or liver disease.[10-11]

Due to lack of proper screening, the effectiveness of the FBC has been hampered.[12] Out of multiple parameters reported routinely from FBC profile, a survey on clinicians and nurses shows that nine of ten only utilize the WBCs, Hb and platelets. The reason behind this is either due to lack of application and interpretation or due to time constraints.[13] Underutilization of FBC data can be due to large volume of work in the laboratory for interpreting all parameters.[12] In this study, we determine the effectiveness of the use of the TLC in conjunction with the Hb value to determine the outcome of the FBC; we determine the nature of the FBC profile in different TLC and Hb senarios:

(i)   both within the normal reference range and

(ii)   beyond the reference range.

(iii)   Peripheral blood smear examination in samples with both Hb and TLC beyond the reference range.

MATERIALS AND METHODS

Hospital based cross sectional study was conducted in Universal college of Medical Sciences and Teaching Hospital (UCMS-TH), Bhairahawa, Nepal. FBC data were collected for 6 months from September 2018 to February 2019. During the study period blood samples were collected from 502 patients who had the test requested by their clinicians.

Sample collection

Venous blood was collected with aseptic procedure, for hematological investigations in Ethylene diamine tetra-acetic acid (EDTA) anticoagulant vial. The samples were processed in their fresh state according to the standard laboratory protocol.

FBC analysis

The collected blood was then analyzed by semiautomated electronic cells counter (Beckman Coulter DxH 520). The analyzer was adequately controlled by Internal Quality control. Hematological parameters including Hb, PCV,MCV, MCH and MCHC, TLC, Differential WBC count, Platelet count were obtained from the coulter. In this study, all the test results were obtained from the Laboratory and Hospital Informatics Systems.
The reference range used for the FBC profile. Table 1[14]

Table 1. Hematological values for normal adults expressed as a mean ±2SD (95% range)

Red blood cell count	
Men	$3.80–5.50 \times 10^{12}/L$
Women	$3.60–4.80 \times 10^{12}/L$
Hemoglobin	
Men	13.0–17.0 g/dL
Women	12.0–15.0 g/dL
Packed cell volume (PCV)	
Men	0.40–0.50 L/L
Women	0.35–0.45 L/L
Mean cell volume (MCV)	83-101 fL
Mean cell hemoglobin (MCH)	26-32 pg
Mean cell hemoglobin concentration (MCHC)	31-35 pg
Total leucocyte count	$4–11 \times 10^9/L$
Differential count	
Neutrophils	$2.0–8.0 \times 10^9/L$
Lymphocytes	$1.0–3.5 \times 10^9/L$
Monocytes	$0.1–1.0 \times 10^9/L$
Eosinophils	$0.01–0.7 \times 10^9/L$
Monocytes	$0.01–0.1 \times 10^9/L$

The FBC data were then classified into two groups, i.e. normal screened group in which both Hb and TLC are within normal reference range and abnormal screened groups with either Hb or TLC is abnormal or both are abnormal. In each of the two groups, the remaining FBC parameters within the reference range was recorded.

Blood film

A corresponding blood film were also prepared from the samples with both abnormal Hb and TLC within 2 hrs of collection and stained with Leishman stain. The peripheral blood smear was examined under low (x10) objective, high (x40) objective and in oil immersion (x100) objective.

RESULTS

FBC data were collected from 502 patients who had the test requested by their clinician. The youngest patient taken was 16 years of age and the oldest was 96 years of age. In total cases, 288 (57.4%) were female, and 214 (48.15%) with male to female ratio of 1:1.34.

A total of 171 (34.1%) FBC profiles were within the normal screened group where both the TLC and Hb

values fell within the normal reference range: TLC = 4–11 x 10^9/L and Hb 13–17 g/dL (men), Hb 12–15 g/dL (women). In this group, there were 142 (83%) samples in which the remainder of the FBC was also within the normal reference range, i.e. there were only 30 cases in which remaining abnormal parameter was seen.

