ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

HOW USEFUL ARE CBC AND RETICULOCYTE REPORTS TO CLINICIANS IN ADDIS ABABA HOSPITALS, ETHIOPIA

By:

Misganaw Birhaneselassie, BSc

Advisors: Aster Tsegaye (PhD)
Amha Gebremedhen (MD, Hematologist)
Asaye Birhanu (MSc)

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School of Medical Laboratory Sciences, College of Health Sciences, Addis Ababa University

Approved by the Examining Board

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Chairman, Dep. Graduate Committee	Signature
_____	_____
Advisor	Signature
_____	_____
Examiner	Signature

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Dedication

This Thesis is especially dedicated to my mother Tsehay Yeshitila; for her devotion and love.

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Abbreviations

A/F → Always/Frequently

ALLPS → Academy of Clinical Laboratory Physicians and Scientists

CBC → Complete Blood Count

CDC → Center for Disease Control

FRBC → Fragmented Red Blood Cell

GP → General Practitioner

HCT → Haematocrit

HGB → Hemoglobin

HO → Health Officers

IRF → Immature Reticulocyte Fraction

IRB → Institute Review Board

MCV → Mean Cell Volume

MCH → Mean Cell Hemoglobin

MCHC → Mean Cell Hemoglobin Concentration

PDW → Platelet Distribution Width

PBS → Peripheral Blood Smear

RBC → Red Blood Cell

R/N → Rarely/Never

RDW → Red Cell Distribution Width

RNA → Ribonucleic Acid

USMLE → United States Medical Licensing Examination

WBC → White Blood Cell

Abstract

***Background*:** *The CBC/Retics are routine Hematology tests that are useful to differentially diagnose anemia and other medical conditions. However, it has been presumed that they are not applied in regular medical practice in Addis Ababa hospitals.*

Objective: *To ascertain the reports of CBC/Retics parameters perceived as useful in medical practice in Addis Ababa hospitals.*

Methodology: *A hospital based cross - sectional questionnaire survey was conducted on 408 clinicians working in Addis Ababa hospitals from Nov –Dec 2010, and the response on use of CBC /Retics reports was analyzed. The Always/Frequently (A/F) response was taken to consider 'adequate / routine use' of the CBC/Retics parameter by the clinicians. The P-value less than 0.05 were taken as statistically significant. Chi square was used to see statistical association among variables.*

Result: *Only four of the thirteen parameters in the CBC were selected as frequently or always useful by more than 85% of the clinicians; HGB, HCT, WBC and WBC Diff. Health Officers were observed to use 12 of the 13 CBC parameters less than the other professional group; Interns and Residents demonstrated highest use of CBC results. More than a third of clinicians preferred WBC differential report in percent than the more useful absolute report. Reticulocyte parameters were not being used by majority of clinicians in patient management. Clinicians rated 'average' regarding the adequacy of clinical laboratory methods course they took during medical education. As service users, clinicians indicated mm^3 as unit of preference in cell count on the laboratory report format.*

Conclusion & Recommendation*: Overall, many clinicians do not use much of the data provided on routine CBC report. This should attract further research, and responsible bodies promote use of CBC/Retics reports by clinicians.*

Key Words: *CBC, Retics, Differential leukocyte count, Clinicians, Laboratory report form, CLM course*

1. INTRODUCTION

1.1 Background of the Study

Clinical practitioners involved in the diagnosis and treatment of disease in clinical practice order and interpret laboratory tests in their day to day health care activity. These health care providers even though are highly trained individuals, they are not immune to mistakes in the process of clinical decision making, such as laboratory test ordering, interpretation, and as a result in patient management. Various questionnaire based studies have indicated that doctors are susceptible to decision making biases. Fortunately, such flaw in clinical decision making can be tackled through additional training, relevant education and improving the quality of the service provided from the Laboratory (1).

Clinical laboratory tests are vital in medical practice because the clinical information obtained from these laboratory tools play a key role in the diagnosis and management of patients. It has been reported from various literatures that lack of adequate knowledge in the proper utilization of laboratory data is found to be one of the main factors for biased clinical decision by doctors (2).

In laboratory test utilization, a 'Good' test provides information that is useful in patient management decisions. In the contrary, improper utilization of tests use resources but fails to provide information useful in patient management decisions, and in the worst of such cases tests use resources and provides information that is misleading or irrelevant to patient management (3).

As health care organizations are re evaluating the service they are providing for the public in delivering optimum health care, the role of the clinical laboratories should also be determined and re evaluated from point of reducing the cost per test and the cost due to inappropriate test request and utilization, in parallel to improving patient out come and benefit. "The challenge for the clinical laboratory in managed care is to achieve appropriate utilization of laboratory tests so that clinical outcomes are optimized. Approaching this goal will require mutual cooperation by both the clinician and the clinical laboratory scientist'' (2).

Studies that focused on the value of laboratory testing have sometimes been flawed because they have been mainly concerned on how to produce good results from the laboratory and had not always tried to determine whether the data generated had been appropriately used by clinicians. It has been a fact that clinicians do not always use objective data effectively, and when the data are not used appropriately by the clinicians, not only care costs would come higher but also morbidity and mortality are increased (3).

The other problem that arises from inappropriate test requisition by physicians is unnecessary discomfort for the patient due to repeated testing and phlebotomy. Specifically, such tests can increase the risk of generating false positive results and can result in further intervention and other medical referrals that are really not necessary. In addition, as the use of the laboratory is a determining factor in the consumption of health care resources, care cost on the patient and the health organization would unnecessarily be raised for such reasons (4).

Even though the cost of a single test is assumed to be low, current technologies apply a larger amount of resource to undertake an individual test as they automate profile of tests at a time. Therefore, the resource used for a single patient and test from inappropriate test requisition results in improper consumption of resources. If such resources have been utilized properly, it would be an advantage to improve the delivery of healthcare in the otherwise. It has also been estimated that 30% of laboratory tests that have been performed were repeated unnecessarily within 30 days, which further indicate the variability of test ordering practice and the possible wastage of resources due to unwise laboratory test utilization practices (5).

Literatures have indicated that the majority of problems that are associated in reducing the efficiency and quality of laboratory diagnostic testing are inappropriate utilization such as abuse in overutilization, and ignorance of diagnostic tests (6). It has also been shown that professionals should pursue a more rational use of diagnostic and therapeutic resources, especially considering the inherent costs which are due to inappropriate utilization. “Thus, improvement in benefits derived from laboratory testing is an obligation of the specialists in the laboratory. The appropriate use of the laboratory is imperative for optimum medical practice. If there is improper use, this must be corrected’’ (7).

In regards to laboratory data acquisition and proper utilization; the pattern and type of tests that should be available, the unit of reporting used for a parameter, and the design of laboratory

report forms in Hematology analyzers should be revised and deserve attention (8). “During the last two decades, automated blood cell counters have undergone a formidable technological evolution owing to the introduction of new physical principles for cellular analysis and the progressive evolution of software. The results have been an improvement in analytic efficiency and an increase in information provided, which, however, require ever more specialized knowledge to best discern the possible clinical applications’’ (9).

Clinical laboratories have a number of divisions and disciplines in which various departments and sections are created to undertake clinical investigations that highly support clinicians in the process of patient management. A Hematology section is one of such laboratory science division that has a battery of tests to undertake to help to investigate Hematologic and other disease states. A complete blood cell count (CBC) is one of the most common Hematology laboratory tests ordered in medicine, which clinicians request and use them in daily respect for patient care (10). For example in USA, at the Institution of Mayo foundation for Medical Research alone, approximately 1800 CBCs are ordered every day, and 10% to 20% of results are reported as abnormal, which the results obtained require proper interpretation and use by the clinicians for accurate clinical decision and management of patients (11).

In Addis Ababa, there are supposed to be around 35-40 Hospitals and 31 Health Centers, both governmental and private serving a population of 2,854,462 in the city administration. In addition 109 Special, 169 Higher, 146 medium and 127 Low Private clinics cover a significant portion of the health care activity in the city (12).

Most of the hospitals and a few of the health centers are equipped with Hematology analyzers as part of the routine laboratory activity, and in relation to the HIV/AIDS treatment and follow up program, the laboratories of Addis Ababa Health Institutions are equipped with Hematology machines that produce CBC results in a routine, day to day health care activity. There is no available published information regarding the number in daily use of CBC parameters in these health institutions; however data from laboratory registration records and monthly laboratory reports indicated 300 CBC results and, no reticulocyte parameter results are issued daily from Black Lion Hospital Hematology Laboratory (13). The St Paulo’s hospital laboratory produces roughly 250 CBC a day (14). As an additional relative reference, ICL produces 50-80 CBC and 1-4 Retics, (15). Arsho laboratories perform 14,000 CBC and 500 reticulocytes a year (16). It

can be estimated that 3,500-4,000 CBC reports can be produced a day from all hospitals in Addis Ababa.

The clinical diagnosis and management of patients in Addis Ababa hospitals is handled by group of professionals in medicine, and likewise the laboratory results specifically the CBC and reticulocyte parameters are requested, and interpreted in clinical decision making by these health care providers. According to the 2010 Health Indicator, 538 Specialists, 170 Health Officers, and 396 General Practitioners are directly involved in the diagnosis and treatment of disease in patient management, for the health service provision of the population of Addis Ababa city. In addition, in the hospitals patient diagnosis and management is handled also by Resident and Intern doctors as part of their academic programs (12).

Even though clinicians in Addis Ababa order and receive many CBC a day, the issue of whether they are well aware of the clinical significance of each CBC/Retics reports and the adequate application of the information obtained from these test results for patient benefit is a question (13, 14).

These professionals tend to vary based on their background, year of experience in medical practice and the specialty in medicine, and therefore it is presumed that they may have different level of understanding in the value they give for each of CBC, differential and reticulocyte tests and in fitting the information obtained from the test result in clinical decision making (17).

Therefore, it is in every clinician's interest to have some understanding of the specific test basics as well as a structured action plan in the ordering, and analysis of the laboratory data when confronted with CBC results (11).

In addition to the CBC parameters, the differential and the reticulocyte count are time-honored hematology laboratory tests with demonstrated clinical usefulness, and are commonly dealt in Ethiopia health institutions as they come with the advancement of laboratory technology and availability of the facility. Although, reticulocyte measuring machines are not available as the CBCs in many hospitals, some higher hospitals and private laboratories have these machines to perform reticulocyte counts, and yet the attention given for usefulness of these parameters in patient management by our clinicians is not yet determined (13-16).

