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REVIEW ARTICLE

EFFICIENCY OF FULL BLOOD COUNT IN ROUTINE PATIENT DIAGNOSIS: A SYSTEMATIC REVIEW

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Abstract

Full blood count is one of the critical laboratory tests. It provides information about the production of all blood cells, identifies the patient's ability to carry oxygen by evaluating red blood cell counts, and allows for immune system evaluation by assessing white blood cell counts with differential. This test helps diagnose anaemia, certain cancers, infections, and many others, as well as monitor the side effects of certain medications. For this reason, medical laboratories are flooded with a large number of blood and tissue samples that need to be analyzed as accurately as possible and in the shortest possible time. Moreover, it has different advantages, such as being cheap, simple to perform, and availability in different departments, from the emergency room to the critical care unit. Due to its usefulness in the assessment of health status of individuals, its parameters in cord blood, a major source of haemopoietic stem cell transplantation and an ideal source for laboratory investigations for newborns were determined to provide a useful guide to local neonatologists and stem cell transplant physicians. Therefore, it is critical to utilize this laboratory test to provide better care for patients.

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Introduction:-

Blood is composed of a fluid portion, called plasma, and a cellular portion that contains red blood cells, white blood cells and platelets. The complete blood count evaluates the three cellular components of blood. Some medical conditions, such as anaemia or thrombocytopaenia, are defined by marked increases or decreases in blood cell counts. Changes in many organ systems may affect the blood, so full blood count results are useful for investigating a wide range of conditions. Because of the amount of information it provides, the full blood count is one of the most commonly performed medical laboratory tests (Melinda, 2022).

The full blood count is often used to screen for diseases as part of a medical assessment. It is also requested when a healthcare provider suspects a person has a disease that affects blood cells, such as an infection, a bleeding disorder, or some cancers. People who have been diagnosed with disorders that may cause abnormal full blood count results or who are receiving treatments that can affect blood cell counts may have a regular full blood count performed to monitor their health, and the test is often performed each day on people who are hospitalized. The results may indicate a need for a blood or platelet transfusion (Beverly and Katherine, 2003).

A full blood count (FBC), also known as a complete blood count (CBC), is a set of medical laboratory tests that provide information about the cells in a person's blood. The full blood count indicates the counts of white blood cells, red blood cells and platelets, the concentration of haemoglobin, and the haematocrit (the volume percentage of red blood cells). The red blood cell indices, which indicate the average size and haemoglobin content of red blood cells, are also reported, and a white blood cell differential, which counts the different types of white blood cells, may be included (Colin, 2018).

The full blood count is often carried out as part of a medical assessment and can be used to monitor health or diagnose diseases. The results are interpreted by comparing them to reference ranges, which vary with sex and age. Conditions like anaemia and thrombocytopaenia are defined by abnormal complete blood count results. The red blood cell indices can provide information about the cause of a person's anaemia such as iron deficiency and vitamin B_{12} deficiency, and the results of the white blood cell differential can help to diagnose viral, bacterial and parasitic infections and blood disorders like leukaemia. Not all results falling outside of the reference range require medical intervention (Melinda, 2022; Obeagu et al., 2017; Obeagu et al., 2017; Obeagu et al., 2018; Obeagu et al., 2019).

The full blood count is usually performed by an automated haematology analyzer, which counts cells and collects information on their size and structure. The concentration of haemoglobin is measured, and the red blood cell indices are calculated from measurements of red blood cells and haemoglobin. Manual tests can be used to independently confirm abnormal results. Approximately 10–25% of samples require a manual blood smear review, in which the blood is stained and viewed under a microscope to verify that the analyzer results are consistent with the appearance of the cells and to look for abnormalities. The haematocrit can be determined manually by centrifuging the sample and measuring the proportion of red blood cells, and in laboratories without access to automated instruments, blood cells are counted under the microscope using a haemocytometer (Mike, 2014).