There were 331 (65.9%) FBC profiles in the abnormal screened group in which 86 (17.1%) cases had both Hb and TLC abnormality. In 198 (39.4%) cases Hb was abnormal but TLC was within reference range and in 47(9.4%) cases Hb was normal but abnormal TLC were seen which is shown in Table 2

Table 2. Status of RBC parameters and Platelet in study Group

Study Group	PCV		RBC		MCV		MCH		MCHC		Platelet	
Abnormal screened	N	A	N	A	N	A	N	A	N	A	N	A
Group(n=331)	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Hb(A)+TLC(A)=86	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Hb(A)+TLC(N)=198	128	203	205	126	212	119	227	104	239	104	247	104
Hb(N)+TLC(A)=47	(38.7)	(61.3)	(61.9)	(38.1)	(64)	(36)	(68.6)	(31.4)	(72.2)	(31.4)	(74.6)	(31.4)
Normal screened	157	14	144	27	142	29	151	20	169	20	156	20
Group (n=171)	(91.8)	(8.2)	(84.2)	(15.8)	(83)	(17)	(88.3)	(11.7)	(98.8)	(11.7)	(91.2)	(11.7)
Hb(N)+TLC(N)=171												
Total (502)	285	217	349	153	354	148	378	124	408	124	403	124
	(56.8)	(43.2)	(69.5)	(30.5)	(70.5)	(29.5)	(75.3)	(24.7)	(81.3)	(24.7)	(80.3)	(24.7)

A: Abnormal; N: Normal; Hb: Hemoglobin; TLC: Total leucocyte count; PCV: Packed cell volume; RBC: Red blood cell; MCV: Mean cell volume; MCH: Mean cell hemoglobin; MCHC: Mean cell hemoglobin concentration

Table3 shows differential WBC abnormality in two groups. Neutrophil and Lymphocyte abnormality was significantly higher (p<0.05) in abnormal screened group compared to normal screened group.

Table 3. Percentage and Number of samples outside reference limits and data range for white cell differential in two screened groups

Study Group	Neutrophil	Lymphocyte	Monocyte	Eosinophil	Basophil
Abnormal screened Group (n=331) (65.9%)	116 (35%)	114 (34.4%)	3 (0.9%)	18 (5.4%)	0 (0%)
Normal screened group (n=171) (34.1%)	3 (1.7%)	2 (1.2%)	1 (0.6%)	6 (3.5%)	0 (0%)
P value	< 0.05 Chi-square 69.09	<0.05 Chi square 70.24	0.7 Chi square 0.147	0.33 Chi square 0.92	0

Table 4 shows that the red cell indices (PCV, RBC, MCV, MCH, MCHC) and platelet abnormality were significantly higher (p<0.05) in abnormal screened group compared to normal screened group (Patient with normal Hb and TLC)

Table 4. Percentage and number of samples outside reference limits for remaining full blood count (red cells and platelets) in two screened groups

Study Group	PCV	RBC	MCV	MCH	MCHC	Platelet
Abnormal screened Group (n=331)	203 (61.3%)	126 (38.1%)	119 (36%)	104 (31.4%)	104 (31.4%)	104 (31.4%)
Normal screened group (n=171)	14 (8.2%)	27 (15.8%)	29 (17%)	20 (11.7%)	20 (11.7%)	20 (11.7%)
P value	<0.05 Chi square 129.74	<0.05 chi square 26.40	<0.05 chi square 19.56	<0.05 chi square 23.58	<0.05 Chi-square 23.58	<0.05 Chi square 23.58

PCV: Packed cell volume; RBC: Red blood cell; MCV: Mean cell volume; MCH: Mean cell hemoglobin; MCHC: Mean cell hemoglobin concentration

Peripheral smear findings in the patients with both Hb and TLC abnormality showed normocytic normochromic anemia in 48 patients, microcytic hypochromic anemia in 36 patients and macrocytic anemia in 2 patients which is shown in table 5.

Table 5: Peripheral smear findings in patients with both Hb and TLC abnormality

Parameters	PCV		RBC		MCV		MCH		MCHC		Platelet	
	N	A	N	A	N	A	N	A	N	A	N	A
Normocytic Normochromic anemia (n=48)	16	32	21	27	47	1	46	2	34	14	33	15
Microcytic hypochromic anemia (n=36)	19	17	0	36	5	31	9	27	1	35	30	6
Macrocytic anemia (n=2)	1	1	0	2	0	2	0	2	2	0	0	2
Total (n=86)	36	50	21	65	52	34	52	31	37	49	63	23

A: Abnormal; N: Normal;PCV: Packed cell volume; RBC: Red blood cell; MCV: Mean cell volume; MCH: Mean cell hemoglobin; MCHC: Mean cell hemoglobin concentration