It is not too far that advanced laboratories in the civilized world used to perform the manual methods to perform reticulocyte counts, although these tests are gradually being replaced and succeeded by automated technology, the manual methods are still important procedures undertaken in places where the automation for reticulocyte reports is not available. Parallel with these changes in methods, laboratory computerization has emerged and dramatically changed the way in which laboratory results are reported and transmitted to clinicians, and hence the meaning that differs in a way and unit of reporting should be understood by our clinicians so that the information provided would not mislead them in decision making (11).

As a consequence of changes in laboratory hematology, additional Hematology parameters have also been included and CBC and reticulocyte count reports have tended to become longer and more complex. Several factors have been indicated to contribute to the report complexity, for example: long-standing traditions in laboratory hematology, the routine inclusion of more hematologic parameters and indices that are produced by automated hematology analyzers, and the belief that more is better. "As a result, many physicians might be receiving more data than they want or find useful for the management of their patients. Although speculative, it is conceivable that excess data that are not useful to clinicians might actually impede their perception and comprehension of essential data and contribute to errors in medical judgment'' (11). Moreover, the importance of each Hematology parameter differs in use from place to place in accordance of the epidemiology and disease pattern, educational background of professionals and available diagnostic technology (12).

1.2 Significance of the Study

- Encourage clinicians to adequately use CBC/Retics reports in clinical - decision making, and patient management.

- Routine application of CBC/reticulocyte report for anemia classification, and other medical condition, reduces the cost of further unnecessary expensive testing, and medical care in patient management.

- It suggests improvement in laboratory report format design and in Clinical Laboratory Methods course (laboratory based medicine course) in college which leads to more effective communication of laboratory information to clinicians.

- Provide different patterns of use of CBC/Retics parameters by different groups of clinicians, and hence advice the LIS (Laboratory Information System) design in Ethiopia.

- As a whole, it contributes to decrease the morbidity and mortality rate in Addis Ababa hospitals as a result of proper management of individualistic patients and betterment of health service.

2. LITERATURE REVIEW

The information derived from the advanced laboratory technology has been the key factor for the innovation of modern medicine. Health care providers use laboratory test results to provide care and treatment. This application, referred to as evidence based practice, helps ensure that the patient is receiving the best possible treatment for a particular problem. Laboratory findings may often be necessary to monitor the patient after certain treatments, especially when medications are utilized for disease management (18).

2.1 Complete Blood Count

A wide variety of laboratory tests are ordered from physicians in medical practice, and even the simplest laboratory result gives valuable information. Hematological tests are one of the laboratory tests which are in common use. The complete print out results from Automated Hematology analyzers make laboratory test ordering and reporting much simpler than the manual methods. Of the Hematology parameters, the complete blood count is a necessary part of the diagnostic workup in a broad variety of clinical conditions, and mainly helps in the differential diagnosis of anemia as presented on Table 1.1 (11).

Similarly, the differential WBC count and reticulocyte reports are important in initial consideration of differential diagnosis in most ill patients. Quantitative and morphologic examination of the cells of the blood is also considered important in clinical diagnosis (19). However, for correct interpretation of CBC/Retics results and for their effective application in clinical decision making it is important to have extensive knowledge of the clinical significance of the results they provide (9).

Modern hematology analyzers such as Coulter, Sysmex, enumerate and differentiate blood cells including red blood cells (RBCs), white blood cells (WBCs), and platelets. Two “measured variables” of the complete blood cell count are hemoglobin (Hgb) and hematocrit (Hct) can also be directly measured by these instruments. Both provide equivalent information, approximately conveyed by the RBC count, and are interchangeable, and are the primary parameters initially used to detect anemia, including RBC count (11).

Hemoglobin assessment is a routine part of clinical practice. 'Over hydration, blood loss, and anemia will all cause decreased hemoglobin values. Conversely, dehydration, adaptation to high altitudes, chronic hypoxia, and polycythemia vera all cause increases in hemoglobin. Hematocrit values are diminished in the presence of many of the same conditions known to decrease hemoglobin. Likewise, factors known to increase hemoglobin will also increase hematocrit. To ensure that reported values for hemoglobin and hematocrit are correct (they are usually reported together); one can use the "rule of three" as a mathematical check. In patients who are normocytic and have normochromic red blood cells HGB X 3 = +/- 3 HCT (deviations in the calculated value beyond +/- 3% of the measured hematocrit laboratory value) could reflect either instrument error or a pathological problem that requires attention (20).

Table 1.1 Clues from CBC and PBS in the Differential Diagnosis of Anemia

Category of Anemia	Differential diagnosis	CBC clue	PBS Clues
Microcytic	Iron deficiency anemia	Increased RDW Thrombocytosis	Anisocytosis Poikilocytosis Elliptocytosis
	Thalassemia	Normal or elevated RBC count Normal or elevated RDW	Polychromasia Target cells Basophilic stippling
	Anemia of chronic disease	Normal RDW	Unremarkable (typically) Rouleaux formation (CD) Myelophthisis
Normocytic	Bleeding Nutritional anemia	Usually unremarkable Increased RDW	Polychromasia Anisocytosis Dimorphic RBCs
	Anemia of renal insufficiency Hemolysis	Normal RDW Normal or elevated RDW Thrombocytosis	Usually unremarkable Polychromasia Spherocytes Schistocytes Bite cells
	Anemia of chronic disease A primary bone marrow disorder	Normal RDW Increased RDW Other cytopenias Monocytosis Leukocytosis Thrombocytosis Abnormal differential	Unremarkable Dimorphic RBCs (MDS) Pseudo Pelger-Huët anomaly (MDS) Oval macrocytes (MDS) Myelophthisis (MMM)† Rouleaux (myeloma) Blasts (acute leukemia) Presence of abnormal cells
Macrocytic	Drug-induced	Increased RDW Marked or mild macrocytosis	Oval macrocytes
	Nutritional	Increased RDW Marked or mild macrocytosis	Oval macrocytes Hypersegmented neutrophils
	MDS or other bone marrow disorder	Increased RDW	Dimorphic RBCs Pseudo Pelger-Huët anomaly cells Oval macrocytes
	Liver disease, alcohol use	Normal RDW Thrombocytopenia	Round macrocytes Target cells
	Hypothyroidism Hemolysis	Normal RDW Normal or elevated RDW	Round macrocytes Polychromasia

*CBC = complete blood cell count; CD = Casteleman disease; MDS = myelodysplastic syndrome; MMM = myelofibrosis with myeloid metaplasia PBS = peripheral blood smear; RBC = red blood cell; RDW = RBC distribution width.
†Myelophthisis implies the presence of nucleated RBCs, immature myeloid cells, and tear-drop–shaped RBCs

Other variables which are called ‘calculated’ in the CBC include the mean corpuscular Hgb content (MCH) and mean corpuscular Hgb concentration (MCHC); these two calculated values are not frequently used in routine clinical practice. Since small cells have less hemoglobin than large cells, variation in the MCH tends to track along with that of the MCV. The MCH is something of a minor leaguer among the indices in that it adds little information independent of the MCV. The variables to focus on when examining the CBC results are Hgb as a general indicator of anemia or polycythemia, and MCV a key parameter for the classification of anemia. The first step in approaching anemia is to classify the process as microcytic (MCV, <80 fL), normocytic (MCV, 80-100 fL), or macrocytic (MCV, >100 fL) using this valuable diagnostic tool, which markedly narrows the differential diagnosis that needs to be considered in each patient (11).

Red blood cell distribution width (RDW) is an automated measure of the heterogeneity of red blood cell sizes (anisocytosis) and is routinely performed as part of a complete blood cell count. The RDW is used in the differential diagnosis of anemia, but otherwise has received little attention (21). Red cell morphology provides valuable information in the differential diagnosis of anemia and gives clues for other disease conditions if utilized properly (11). (Table 1.1).

Platelet count is useful to detect either thrombocytopenia or thrombocythemia. Automated counters provide platelet counts and generate the MPV and a measure of their size variability (PDW). The great dispersion of platelet volumes depends on the process of platelet production, by fragmentation of cytoplasm of megakaryocytes and pro platelet formation (9, 11).

2.1.1 WBC count, WBC differential and Interpretation

WBC and WBC differential count is very important in evaluation of infections. They also usually give important indication for the diagnosis of acute leukemia and chronic lymphoid or myeloid disorders as well as for the presence of leucopenia and neutropenia. Moreover, in patients with an abnormal WBC count, the clinician should immediately ask which WBC type is affected: neutrophils, lymphocytes, monocytes, eosinophils, or basophils. In this regard, the machine-derived 5-part differential should be confirmed by the manual method (i.e., peripheral

blood smear [PBS] examination) before it is acted on. The differential leukocyte count is probably the least understood and over utilized of all hematologic assays (11, 22).

To correctly interpret the differential count, it requires calculation of absolute counts by multiplying the percentage of each cell type counted by the total WBC count. In contrast, automated hematology analyzers enumerate thousands of WBCs and calculate percentages from the absolute numbers (11).

The absolute leukocyte count provides clinical information of much greater value than the relative differential count. In fact, the relative count can be misleading, and the sole use of this parameter can conceal the diagnosis of certain cytopenias or obscure clinically significant trends that are occurring. The absolute differential count, and not the relative count, is helpful in treatment process of absolute differential count is a superior indicator of infection, and very useful to follow patient progress after treatment (22).

The report of an abnormal blood count is often the first clue to an abnormality of the white cell series. However, the peripheral blood leukocyte count is only one measure of white cell activity, and several factors must be considered in data interpretation (22). For example, a reversal of the neutrophil/lymphocyte ratio can be misinterpreted as lymphocytosis, when in fact the patient is neutropenic (11).

Absolute leukocyte numbers must always be reviewed. In addition, the peripheral blood is only a means of expression for leukocytes, and only a small percentage of the total white blood cells in the body are present in the peripheral blood at any one time. Therefore, the total white blood count and absolute leukocyte count must be interpreted in light of the physical findings and other laboratory data (22). To facilitate the correct interpretation of the differential count, many laboratories, began reporting both percentages and absolute cell counts, adding length and complexity to the report. Some laboratories report only the absolute WBC counts (23, 24).

2.2 Reticulocyte reports

The reticulocyte count, an immature young red blood cell and indicator of effective red blood cell production provides useful information in characterizing anemia and particularly in estimating such conditions as acute bleeding and hemolysis (25, 26). Recent advances in analytical technology allow simultaneous measurement of reticulocytes with CBC on an automated analyzer (27). Automated reticulocyte count testing has improved precision and has been widely used in clinical laboratories. However, simultaneous measurement of reticulocytes in combination with CBC requires an additional cost (28).