In 1852, Karl Vierordt published the first procedure for performing a blood count, which involved spreading a known volume of blood on a microscope slide and counting every cell. The invention of the haemocytometer in 1874 by Louis-Charles Malassez simplified the microscopic analysis of blood cells, and in the late 19th century, Paul Ehrlich and Dmitri LeonidovichRomanowsky developed techniques for staining white and red blood cells that are still used to examine blood smears. Automated methods for measuring haemoglobin were developed in the 1920s, and Maxwell Wintrobe introduced the Wintrobehaematocrit method in 1929, which in turn allowed him to define the red blood cell indices. A landmark in the automation of blood cell counts was the Coulter principle, which was patented by Wallace H. Coulter in 1953. The Coulter principle uses electrical impedance measurements to count blood cells and determine their sizes; it is a technology that remains in use in many automated analyzers. Further research in the 1970s involved the use of optical measurements to count and identify cells, which enabled the automation of the white blood cell differential (Ralph, 2015).

The full blood count measures the amounts of platelets and red and white blood cells, along with the haemoglobin and haematocrit values. Red blood cell indices—MCV, MCH and MCHC—which describe the size of red blood cells and their haemoglobin content, are reported along with the red blood cell distribution width (RDW), which measures the amount of variation in the sizes of red blood cells (Gauhar, 2015). A white blood cell differential, which enumerates the different types of white blood cells, may be performed, and a count of immature red blood cells (reticulocytes) is sometimes included.

The paper was written to educate individuals on the importance of full blood count as a part of routine health checkup, or when a person shows symptoms of an underlying health condition such as, infections, inflammation, cancer, leukaemia, some autoimmune conditions, some viral or severe infections, bone marrow failure, enlarged spleen, liver disease, alcohol excess and congenital marrow aplasia. It is important to note that depending on the reason for the test, it may be necessary to avoid eating or drinking before the test. This is because certain foods and beverages may influence the results. Full blood count is a fast readily available investigation, which adds essential

information to clinical assessment of a patient. Interpretation of the blood count is and important skill requiring knowledge of causes of individual abnormalities and the ability to recognize pattern associated with certain conditions.

Full blood count

A full blood count (FBC) is a common test that can help identify many different conditions. It is useful in monitoring a person's recovery from injuries, surgery, or another health condition (Alana and Aaron, 2020).

The full blood count (FBC) with differential is one of the most common laboratory tests performed today. It gives information about the production of all blood cells and identifies the patient's oxygen-carrying capacity through the evaluation of red blood cell (RBC) indices, haemoglobin, and haematocrit. It also provides information about the immune system through the evaluation of the white blood cell (WBC) count with differential. These tests are helpful in diagnosing anaemia, certain cancers, infection, acute haemorrhagic states, allergies, and immunodeficiencies as well as monitoring for side effects of certain drugs that cause blood dyscrasias (Beverly and Katherine, 2003).

The complete blood count generally includes the following components:

1. White blood cell count (WBC or Leukocyte count)
2. WBC differential count
3. Red blood cell count (RBC or erythrocyte count)
4. Haematocrit (Hct)
5. Haemoglobin (Hbg)
6. Mean corpuscular volume (MCV)
7. Mean corpuscular haemoglobin (MCH)
8. Mean corpuscular haemoglobin concentration (MCHC)
9. Red cell distribution width (RDW)
10. Platelet count
11. Mean platelet volume (MPV)

The main components are the blood cells such as white blood cells, red blood cells, and platelets. The other components represent additional information about these cells including their size, color, function, and maturity (Regina, 2020).

The white blood cell (WBC) differential refers to the number of the different types of white blood cells seen in the blood. The different types of WBCs that have specific functions that are routinely reported in a complete blood count are neutrophils, lymphocytes, basophils, eosinophils and monocytes (Siamak, 2020).

Procedure And Analysis Of Full Blood Count

The blood sample drawn for a complete blood count is analyzed in a medical laboratory. The complete blood count analysis is routinely and reliably done by automated machines in most laboratories. A small sample of the blood drawn from a person is fed into the machine and within a few minutes, the values of the components of the complete blood count are displayed and printed for review. This is called an automated cell count and differential (Colin and Adrian, 2018).

The conventional method to analyze these data is to obtain a small sample of the collected blood and place it on a glass slide for visual view under a microscope. This is usually done by a trained laboratory technologist or a doctor. This method is still widely used when results of a complete blood count need further review to confirm certain abnormal values, or a doctor wants to see how the blood cells look (for example, if any abnormal features are present which would not be reported by an automated complete blood count). This is called the manual differential analysis (Barbara and John, 2022).