DISCUSSION

Information about the patient's blood cells is achieved by a panel of hematological tests known as FBC and PBS requested by a medical professional. According to the literature, 70% of clinical decisions and diagnosis are supported by laboratory medicine.[15] Studies reveal that although physicians commonly request for the laboratory test, they ignore or misinterpret the results which have obvious implications for the quality of patient care.[16-18]

White cell parameter ranges were significantly closer to the corresponding reference range in the normal screened group in comparison with the abnormal screened group. Within the normal screened group, the WBC differential was normal in most cases, and the data range for each of the white cell subtypes was significantly narrower in comparison with the abnormal screened group, (P<0.05). We observed that there were considerably few patients in the normal screened group (1.7% and 1.2% beyond the reference limit for neutrophils and lymphocytes respectively). These abnormal values can be caused by physiological condition like pregnancy, where counts return to normal after delivery.[19]

The red cells and their indices were within the normal reference limits in most cases when the TLC and the hemoglobin were normal. A rise or drop in the RBC count must be interpreted in conjunction with other parameters, such as Hb, PCV, and/or RBC indices. [20,21] The erythrocyte count, PCV and Hb are determined using routine laboratory tests used to screen for the presence of anemia. Generally, concentrations for these parameters parallel each other. If one of the three screening tests is abnormal, it is helpful to have the results of the other two so that the red cell indices can be calculated. A decreased concentration in one or more of these parameters based on the individual's age and sex should be followed by other laboratory test to help establish criteria for diagnosis.[22]

Mean cell volume must be taken into consideration while interpreting MCH however, MCH does not take into account the size of a cell. Less hemoglobin is found in smaller cells and more hemoglobin is found in larger cells. In some anemias, the cells are normochromic (normal MCHC) because of a decrease or increase in cell size (MCV) associated with a proportional decrease or increase in the amount of Hb within the cell (MCHC). In other anemias, the cell appears hypochromic (decrease MCHC) because the decrease in the amount of hemoglobin within the cell (MCH) is relatively more than the decrease in cell size. Therefore, microcytic cell with an MCH less than 28 pg are not necessarily hypochromic and microcytes with MCH more than 34 pg are usually normochromic.[22]

The MCHC is the ratio of Hb mass to volume of RBC in which it is contain and is calculated from the Hb and hematocrit. The MCHC can be falsely increased with hemolysis, cold agglutinins, or insufficient blood in relation to EDTA in the collection tube. The MCHC rarely changes using impedance analyzers and therefore its usefulness in classifying anemia can be limited.[22] The platelet count was outside the normal reference range in only 11.7% of samples with a normal TLC and Hb. When either or both the TLC and Hb were abnormal, the platelet count was beyond the reference rangein 31.4% of cases and the degree to which the value deviated from the normal range was significantly higher. The possible reason for platelet beyond reference range in normal screened group could be due to isolated quantitative abnormality such as immune thrombocytopenic purpura. Routine laboratory test to screen anemia are RBC count, PCV and Hb and concentrations for these parameters parallel to each other. Based on the individuals age and sex, if there is a decrease concentration in one or more of these parameters it should be followed by other laboratory test to establish diagnosis.[22]

Thus, the high probability of FBC abnormality can be screened by measurement of TLC and Hb. This can help laboratory staff to focus on interpreting abnormal FBC more rapidly and effectively, focusing on more likely on abnormal FBC and if necessary, review with peripheral smear. Laboratory staff can properly utilize the time doing other important test in cases where the TLC and Hb are normal in FBC. In such a way, greatest benefit would be obtained at least cost. Majority of cases, the clinician just needs to know increment of Hb in case of post transfusion or whether leukocytosis is resolved in response to an antibiotic. In these circumstances, a finger prick to determine TLC and Hb accurately is sufficient with the advent of high utility of devices.[14] In developing country like Nepal, this is more economic approach rather than running FBC in the analyzer which can save chemicals and tubes. Moreover, it can also take time and travel for FBC testing. It is more valuable in rural clinics and in general practice where FBC analyzer is not available.[1] Numerous circumstances like disaster and war zones where adequate facilities may not be available for FBC, rapid determination of TLC and Hb value can be an effective tool to look of potentially abnormal FBC.[23]

CONCLUSION

In this study, we have found that majority of FBC parameters are out of normal reference range when both Hb and TLC are abnormal. Abnormality in both Hb and TLC can be used for screening of other FBC parameters.

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