Automated reticulocyte counts are typically reported in absolute numbers (reticulocytes per L), preventing the need to correct for hematocrit. 'The RPI is an index which helps to evaluate erythropoiesis efficiency and thus the productivity of the bone marrow. The physiological maturation of reticulocytes is divided into 3 days' maturation in the bone marrow and 1 day in the peripheral blood stream (29). In case of pronounced red blood cell production, the maturation of the reticulocytes shifts into the blood as the reticulocytes are passed into the peripheral blood earlier ('shift'). This leads to a pronounced increase in circulating reticulocytes, but does not represent proof of erythropoietic performance. The altered length of duration in the peripheral blood is called a 'shift'. The maturation time of reticulocytes in the bone marrow is proportional to the haematocrit, i.e. it decreases with the haematocrit, and the maturation time in the blood increases.' To give an indication of the efficiency of the bone marrow, the reticulocyte count is corrected by this haematocrit-dependent factor (29). Further considerations are necessary regarding the possible clinical use of new analytic parameters that are available only with automated analyzers but that have not yet reached their full potential (9).

2.3 Practice variation in professionals

Practice variation in laboratory test requisition, among physicians is well documented, which in part reflects uncertainty in medicine: although the number of clinical guidelines is increasing, in many specific clinical situations physicians determine the tests or interventions needed for their patients. Clinicians based on their experience, their training, the department of medicine they practice and their temperaments develop individual styles of patient management. Some physicians are comfortable ordering fewer tests, whereas others prefer the additional information

made available by using more testing, and also (30) organizational factors, such as the logistics and layout of the request form, also do have an influence (31).

The CBC has been advocated as routine components of the diagnostic investigation of persons who are sick and also as part of a screening program for those who are well. The CBC has no value in screening asymptomatic members of the general population. The complete blood count may be useful for screening infants in the first year of life, institutionalized elderly persons, pregnant women, and if poor nutrition or inadequate iron intake is suspected. These tests are not useful for hospitalized patients, unless an abnormality is suspected or surgery with major blood loss is anticipated. It is appropriate to obtain the tests when a hematologic or infectious disorder is suspected, but they may not affect decision making if the diagnosis is clinically evident. The leukocyte differential count is unnecessary to confirm an infection in most cases in which leukocytosis is present. Repeat tests should be limited to situations where the clinical course is unclear and at intervals long enough such that the results might affect clinical decision making (32).

For a long time there has been a discussion on the potential effects of tests ordered for patients with mild, probably self-limiting, complaints. From the perspective of evidence-based medicine, testing may be called 'superfluous' if the test results do not influence the medical decision making process, and the general practitioner (GP) would have had the same management with or without the test result. 'Superfluous' testing carries the risk of false-positive outcomes and may increase the risk of somatisation by labeling healthy persons as unhealthy, which in turn leads to a cascade of unnecessary interventions. In addition, it raises the costs of health care (31). Therefore, to improve the outcomes for patients and to ensure the best cost containment strategy, an appropriate test requesting and interpretation coupled with a patient-oriented vision is necessary (33).

2.4 Laboratory –Clinic communication

The laboratory is often involved in decision making directly or indirectly as estimated over 70% of medical decisions are made using laboratory data. For this reason, the laboratory is often involved either directly or indirectly in medical decision making. The laboratory and hospital need to design systems that reduce the possibility of error and to rapidly identify and resolve the

errors that do occur. This quality analytic process encompasses critical aspects as the formulation of the clinical question to the interpretation of laboratory results in the pre analytical, analytical and post analytical issues. Therefore, "laboratory–clinic communication is fundamental in achieving and maintaining total quality in laboratory services, as well as continuous education is required to maintain the best utilization of laboratory information in medical practice (33).

A technique for prompt communication between the laboratory and the clinicians in use of CBC/Reticulocyte report is to alter the format and content of the information that is exchanged routinely between the clinic and the laboratory. In most cases, the laboratory requisition, whether on paper or on a computer screen, serves as an obligatory interface in the process. The clinical laboratory undertook the project of redesigning laboratory requisitions to achieve the dual goals of ensuring compliance with all applicable regulations and to significantly influence test utilization. In addition, the units of reporting of cell counts in the report format need to be understandable and familiar for the clinicians using it (34).

Many physicians might be receiving more data than they want or find useful for the management of their patients. Although speculative, it is conceivable that excess data that are not useful to clinicians might actually impede their perception and comprehension of essential data and contribute to errors in medical judgment, and in the otherwise little data limit clinicians' decision skill (11).

2.5. Clinical Laboratory Methods course

Another tool for proper ordering and utilization of laboratory data is the adequacy of the Clinical Laboratory Methods course. It has been a practice that the course is offered to students in medical education, perceived as a tool in the introduction of the clinical laboratory discipline to clinicians. Interpretation of laboratory tests is one of the essential skills that students must learn and practice during an internal medicine clerkship. This basic course if not delivered adequately, and students couldn't have the chance to put hands on some laboratory techniques, the clinicians skill in test ordering and interpretation for patient management in their future actual work can be limited (35,36).

Appropriate use of laboratory testing is essential to achieve safe, effective, and efficient care to patients. Yet, despite data documenting that the ability of practicing physicians to appropriately order and interpret laboratory tests is declining as laboratory information increases. There has been little attention given to appropriate medical student education in the area of laboratory medicine. CDC addressed, "Medical education on laboratory testing is inadequate. Despite the integral role of laboratory testing in the practice of medicine, formal teaching of laboratory medicine is a relatively neglected component of the medical school curriculum. Without sufficient knowledge of laboratory tests, health care providers are more prone to inappropriate ordering and mistakes in interpreting test results, which can lead to poor case management, increased costs per patient, and adverse outcomes" (36,37).

Exposure of medical students to laboratory medicine has been an area of particular concern. A survey which was conducted by US medical schools evaluated the status of laboratory medicine education, and revealed that required courses were conducted in only 57% of schools, while only less than 5% of schools report no training at all in this aspect of medical practice. Several others have confirmed the total exposure to be suboptimal (35).

One approach to improving medical student training in laboratory medicine and pathology has been to insert it into the clinical clerkship years as a brief, but required, rotation. Other researches question the success of current laboratory medicine teaching in educating students to apply critical principles in practice. Non pathology residents were no better than medical students, further suggesting a failure throughout the medical undergraduate years that persists into postgraduate education. Attending physicians also show suboptimal ability to properly order diagnostic tests in various settings. In a British survey, around 20% of medical graduates described themselves as "less than competent" in using laboratory testing and more than 20% thought they were less than competent in all diagnostic approaches''(35).

In Ethiopia no documented data exists regarding the use and interpretation of hematological parameters in clinical practice. In addition, feedback of physicians' on appropriateness of the laboratory format design and unit of measurements preferred by Ethiopian physicians is not yet surveyed. Therefore, to alter the format and content of the information that is exchanged routinely between the clinician and the laboratory can be one means of dealing with such

operational challenge in proper use of Hematological parameters. Promoting appropriate test use behavior is a major focus of quality improvement, and many interventions should be targeted towards laboratory test ordering and interpretation of the results by clinicians according to the medical practice and availability of the technology.

3. STUDY OBJECTIVES

3.1 General Objective

To ascertain which components of the CBC, differential, and reticulocyte count reports issued by the laboratory of Addis Ababa hospitals are perceived as useful in clinical practice.

3.2 Specific Objectives

1. To determine the value of different components in the CBC/ Reticulocyte laboratory reports of Hematology department in patient management.

2. To evaluate the feedback of clinicians on the CBC form of reporting in Hematology department as service users.

3. To evaluate the adequacy of Clinical Laboratory Methods course at the medical schools.

3.3 Study Hypothesis

Clinicians in Addis Ababa (Ethiopia) do not adequately use (order and interpret) Hematological laboratory tests in clinical decision making; and clinicians may have a dissatisfaction on the adequacy of the Clinical Laboratory Methods course (CLM) during training, and on the design of the CBC laboratory report format.

4. MATERIALS AND METHODS

4.1 Study Design

The study was a hospital based Cross Sectional, questionnaire survey.

4.2 Study Area

The study was conducted in Addis Ababa hospitals (Private, Governmental, and NGOs) from Nov 2010 –Dec 2010.

4.3 Source Population

Clinicians who work in Addis Ababa hospitals

4.4 Reference Population

Clinicians who were directly involved in the diagnosis and treatment of patients in Addis Ababa hospitals.

4.5 Target Population

Interns, Residents, Health Officers, General Practitioners, and Specialists doctors in Addis Ababa hospitals

4.6 Inclusion and Exclusion Criteria

Clinicians working in either in the OPD and wards of hospitals were included in the survey. Health professionals that were involved in health provision but who did not belong to the above professional category and career were not included in the study. Professionals working in more than one health facilities were considered only once in the study.

4.7 Sample size

The required sample size is determined by using single population formula considering the following assumptions:

- Proportion of 50% (considering clinician use of CBC/Retics, 50 % was taken due to the absence of reliable previous study in this area)
- Level of significance = 0.05,
- Marginal of error (d) = 5%
- Sample size = n
- Z ($\alpha/2$) = -score at 95% confidence interval = 1.96

The formula for calculating the sample size (n) was:

$$n = \frac{Z_{\alpha/2}^2 P(1-P)}{d^2} \; ; \qquad n = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384$$

Considering a 5% non response rate, the sample size found to be 384 +15= 399. Therefore, a minimum of 399 study subject were required for the survey.

4.8 Sampling Technique

Convenient sampling, with stratified non proportional technique was employed.

4.9 Questionnaire design

A survey was designed that asked physicians to rate the frequency of use of each component of the CBC/Differential and Reticulocyte reports for their patients in medical practice. The components of the Addis Ababa hospital laboratories CBC/differential reports were listed in Table 4.1.

A 5-scale response option (Always, Frequently, Sometimes, Rarely, and Never) were used as alternative responses for rate of use of CBC/Retics parameters. The Always/Frequently response was taken to consider proper or routine use of the CBC/Retics parameter by the clinicians.

Reticulocyte reports included were the reticulocyte percentage, reticulocyte absolute count, Reticulocyte Production Index (RPI) and the Corrected Reticulocyte count. Physicians were also asked to select their preferences for differential (Absolute vs. Percent), and provide their opinion about the amount of data contained in the CBC/ Differential reports (too little, too much, or just right), and the preferred unit of measurement in cell counts to improve understandability and use of the report. Physicians were assessed in the adequacy of the Clinical Laboratory Methods education at medical school to evaluate the satisfaction of students by the quality of CLM course during training.

Table 4.1 Items included in a Complete Blood Count test report in Addis Ababa hospitals.

COMPONENTS OF CBC AND DIFFERENTIAL TEST BATTERY		
Parameter	***Definition***	***Units***
WBC	WBC count	$\times 10^9$/L
RBC	RBC count	$\times 10^{12}$/L
HGB	Hemoglobin concentration	g/dl
HCT	Hematocrit	%
MCV	Mean cell volume	fL
MCH	Mean cell hemoglobin	pg
MCHC	Mean cell hemoglobin concentration	g/dl
RDW	Red cell distribution width	%
PLT	Platelet count	$\times 10^9$/L
MPV	Mean platelet volume	fL
WBC differential	in percentages	%
WBC differential	in absolute counts	$\times 10^9$/L
Morphology comments on RBC and WBC morphologic features		

The survey was designed in Microsoft word, 1 page, and 2 sided form with check boxes for each of the response categories (Annex iii). Questionnaires for the survey were delivered to the medical director or administrative body of each hospital, and clinicians were asked to provide their feedback on the questionnaire on a morning meeting or in any convenient working time.

4.10 Study Variables

4.10.1 Independent Variable

-Profession: (HOs/GPs/Specialists/Residents and Interns)

-Experience: (1-5 years), (6-10years), more than 10 years

-Specialty area: (Surgery/Medicine/Pediatrics/Gymea-Obs)

- Adequacy of Clinical Laboratory Methods course at the medical college

4.10.2 Dependent Variable

- Rate of use of CBC and Retics

- Feedback on laboratory report format

4.11 Statistical Analysis

The data from the survey was entered in Microsoft excel, frequency distribution was done, and the Chi Square was used to determine the statistically significant association in response patterns between groups. SPSS statistical package version 17 was used. P values less than 0.05 was considered significant. The results from the survey were presented, discussed and explanations were provided for important findings.

4.12 Operational Definitions:

- ***Clinician/Physician/Doctors*:** are health practitioners who are directly involved in the diagnosis and treatment of disease, and management of patients in Addis Ababa hospitals.

- ***Low CBC/Retics use:*** when the key parameters of CBC which are important in diagnosis and classification of anemia and other conditions are rated low, and /or more of the parameters of CBC /Retics are rated low in (A/F) cases.

- ***Low use of a parameter:*** when the (A/F) rate of use of a parameter by clinicians is relatively low in relation to its theoretical clinical benefits, and its reported usefulness in other surveys.

- ***Adequate use of a parameter:*** when the (A/F) rate of use of a parameter by the clinicians is relatively satisfactory in relation to the clinical benefits of the parameter and its reported usefulness in other surveys.

- ***Always use of a parameter:*** routine, consistent, regular use of a parameter as to the understanding of the conceptual meaning.

- ***Sometimes use of a parameter:*** intermittently, occasionally or on and off use of a parameter at intervals or at random, as of its literal English meaning.

- ***Rarely / Never use****:* seldom, scarcely or not at all use of a parameter.

4. 12 Ethical Consideration

The study proposal was defended in the School of Medical Laboratory Sciences and was approved by the Institutional Review Board (IRB) of Addis Ababa University, School of Medicine. The Addis Ababa Health Bureau, the administration and the Medical Director Office of the hospitals were requested for permission and cooperation to conduct the survey. Permission was requested from every participant during data collection.

5. RESULT

This study mainly aimed to assess the vitality of the different CBC and reticulocyte parameters to clinicians in Addis Ababa hospitals. The diagnostic value of routinely considered CBC and reticulocyte parameters was identified by the always /frequently rate of use of the parameters by the clinicians. This survey succeeded in identifying several patterns of CBC/Retics use that might help in the design of computerized laboratory reports and Laboratory Information System (LIS) in Ethiopia.

5.1 Study participants

The survey rated the frequency of use of CBC, and reticulocyte reports to clinicians in a total of **408** clinical practitioners from thirty four hospitals in Addis Ababa city administration. The hospitals surveyed were nominated generally as governmental and private, accordingly 69% of the respondents were from 13 governmental hospitals and 31% of respondents were from 21 private hospitals.

GPs and Specialists covered the majority (60%) of study participants. HOs were in third place, following Residents and Interns contributing for the total respondents in the survey, as shown in Fig 5.1.

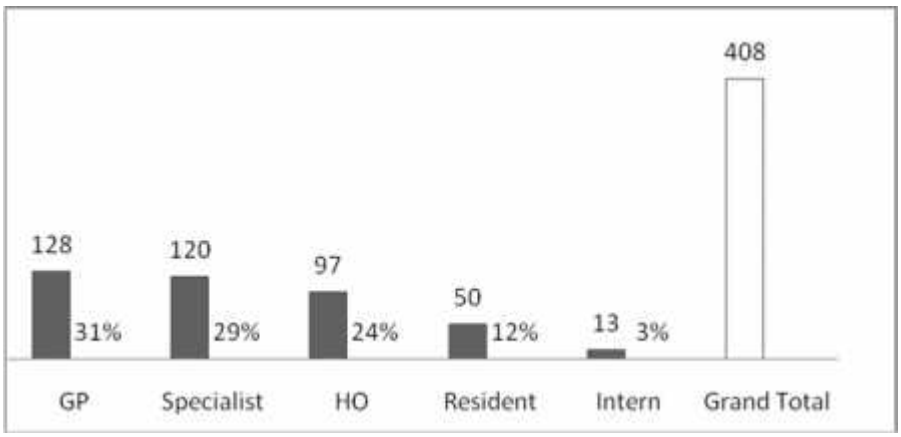

Fig 5.1 Distribution of clinicians participated in the survey.

Specialist doctors further indicated their specialty area, and 28% (33) of the specialists were from Internal Medicine, 24% (28) Gynecology - Obstetrician, 13% (15) Surgery, and 20% (24) Pediatricians. The remaining 20 (15%) are specialists in other areas of medical specialty. Of the respondent clinicians, 58% (234) had a clinical experience which falls between 1-5 years, and 24% (99) had a clinical experience of more than ten years and the rest 18% between 6-10 years. As indicated the majority of clinicians surveyed had a clinical experience of less than 5 years. Obviously, 100% Interns were grouped in this category. 87% Health Officers and 63% Residents who responded to the survey were found in this group. Majority of specialists (53%) had a clinical experience of greater than 10 years, and dominated the > 10 years experience category, as shown in Table 5.1.

Table 5.1: Percent distribution of professionals over clinical years of practice in Addis Ababa hospitals, Ethiopia (Nov 2010-Dec 2010)

Profession	**Years of experience of clinicians**		
	< 5 yr	***6-10 yr***	***>10yr***
GP	58	22	21
HO	87	9	4
Intern	100	0	0
Resident	63	20	16
Specialty	25	22	53
Total	**58**	**18**	**24**

5.2 Complete Blood Count

The reported use of CBC parameters for the clinical practitioners in Addis Ababa hospitals was shown in Table 5.2. Only 4 of the 13 parameters in the CBC were selected as frequently or always useful by more than 85% of the physicians: hemoglobin, haematocrit, WBC count, and WBC differential. Three of the parameters out of 13 reported as never or rarely useful by the majority of clinicians are RDW (67%), PDW (70%) and MPV (68%). Intern and Resident doctors rated to use the majority of CBC parameters in always and frequently cases than the other professional categories. Overall, HOs gave lesser ratings to more component of the CBC battery (12/13) than did the other professional group.

Among the respondents, professional variation associated significantly with use of some of CBC parameters: RBC, MCV, MCH, and PLT ($p < 0.001$), MCHC ($P<0.01$) and RDW ($p<0.05$). Year of experience of clinicians associated with only use of RBC count ($p < 0.001$) and red cell morphology ($p<0.05$), less than 5 years experienced professionals use RBC count and morphology more than the others. Similar trend has been observed in use of PLT count though it didn't associate statistically (Table 5.3). The specialty category has also been assessed and analyzed for variation of use of the CBC parameters, Table 5.4. There is significant association between medical specialty and use of RBC ($p<0.01$), MCHC ($P<0.05$), and MCV, MCH ($p<0.001$). Overall, in the specialty category, Internist (Internal Medicine) highly rated use of the CBC parameters than the other specialist counterparts. However, there was no relevant variation found between governmental and private working clinicians in use of CBC parameters (data not shown).

Table 5.2 Rate of use of CBC parameters by profession in Addis Ababa hospitals Nov 2010 –Dec 2010

Profession	RBC count		HGB		HCT		MCV		MCH		MCHC		RDW		Cell morphology		PLT count		MPV		PDW		WBC count		WBC Diff	
	F/A	R/N	F/A	R/N	F/A	R/N	FA	R/N	F/A	R/N	FA	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/ N	F/A	RN	F/A	R/N
GP (n = 128)	59	19	91	<1	90	2	28	24	24	29	22	32	11	66	15	23	63	8	10	69	12	67	98	<1	96	0
HO (n = 97)	41	14	73	2	77	3	16	42	13	45	12	47	2	74	19	31	39	24	5	68	3	77	87	0	81	5
Intern (n = 13)	77	15	100	0	92	0	39	0	31	0	31	8	15	62	23	8	92	8	15	62	15	62	100	0	85	15
Resident (n = 50)	64	10	94	0	98	0	50	16	44	18	32	32	8	56	30	28	72	8	10	62	6	58	94	2	96	2
Specialist (n=120)	43	29	89	3	93	< 1	38	29	35	30	33	31	15	68	19	26	58	9	12	73	11	73	93	0	88	0
All=408	**52**	**20**	**87**	**2**	**89**	**1**	**31**	**28**	**27**	**31**	**24**	**35**	**10**	**67**	**19**	**26**	**58**	**12**	**10**	**68**	**9**	**70**	**93**	**<1**	**90**	**2**

Table 5.3 Rate of use of CBC parameters by years of clinical practice of clinicians in Addis Ababa hospitals, Ethiopia (Nov 2010- Dec 2010)

Profession	RBC count		HGB		HCT		MCV		MCH		MCHC		RDW		Cell morphology		PLT count		MPV		PDW		WBC count		WBC Diff	
	F/A	R/N	F/A	R/N	F/A	R/N	FA	R/N	F/A	R/N	FA	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/ N	F/A	RN	F/A	R/N
1-5 year (n =234)	58	12	85	<1	87	2	33	25	29	29	24	33	8	65	22	21	61	13	8	65	8	67	92	1	89	3
6-10 year (n = 74)	49	26	86	3	92	1	27	30	26	31	22	35	12	65	19	26	55	11	9	74	12	72	99	0	96	1
>10 year (n = 99)	38	31	92	4	92	1	29	34	26	36	26	40	12	74	12	37	53	11	12	73	9	77	92	0	86	0
All = 407	**52**	**20**	**87**	**2**	**89**	**2**	**31**	**28**	**27**	**31**	**24**	**35**	**10**	**67**	**19**	**26**	**58**	**12**	**10**	**69**	**9**	**70**	**93**	**1**	**90**	**2**

F/A, (frequently or always use); R/N, (rarely or never use).

Response rates are given in percentages. The "sometimes" response rate (not shown) can be calculated by using the following equation: 100% – [F/A + R/N].

Table 5.4 Rate of use of CBC parameters by specialty in Addis Ababa Hospitals Ethiopia, Nov 2010-Dec 2010

Profession	RBC count		HGB		HCT		MCV		MCH		MCHC		RDW		Cell morphology		PLT count		MPV		PDW		WBC count		WBC Diff	
	F/A	R/N	F/A	R/N	F/A	R/N	FA	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/N	F/A	R/ N	F/A	RN	F/A	R/N
Gynea Obs (n = 28)	25	43	93	7	96	0	15	56	14	54	11	56	7	93	19	35	36	18	11	86	7	93	82	0	71	0
Int Medicine (n = 34)	73	12	97	0	100	0	76	9	67	9	58	12	24	49	31	13	88	3	21	58	22	50	100	0	100	0
Surgery (n = 15)	40	27	100	0	93	0	27	33	20	40	27	40	13	67	0	43	60	7	13	60	13	67	100	0	100	0
Pediatrics (n = 24)	33	33	70	4	88	0	42	12	46	17	46	17	21	50	8	8	42	12	4	75	4	75	96	0	92	0
Others (n=20)	35	35	85	5	85	5	10	40	10	40	10	40	5	85	25	45	60	5	5	85	5	85	85	0	75	0
All =120	**43**	**29**	**89**	**3**	**93**	**<1**	**38**	**29**	**35**	**30**	**33**	**31**	**15**	**67**	**19**	**26**	**58**	**9**	**12**	**72**	**11**	**73**	**93**	**0**	**88**	**0**

F/A, (frequently or always use); R/N, (rarely or never use).

Response rates are given in percentages. The "sometimes" response rate (not shown) can be calculated by using the following equation: 100% – [F/A + R/N].

Regarding WBC differential count, 90% of the clinicians reported use of WBC differential in always and frequently cases in medical practice. In addition, the clinicians responded their preference for a WBC differential report as *absolute only*, *percent only* and both *absolute* and *percent.* Accordingly 46% (184) of the clinicians preferred WBC differential to be reported in both absolute and percent, 39% (158) of them in percent only and 15% (60) of them as absolute only (Fig 5.2). This data showed more than a third of the clinicians prefer a percent report of WBC differential than the more useful absolute report.

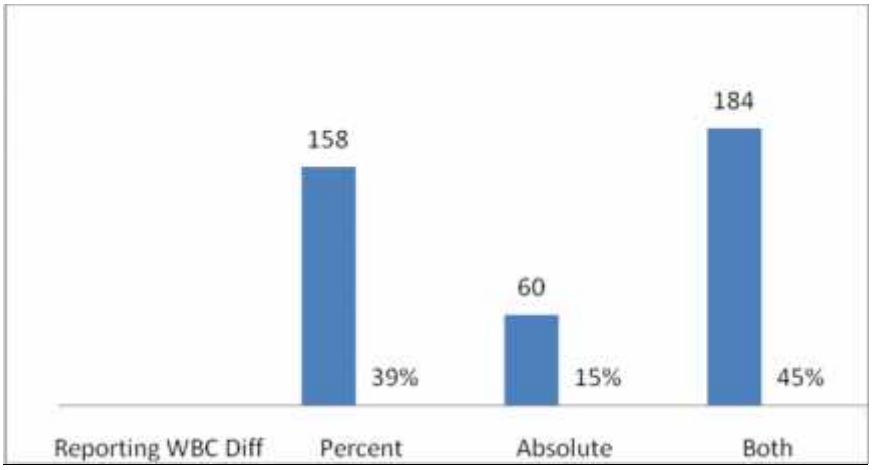

Fig 5.2: Clinicians preference for unit of reporting of WBC differential count

5.3 Reticulocyte count

Most clinicians rated use of reticulocyte parameters, rarely or never (Table 5.5). This shows reticulocyte parameters were not well considered for clinical decision making and patient management in Addis Ababa hospitals.

Table 5.5: Rate of use of reticulocyte parameters by clinicians in Addis Ababa hospitals, Ethiopia (Nov 2010 – Dec 2010)

	Retics %		Retics Abs		RPI		Corr Retics	
Profession	**A/F**	**R/N**	**A/F**	**R/N**	**A/F**	**R/N**	**A/F**	**R/N**
GP (n=128)	8	41	7	59	4	75	2	74
HO (n=97)	9	66	5	68	4	84	5	79
Intern (n=13)	23	23	15	23	0	31	8	39
Resident (n=50)	10	40	8	44	6	64	6	60
Specialist (n=120)	10	47	5	64	3	77	2	75
Total (n=408)	10	48	7	59	4	75	4	72

F/A, (frequently or always use); R/N, (rarely or never use). Response rates are given in percentages. The "sometimes" response rate (not shown) can be calculated by using the following equation: 100% – [F/A + R/N].

The use of reticulocyte count as percent and absolute unit assessed from the frequency of use of reticulocyte parameter (Table 5.5). 52% of the clinicians claimed to Always, Frequently and Sometimes use reticulocyte count in (%) unit and 41% of the clinicians claimed to use reticulocyte count in absolute unit. It showed clinicians prefer % unit than absolute unit in monitoring reticulocyte count. Overall (data not shown); reticulocyte count is more useful to Internists among the specialty, in that 100% (5/5) of the always/frequently use response in absolute reticulocyte count and 70% (7/10) of the always/frequently use of (%) reticulocyte among the specialty group is reported by Internists.

5.4 Feedback of Clinicians and Adequacy of CLM Course

To find out if any improvement measures are necessary in the laboratory report format design, and to help enhance the clinicians understanding and use of the materials reported, the clinicians were asked regarding the preference in unit of reporting of cell count. The clinicians, when asked for the preference of units of measurement in cell count, 67% (264) of them preferred cell counts to be reported in mm^3, whereas 28% (110) of them preferred µL and the remaining 6% (22) preferred cell counts to be reported in liter (Fig 5.3).

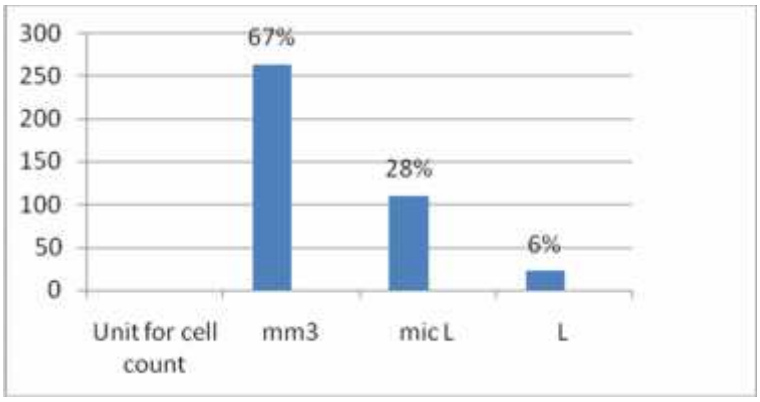

Fig 5.3: Clinicians preference for unit of reporting of cell counts.

Clinicians provided their feedback on the amount of data on the CBC laboratory report format, 66% (262) of the clinicians reported as *just right*, and 23% (91) commented it is *too much* and the rest *11% (*46) responded as *too little,* Fig 5.4. 70% (5/7) of the 'too little' responses regarding the amount of data on the laboratory report amongst the specialty is made by Internists (data not shown).

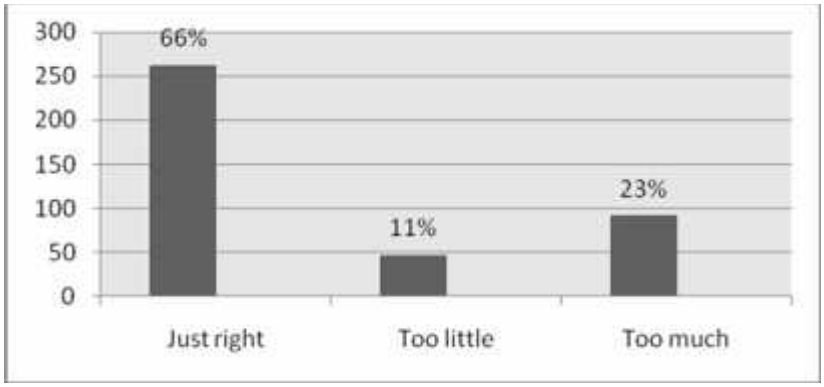

Fig 5.4: Feedback of clinicians on the content of CBC report

The quality of the Clinical Laboratory Methods course, given in medical education training was evaluated to assess its basic effect in the rate of use of CBC and Retics parameters. Clinicians were asked to express their opinion on the adequacy of CLM course in medical education; and 150 of them reported it to be *good*, 104 *(very good*), 76 (*fair*), 30(*poor*), 23(*excellent*) and 8(*bad*) out of the total 391 respondents in this regard. Merged responses showed, 28% of clinicians suggested strong satisfaction, however, the majority (61%), reported average satisfaction, and only 10% reported to the negative (Fig 5.5).

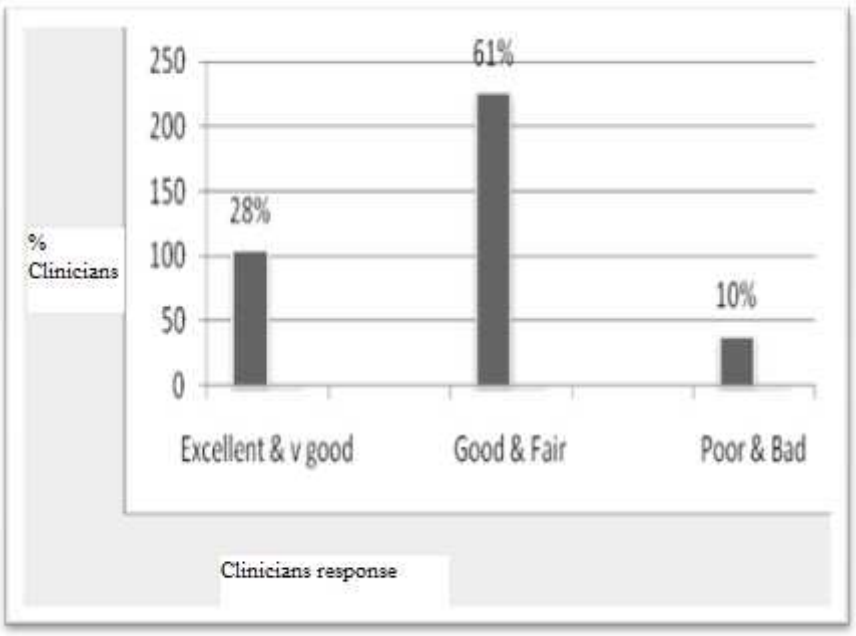

Fig 5.5: The feedback of clinicians on the competence of CLM course in medical education training.

6. DISCUSSION

Overall, in spite of a fundamental reason in the routine use of CBC and Retics parameters, adequate use of CBC and Reticulocyte results to clinical decision making in patient management in Addis Ababa hospitals was found out to be low, as implicated on Table 5.2 & 5.5.

Interns and Residents seem to be the highest user of CBC and reticulocyte parameters than the other professional group. This might be because as newly starting doctors, Interns may have a tendency to assess most of parameters for finding abnormal results that can fit to their decision making. They also may have an inclination to experience the parameters they read on books, in spite of selective use of parameters in specific situation. This inappropriate use, which give the impression of higher rate of use than their experienced medical counterparts can be a reflection of 'superfluous' laboratory test ordering habits by these professional group (17).

Residents alike the Interns can have a student syndrome, secondly they have a higher level of profession that inquire about further evaluation of disease. Residents and Interns use can also be affected as they can be highly dependent on laboratory based investigation of disease subjected to fear of their seniors in leaving any parameters unchecked for academic evaluation reasons (17, 38). If Residents used the parameters properly they couldn't have been better than their specialists counter parts. A possible rationalization here is that specialists, though use the parameters better than GPs and HOs, they are not better users than Residents and Interns because specialists are selective users, whereas Residents and Interns tend to be 'superfluous'. In such circumstances the impact of the CBC test result for patient management is limited. It can be that the results may not be reviewed by the requestor and also that the reviewed result had no impact on clinical management (39). 'Often, the risk of false positive test result is relatively high in overuse and this may result in a chain of unnecessary further testing, which in turn might lead to patient anxiety, high costs, somatisation and a risk of serious side effects or even unnecessary morbidity' (40,41).

Health officers were observed to use 12 of the 13 CBC less than the other professionals. This can be because; HOs educational background (make up) is supposed to be diverse from their MD counterpart. Health Officers curriculum is structured in less 'clinical courses' and attachment than MDs, and it is more of preventive and public health approach (42, 43). This may have

contributed for the low rate of use across most of the parameters in the CBC/Retics which are more associated with clinical disease investigation. The other possibility is that HO's working places in the hospitals, it has been found 'CBC results do not have much yield if they were ordered from Admission and Emergency departments' as they are not so necessary, and that the Health Officers may mostly work in such departments of the hospitals that they do not use the tests in investigation of disease (44).

6.1 COMPLETE BLOOD COUNT

The Red Cell Indices

The three cardinal RBC measurements (RBC count, HGB and HCT) are a primary and general indicators in evaluation of anemia, polycythemia and other conditions (20). The survey has indicated, HCT and HGB are equivalently most often used by clinicians. However, almost half of the clinicians do not frequently use RBC count contrary to the high level of use of HCT and HGB. A report by Patrick also indicated it is not common to use RBC count in decision –making (45).

These findings were comparatively similar with a study of the Sandhaus where they reported usefulness ratings of CBC among the specialists in USA (23). This may partially be explained as it is easier to remember the normal value of HCT and HGB, than the normal range of RBC as it would be difficult to mentally conceptualize normal ranges and results in millions of RBC, and it is also easier to clinicians to cross check the value of HGB and HCT as HGB x3 = +/- 3 HCT value as a quality control (20).

MCV, MCH, MCHC and RDW are valuable in the differential diagnosis of anemia. They are also valuable guide to further decide more specific measurements such as the hematinics (ferritin, serum iron, folic acid, and/or vitamin B12 levels) which have further diagnostic value to identify the underlying cause of anemia. However, the values of MCH and MCHC are generally not of great value in evaluation of anemia, but are more useful in the quality checks than usefulness in clinical decision making (11, 23, 46).

This survey found out the key parameters in classification of anemia MCV and RDW were rated to be used by 31% and 10% of the clinicians in always and frequently cases. In relation to a

similar article from USA by Sandhaus, our clinicians have differently very low use of the MCV and RDW parameters. According to this article, MCV is regarded as the single most useful erythrocyte index in the evaluation of anemia, and there was low use of MCH and MCHC report in all physicians alike our study (23). Patrick, remarks MCV as a critical and extremely accurate measurement (45). The majority of the clinicians on the Sandhaus report used RDW as always or frequently.

Nevertheless, it is only less than a third of our clinicians use MCV (Always and Frequently) in the many of patients with anemia in the hospitals needing proper treatment, and in spite of the fact that the first step in approaching anemia is to classify the process as microcytic (MCV, <80 fL), normocytic (MCV, 80-100 fL), or macrocytic (MCV, >100 fL) using this valuable diagnostic tool, which markedly narrows the differential diagnosis that needs to be considered in each patient (11).

This low use of MCV in medical practice by our clinicians, may indicate the lack of understanding in the use of MCV as an important index in the morphologic classification of anemia, which should have been used routinely from the point of view of appliance of evidence based medicine, and that there is no place for empirical use of Fe therapy for treatment and management of anemia in modern medical practice, (47) while Hematology machines are available in most hospitals in Addis Ababa as accessibility can't be a justification for such inadequate use.

Yet, some explanation as Quality Control issues, reference range set ups per population of Ethiopians may slightly hold back the clinicians not to trust the results obtained from the machines, even though these can't be a convincing way of thinking for lower rate of use of CBC parameters (20).

Among the professionals, use of MCV had significant association ($p<0.001$). Interns and Residents as pointed out demonstrated a highest rate of use which is considered more of superfluous use as rationalized. MCV was rated to be used by 38 % of Specialists > 28% of GPs and > 16% of HOs. This difference can be explained as specialists are geared to look for unusual diagnoses or rare diseases; this orients them toward laboratory workups (38) than GPs and HOs. GPs seem to have to use MCV for investigation of clinical disease than HOs, which may have

been limited to use due to the educational background and the area of department in the hospital they usually may attend (38).

Always/Frequently use of MCV among the specialists had significant association ($p<0.001$). Internal Medicine 73% > Pediatrics 42% > Surgery 27% > GO 15%. Internists are supposed to use MCV frequently than others because they daily treat patients with anemia and other internal disorders. Pediatricians also deal with this parameter as anemia is a common condition in children. But, this parameter is relatively less useful for the Surgeons, who need more of their patients' hematological stability than anemia differentiation, and likewise Gynecologists-Obstetricians focus more on delivery related matters.

The RDW, which is the coefficient of variation of the MCV, represents the degree of size variation (anisocytosis) in the erythrocyte population. RBC distribution width (a relatively useful parameter in the differential diagnosis of microcytic anemia), typically is useful when doctors treat anemia based on type and classification, and when particularly try to find out the degree of homogeneousity and heterogeneousity of RBC population. RDW is routinely performed as part of a complete blood cell count, but otherwise has received little attention (21).

RDW in Addis Ababa hospitals was rated to be even less important from the other Red Cell Indices. About 67% of the physicians in this survey reported to never or rarely use RDW, while the majority of the clinicians on the Sandhaus report used it always or frequently, nevertheless only 10 % of our clinicians use RDW always and frequently (23). Another study by Todd stated this parameter is largely overlooked (21). Use of RDW in Always/Frequently cases associated significantly in the professional group ($p<0.05$), specialists (15%) > GPs (11%) > HOs (2%). Specialists have higher qualification, dwell more in investigation of complicated disease and differential diagnosis, and hence is the relatively higher use of the RDW than GPs and HOs.

Anemia treatment is a day to day clinical activity of Addis Ababa hospitals as it is a common problem in most patients, or as a result of complication of other disease (47). It is known that prescribing drugs for anemic patients should have depended on the type of anemia of the patient, and likewise these red cell indices should have been used and practiced regularly.

Cell Morphology comments

Peripheral blood smear study in conjunction with red cell indices provides valuable information in the diagnosis of anemia. It is strongly recommended to obtain a PBS during the initial evaluation of anemia, regardless of subtype. A PBS substantially enhances the initial process of differential diagnosis and provides guidance for further testing. It also gives additional clues from morphologic features of RBC and WBCs on other disease states (11, 23).

This survey found only19% of the clinicians in Addis Ababa hospitals use RBC morphology in most of the cases, while the Sandhaus study found 52% of the clinicians use RBC morphology always and frequently for anemia diagnosis and differentiation (23).

Such low level of use of morphologic comments on RBC and WBCs can partially be explained as it is difficult to standardize red cell morphology report to characteristically determine a diseases condition, and hence clinicians may not often depend on it (48). In addition, in the past manual methods of blood smears couldn't give much confidence for clinicians due to the poor quality of report obtained from laboratories.

Platelet parameters

Platelet count is reported to be used in most cases by 58% of clinicians. The Sandhaus showed they use the platelet count in a higher rate than our clinicians. Sandhaus reported platelet count to be used always and frequently by most of the clinicians (88%), and MPV used rarely and never by majority of clinicians. This survey indicated the MPV and PDW are the least useful index reported from the CBC parameters. It is only less than 10% of the clinicians who reported they find the MPV or PDW frequently or always useful in medical practice. The difference with use of PLT count in USA can be due to the higher standard health service in the civilized world that clinicians use every diagnostic tool for patient benefit.

'The MPV is an indicator of the size distribution of platelets (analogous to the MCV), and was introduced into laboratory and clinical hematology as a potentially useful index in the differential diagnosis of thrombocytopenia' (9). The MPV is directly correlated with the rate of platelet production and, on this basis, was proposed as a discriminator of consumptive versus hypoproliferative thrombocytopenia (23). PDW is also useful in differentiating reactive thrombocytosis from the essential type, especially when combined with the MPV and Platelet

count to obtain a discriminate function (9). However, the contribution of the MPV and PDW to clinical practice in Addis Ababa hospitals as confirmed by this survey was very low.

WBC Count, WBC Differential & Unit of report

WBC count has been considered a cardinal measurement in a routine laboratory workup for just about any condition. The various types of infection and conditions that alter the number and proportion of the white cells occur in Ethiopia (49). Therefore, clinicians are assumed to use patient WBC value frequently. The data from the survey showed 93% (380) of clinicians use this parameter in most of the cases, which goes with the general trend of disease condition in the country.

WBC differential is another common Hematology parameter which has been done from earliest times of clinical practice in Ethiopia. Since it is a very good tool in indication of infection and severity, frequent use of WBC differential has been anticipated as infectious disease management is a common practice in Addis Ababa hospitals. Likewise, 90% (366) of the clinician use this parameter in most of the cases in medical practice.

Correct interpretation of the differential count requires calculation of absolute counts by multiplying the percentage (from 100 WBC counted) of each cell type by the total WBC count. In contrast, automated hematology analyzers enumerate thousands of WBCs and calculate percentages from the absolute numbers. Failure to convert WBC percentages into the absolute cell counts can result in misinterpretation of abnormalities in the relative cell proportions (22).

Moreover, the relative cell count has a disadvantage in that it obscures certain cytopenias, and clinically significant trends. While the absolute count is a superior indicator of infection, and is very much helpful in monitoring treatment process and follow up of patient progress after treatment (22). Therefore, in clinical practice absolute reports are more explanatory and useful than % count, and the presence of both may offer a disadvantage creating complexity in the report.

The survey showed 39% of the clinicians' preferred only percent forms of reporting rejecting the more useful absolute report. This certainly shows significant number of the clinicians, though mostly use the differential count, do not interpret it on the right aspect and may not succeed in obtaining the valuable information they required and mislead diagnosis as a result.

One possible explanation for such a strong preference to percent form of reporting by the clinicians in this survey is that it is easier to conceptualize relative proportions of cells than absolute cell counts per unit volume. In addition, most physicians may have practiced in the laboratory, how to perform and report differential percentages from blood smears during their medical education training, and possibly tend to use proportion of cells in percentages. It is also more difficult to remember reference ranges for absolute cell counts, unless they take time to review the report to analyze the findings. What is more, the information the clinicians have in the significance of the absolute report is still a query.

6.2 RETICULOCYTE COUNT

The reticulocyte count has historically been used as a tool for providing information regarding red cell production. Typically, the most common clinical indicator for performing a reticulocyte count is to diagnose or monitor the treatment of anemia (29).

The rate of use of the reticulocyte parameter seems quite low in comparison with the clinical benefits obtained from reticulocyte parameters. In addition, the unit of reporting preferred in reporting the result of a reticulocyte count in the surveyed clinicians may lead to misinterpretation of results. It is usual to give the reticulocyte value in percent. The interpretation of the reticulocyte count is problematic in severe anemia. A moderately increased relative reticulocyte count in severe anemia does not indicate a sufficiently strong regeneration of erythropoiesis, but merely indicates a shortened life span of the red blood cells. It is, therefore, preferable to give the absolute reticulocyte concentration in reticulocytes/µL, as this provides a direct measurement of erythropoietic performance (29).

In spite of this fact, 52% of the clinicians preferred reticulocyte to be reported in percent than in absolute count (41%). This is an area which needs improvement and clinicians need to be

advised to use the absolute count form of report when they are faced with medical condition that require the value of reticulocyte count.

Generally, reticulocyte parameters were considered low for patient management in medical practice in Addis Ababa hospitals. One reason for this can be lack of the information in how to fit in the results of reticulocyte count in decision making. However, most laboratories do not have the machines that report reticulocyte results, unless some private laboratories like Arsho's, ICL and a few other laboratories can do the tests in Addis Ababa, which practically is difficult to use such independent style of testing only for reticulocyte results in a differently located laboratory from economic and time management points (15,16).

If the reason for not practicing reticulocyte parameters was the unavailability of machine at hand in the laboratory while the clinicians find this usefulness for patient management, the responsibility goes to the service providing laboratories that were reluctant to provide the modern machines or manual techniques that perform these parameters. However, if reticulocyte count had been useful to the clinicians, the manual reticulocyte measurements could have been practiced as they are much cheaper than the automated techniques. It is, therefore, laboratories in Addis Ababa hospitals couldn't provide these tests can be because clinicians do not often request them, and as a cycle means they didn't find them useful and are not using them.

6.3 FEEDBACK OF CLINICIANS ON COMPLETE BLOOD COUNT

The laboratory report format should be of quality: clear, precise, simple and correct for easier understanding and interpretation of the data presented. A point which may contribute for a better design of a laboratory report format is its easier understanding of the contents. Data are easily taken in to application and are meaningful when presented by proper units of measurement. This survey showed up such issue by taking unit of measurement, and amount of data in the CBC report format in to account.

Units of measurement

Cell counts such as RBC/PLT/WBC can be reported per mm ^{3}, per μL (conventional), or per L (SI system) of unit of measurement. The mm^3 and μL give the same meaning; while cell counts reported in L provide a different multiplication numbering (factor) (20). When the reference volume is the liter, cell count values will increase by 10^6 from those obtained with μL or mm^3 as reference volume. However, the numerical values will remain the same if the multiplication factor is included as part of the unit-for example, X 10^6/L (50).

This survey reported that most of the clinicians (64%) prefer cell count to be reported in mm^3 unit, (Fig 5.3). The rationale for reporting laboratory test data in SI unit is that it is common practice in much of the world where such units are used on a daily basis in patient care and in publications from research and other studies (50).

In our context, as we are coming to the automated technique from manual method only recently, which often used mm^3 as a unit of report, this may have led most of our clinician to understand and have a preference to mm^3 as a unit for reporting of cell counts in Hematology. This implies, emphasis should be given in the reporting systems during medical education training thus clinicians in Ethiopia be very well acquainted to the use of the SI measurement unit. Otherwise, a possibility may be sought to change the reporting units on the Hematology machines as of the preference of the clinicians using the results.

Amount of Data

The data content of the laboratory report may deceive clinician's in decision making. Too much laboratory data may misinform clinicians and mislead diagnosis. In the same way limited information on laboratory report may also make the clinician uncertain in decision making for lack of sufficient information (11). However, concerning the Hematology CBC report most clinicians (66%) suggested the available data is averagely just right, Fig 5.4. 'Too little' data availability has been commented by 11% of clinicians. Among the 'too little' responses in the specialty, 70% of the ''too little'' responses were made by Internists who seek more data to be available on the laboratory report format. This data had been demonstrated in Internists higher

use of reticulocyte reports, which further suggests the need of additional laboratory tests to a segment of medical specialty (Internists).

Clinical Laboratory Methods course

It is generally believed that, clinicians participating in clinical decision making gained their skill and familiarity in the laboratory tools and diagnosis from the medical education they attended. CLM course in the medical education syllabus is an essential course in equipping tomorrow's clinicians in some basic laboratory skills and interpretation of laboratory data for diagnosis (35, 36).

The survey showed as on Fig 5.5, 61% of the clinicians reported the course to be 'Good and Fair' while 28% of the clinicians claimed 'Excellent and Very good'. This indicates there is no much satisfaction on the quality of the CLM course given at medical schools.

The quality and adequacy of a course in academic excellence is elucidated by the satisfaction level of students in the program. Most of the clinicians expressed their satisfaction level of the CLM course averagely saying 'good and fair' only. This large group of respondents need to be reversed to a level of adequacy in to a range of 'Excellent and V. good'.

Hence, a shortcoming in proper use of some laboratory parameters as obtained from the survey for one reason may steam from the competency of the CLM course in medical studies. Therefore, improving the course from various views can help students acquire the necessary skills that they will use in the true world of medical practice.

Strengths and Limitations of the Study

Strengths:

1. The research is a peculiar start that indirectly tells the health service provision in a bird's eye view in Addis Ababa hospitals linking with the educational grounds of clinicians.

2. The research surveyed most of the hospitals in Addis Ababa, and the data represents the true experience of clinicians.

Limitations:

1. The responses in frequency of use of CBC/Retics were not quantified during the survey, however, responses were merged /categorized in a distance (space) that avoids ambiguity, and in a way can be understood from literal English meaning.

2. The survey didn't directly inquire the knowledge gaps of CBC/Retics parameters of clinicians. Instead, rationalized and explanation was provided for low usage of CBC/Retics parameters by the clinicians.

3. There were not sufficient literatures directly related to this survey to have compared use of percentages of CBC/Retics parameters with this finding.

7. CONCLUSION & RECOMENDATION

7.1 CONCLUSION

The CBC/reticulocyte parameters are very useful hematological tests which are supposed to be used routinely in clinical decision making related to anemia, other blood disorders and disease conditions. However, the total use of CBC/Retics parameters in the clinicians surveyed in Addis Ababa hospital is quiet low. In investigation of anemia, bone marrow studies are invasive and hematinics (Ferittin, Folate etc) are relatively expensive. If the CBC/Retics parameters had been used effectively, the cost of anemia work up would drop considerably as CBC /Retics suggestive of a particular anemia would not have to undergo further evaluation, and the right treatment had gone to the right patient. The contribution of a laboratory based medical course (CLM), and the design and content of a CBC report form for the low use of these parameters has only been suggestive.

7.2 RECOMMENDATION

1. Responsible bodies to intervene, and promote adequate use of CBC/Retics parameters in medical practice of Addis Ababa hospitals.

2. Further research to determine provision of reticulocyte parameters in medical practice of Addis Ababa hospitals.

3. Additional research to identify the reasons for low use of CBC/Retics reports by clinicians including the Clinical Laboratory Methods course (laboratory based medical course) and CBC report format design as reasons.

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ANNEXES

Annex I: SUBJECT INFORMATION SHEET

Questionnaire for data collection on the survey of how useful are CBC and Reticulocyte reports to Clinicians, in Addis Ababa Hospitals.

Identification: Type of facility_____Name of facility_____Institution code_____
Address: Kifle Ketema_____ Kebele_____ Telephone_____

My name is Misganaw Birhaneselassie, a Master of Clinical Laboratory Science student at Addis Ababa University, Medical Faculty, and School of Medical Laboratory Sciences. The study will find out how well CBC and Reticulocyte Laboratory results are being used by clinicians in Addis Ababa Hospitals, and their applicability in clinical decision making. In addition, it surveys to identify the problems associated with inadequate use of these parameters. I believe that this research will provide appropriate data in this regard and will assess possible solutions towards appropriate test ordering, interpretation and overall clinical decision making in clinical practice. The survey is undertaken by a Questionnaire which is a single page, double sided paper containing clear questions which are tailored to the objective of the research. It will not take more than 5 minutes to fill in the Questionnaire. The data from the Questionnaire will be utilized only for the research purpose. The Questionnaire filled in would not be identified by person and the confidentiality would be kept. Once the data is utilized for the research purpose the collected information and the Questionnaire would be destroyed. You are kindly requested to fill in the Questionnaire to provide supportive data for the above mentioned rationale. You will not have any obligation to fill in the questionnaire if you are not willing to do so for any of your reasons.

For any information you can contact:

Mr. Misganaw Birhaneselassie

Tel 0912006832, misganawb@yahoo.com, misganawbs@gmail.com

Institutional Review Board (IRB): E-mail: aaumfirb@yahoo.comTel: 011-553-87-34 Fax +251-1-1-513099.

SUBJECT INFORMATION SHEET (Amharic Version)

ይህ መጠይቅ በአዲስ አበባ ከተማ ሆስፒ ሎች ውስጥ ሀኪሞች ምን ያህል በደም ላይ ከሚሰሩ የተወሰኑ የላቦራቶሪ ጥናቶች ለበሽተኛ በሚጠቅም መልኩ ንደሚገለገሉበት የሚያጠና ነው።

መለያ መረጃ፣የሆስተፕ ሉ አይነት---------- የሆስፒ ሉ ስም----------

አድራሻ፡- ክ/ከተማ----------የሆስፒ ሉ ኮድ----------የሆስፒ ሉ ስልክ ቁጥር---------

የቃል ስምምነት፣

ንደምኖት? የኔ ስም ምስጋናው ብርሃነሥላሴ ይባላል።

በአዲስ አበባ ዩኒቨርሲቲ ህክምና ላብራቶሪ የክሊኒካል ላብራቶሪ ሳይንስ የማስተርስ ተማሪ ነኝ።

ይህ ጥናት በደም ናሙና ላይ የሚሰሩ የተወሰኑ የምርመራ አይነቶች በምን ያህል ደረጃ በአዲስ አበባ በሚገኙ ሀኪሞች ለበሽተኛ ህክምና ድጋፍ ላይ ንደሚውሉ የሚያጠና ነው በተጨማሪም ሀኪሞቹ ነዚህን የምርመራ አይነቶች ንዳይጠቀሙ የሚያደርጉአቸው ችግሮች ካሉም ለመሌትና መፍትኤ ለማቅረብ ይሞክራል።

ጥናቱ በመጠይቅ በተዘጋጀ ፎርም የሚካሄድ ሲሆን መጠይቁ ከ5 ደቂቃ በላይ የማይፈጅ ነው።

መጠይቁም የሚውለው ለተጠቀሰው ጥናት አላማ ብቻ ሲሆን ሚስጥራዊነቱም የተጠበቀ ነው።

መጠይቁም ለጥናቱ ግልጋሎት ላይ ከዋለ በ ላ ይቃጠላል። በዚህ ጥናት ላይ መሳተፍ በርሶ ፍቃደኝነት ላይ የተመሰረተ ነው። ርሶ በተሰማዎት ማናቸውም ምክንያት መጠይቁን ላለመመሉት ከፈለጉ መብትበ ጆ ነው።

ምስጋናው ብርሀነ ሥላሴ ----------

ይህን ጥናት በተመለከተ ወይም ከዚህ ጥናት ጋር በተዛመደ መልኩ ስለሚያጋጥሙ ድንገተኛ አደጋ ችግሮች ወይም ጥያቄ ካለዎት በሚከተለው አድራሻ ይጠቀሙ።

ምስጋናው ብርሀነ ሥላሴ

ሞባይል 0912006832፣ኢሜል፣misganawb@yahoo.com

ለተጨማሪ መረጃዎች የአዲስ አበባ ዩኒቨርሲቲ ህክምና ፋኩልቲ ኢንስቲትዩሽናል ሪቪው ቦርድ ይጠይቁ።

ስ.ቁ +251-11-5-53-87-34

ፋክስ +251-11-5-51-30-99 **ኢ.ሜል** aaumfirb@yahoo.com

Annex II: CONSENT FORM

I have read the information sheet above and clearly understood the purpose and anticipated benefit of the research. I hereby need to assure with my signature below that I, without any coercion or forceful act by the research team, have decided to voluntarily participate in the study to contribute my part in the effort being made for the understanding of usefulness of Hematology parameters in clinical decision making by clinicians.

Unique ID No._____ Signature _____ Date_____

Interviewer's name _____Signature_____

Date of interview_____Time started_____Time finished_____

Supervisor's Name_____ Signature_____

I thank you for your cooperation

Please direct any questions or problems you may encounter during this study to: Misganaw Birhaneselassie; Department of Medical Laboratory Sciences - Addis Ababa University. Mobile 0912006832, e mail- misganawb@yahoo.com, misganawbs@gmail.com

For additional information, please contact Addis Ababa University Medical Faculty Institutional Review Board (IRB) office at:

Tel: +251-11-5-53-87-34, Fax 251-11-5-51-1-51-30-99, POBox9086, Addis Ababa, Ethiopia. E-mail: aaumfirb@yahoo.com

CONSENT FORM (Amharic Version)

ከላይ የተጻፈውን የመረጃ ሀሳብ አንብቤ፣የጥናቱን አላማበግልፅ ተረድቻለሁ፡፡ በዚህም መሰረት ለጥናት ቡድኑ አባላት ያለምንም ተፅ ኖ በሙሉ ፈቃደኝነት በዚሁ ጥናት በመሳተፍ በደም ናሙና ላይ ለሚደረጉ የላብራቶሪ ምርመራ አገልግሎት መሻሻል በሚደረገው ጥረት ውስጥ የበኩሌን አስተዋፆ ለማበርከት መወሰኔን በፊርማዮ አረጋግጣለሁ፡፡

የተጠያቂው መለያ ቁጥር----------ፊርማ----------ቀን----------

የመረጃ ሰብሳቢ ስም ----------ፊርማ----------ቀን----------

መረጃ የተሰበሰበበት ቀን----------የተጀመረበት ሰዓት---------- ያለቀበት ሰዓት----------

የተቆጣጣሪ ስም----------ፊርማ----------ቀን----------

ይህን ጥናት በተመለከተ ወይም ከዚህ ጥናት ጋር በተዛመደ መልኩ ለሚያጋጥሙን ችግሮች ወይም ጥያቄ ካሎት በሚከተለው አድራሻ ይጠቀሙ፡፡

ምስጋናው ብርሃነሥላሴ ሞባይል 0912006832፣ኢሜል፣misganawb@yahoo.com

ለተጨማሪ መረጃዎች የአዲስ አበባ ዩኒቨርሲቲ ህክምና ፋኩልቲ ኢንስቲትዩሽናል ሪቪው ቦርድ ይጠይቁ፡፡

ስ.ቁ +251-11-5-53-87-34

ፋክስ +251-11-5-51-30-99**ኢሜል** aaumfirb@yahoo.com

Annex III: **QUESTIONNAIRE**

1. Please, indicate which Hospital (Institution) you are working in?

◯ **Private** ◯ **Governmental (Public)** ◯ **Other (Ps mention) ----------**

2. Please, identify if you are:

◯ **Health Officer** ◯ **General Practitioner** ◯ **Specialist** ◯ **Other**

3. If you are a specialist, please indicate which area of specialty you belong to:

◯ **Pediatrics** ◯ **Internal Medicine** ◯ **Surgery** ◯ **Other (Ps indicate) ----------**

4. Year of experience in Clinical practice:

◯ **1-5 years** ◯ **6-10 years** ◯ **more than 10 years**

5. How frequently do you use the following CBC parameters in investigation of medical conditions? (Please tick one of the boxes for each item).

	Always	Frequently	Sometimes	Rarely	Never
1. WBC	◯	◯	◯	◯	◯
2. RBC	◯	◯	◯	◯	◯
3. HGB	◯	◯	◯	◯	◯
4. HCT	◯	◯	◯	◯	◯
5. MCV	◯	◯	◯	◯	◯
6. MCH	◯	◯	◯	◯	◯
7. MCHC	◯	◯	◯	◯	◯

8. PLT	○	○	○	○	○
9. PDW	○	○	○	○	○
10. RDW	○	○	○	○	○
11. MPV	○	○	○	○	○
12. WBC Diff	○	○	○	○	○
13. Morphology of RBC and WBC	○	○	○	○	○

6. How frequently do you use the following Reticulocyte parameters in investigation of medical conditions? (Please tick one of the boxes for each item).

	Always	Frequently	Sometimes	Rarely	Never
1. Retics (%)	○	○	○	○	○
2. Retics (Absolute)	○	○	○	○	○
3. RPI	○	○	○	○	○
4. Corrected Retics	○	○	○	○	○

7. How do you prefer a WBC differential to be reported in a Laboratory result?

○ **In percent** ○ **In Absolute count** ○ **Both**

8. Which units of measurement do you prefer in the reporting of some tests such as cell counts (RBC, WBC, and Platelet)?

○ **per microliter («L)** ○ **per Liter** ○ **per mm^3**

9. What is your opinion in the amount of data contained in the automated hematology report?

○ **too little** ○ **too much** ○ **just right**

10. How do you rate the adequacy of Clinical Laboratory Methods course in Medicine, to introduce the Hematology parameters and Clinical significance satisfactorily to medical students?

○ **Excellent** ○ **Very good** ○ **Good** ○ **Fair** ○ **Poor** ○ **Bad**

THANK YOU VERY MUCH FOR YOUR HELP

Annex IV: **Participating hospitals in the survey.**

Participating centres in the survey

Hospital (Institution)	Total
Addis Ababa Fistula	5
Addis Cardiac	3
ALERT	19
Amanuel Mental	18
Armed Force	36
Bella Defense	24
Betezata	7
Bethel	8
Betsegah MCH	8
BGM MCH	6
Brass MCH	2
Denberua MCH	7
Ethio-Tebib	12
Federal Police	9
Ghandi Memorial	11
Girum	7
Hayat	6
International Cardiovascular	3
Kadisco	7
Landmark	6
MCM	16
Megbare senay	5
Menilik II	14
Ras Desta	12
St Gebriel	7
St Paulos	33
St Peter TB Specialized	16
Tibebu General	3
Tikur Anbesa Specialized	54
TZNA	2
Yekatit 12	15
Zenbaba General	5
Zewditu Memorial	22

Grand Total	408

Annex V: Declaration

I the undersigned, declare that this is my original work and has not been presented for a degree in this or any other university and all sources of materials used for this thesis have been acknowledged.

Name: Misganaw Birhaneselassie

Signature _____

Place _____

Date of submission _____

(1) This thesis has been submitted with my approval as University advisor.

Name: Dr Aster Tsegaye

Signature _____

Place _____

Date of submission _____

(2) This thesis has been submitted with my approval as University advisor.

Name: Dr Amha Gebremedhen

Signature _____

Place _____

Date of submission _____

(3) This thesis has been submitted with my approval as University advisor.

Name: Mr Asaye Birhanu

Signature _____

Place _____

Date of submission _____