Typical Values and Ranges of the Components of the Full Blood Count

Components	Values and Ranges
WBC (White Blood Cell)	4,300 and 10,800 cells per cubic millimeter (cmm)
RBC (Red Blood Cell)	4.2 to 5.9 million cells per cmm
Hemoglobin (Hbg)	13.8 to 17.2 g/dL for men, and 12.1 to 15.1g/dL for women

Hematocrit (Hct)	45% to 52% for men and 37% to 48% for women
Mean Corpuscular Volume (MCV)	80 to 100 femtoliters (a fraction of one- millionth of a litre)
Mean Corpuscular Hemoglobin (MCH)	27 to 32 picograms (a small fraction of a gram)
Mean Corpuscular Hemoglobin Concentration (MCHC)	32% to 36%
Red Cell Distribution Width (RDW) size and shape	11 to 15
Platelet Count	150,000 to 400,000 per cmm
Mean Platelet Volume (MPV)	6 to 12 femtoliters (a very small fraction of a liter)

It's worth noting that these are typical ranges. However, ranges may vary by the laboratory that analyzes them. (Xavier et al., 2003).

Efficiency Of Full Blood Count In Routine Patient Diagnosis

A full blood count is a common blood test that is often part of a routine checkup. Full blood counts can help detect a variety of disorders including infections, anaemia, diseases of the immune system, and blood cancers (Jonathan et al., 2021).

The test may also be used to:

Help diagnose blood diseases, infection, immune system disorders, or other medical conditions

1. Check for changes in an existing blood disorder
2. Full blood counts measure the three primary components of blood: red blood cells, white blood cells, and platelets (Melinda, 2022).

Red blood cells

1. For red blood cells, a full blood count measures:
2. How many red blood cells are present, or red blood cell count
3. The proportion of red blood cells to other cells, or haematocrit
4. Haemoglobin
5. The physical features of the red blood cells, such as their volume
6. The number of young red blood cells in circulation

Red blood cells contain haemoglobin, which carries oxygen around the body. They are typically flat and rounded with a dip toward the center.

The body produces red blood cells in the bone marrow before releasing them into the bloodstream.

Red blood cells have a lifespan of around 120 days, and the bone marrow must keep producing enough red blood cells to replace those that die or are lost through bleeding.

Some conditions can affect the production of red blood cells. For example, having a low red blood cell count can indicate anaemia (Aaron, 2020).

White blood cells

A full blood count will measure the white blood cell count and the count of each white blood cell type.

White blood cells are a part of the immune system and fight off infections. The body produces these cells in the bone marrow. It stores 80–90% of them in the bone marrow until the immune system needs them. Small numbers of white blood cells normally circulate in the blood. Having a high white blood cell count can indicate an infection or inflammatory condition (Deborah and Rachel, 2020).

There are several types of white blood cells. A rise in each type can mean something different. For example, an increase in neutrophils can indicate a bacterial infection, while increased eosinophils may be a sign of an allergy (Aaron, 2020).

Platelets

The full blood count will also measure the:

1. Patelet count
2. Average platelet volume
3. Average platelet width

Platelets, or thrombocytes, are small blood cells that form blood clots to prevent excessive bleeding. They have a short lifespan of approximately 10 days. The body typically produces platelets when it needs to repair damage (Paola et al., 2019).

Some conditions can cause high or low platelet counts. For example, an autoimmune condition or an infection can cause a low platelet count.

Having a high platelet count increases the risk of blood clotting. Sometimes, the body temporarily increases platelet levels, such as after surgery or an injury. Some conditions, such as cancer, also cause long-term increases. (Aaron, 2020).

Complete Blood Count also measures the following:

1. Haemoglobin, a protein in red blood cells that carries oxygen from your lungs to the rest of your body. It measures the amount of the haemoglobin molecule in a volume of blood and normally is 13.8 to 17.2 grams per deciliter (g/dL) for men and 12.1 to 15.1 g/dL for women.
2. Haematocrit, a measurement of how much of your blood is made up of red blood cells. It signifies the percentage of the whole blood occupied by red blood cells and usually ranges between 45%-52% for men and 37%-48% for women.
3. Mean corpuscular volume (MCV), a measure of the average size of your red blood cells and usually ranges between 80 to 100 femtoliters (a fraction of one-millionth of a liter).
4. Mean corpuscular haemoglobin (MCH) measures the amount of haemoglobin in an average red blood cell and usually ranges between 27 to 32picograms (a small fraction of a gram).
5. Mean corpuscular haemoglobin concentration (MCHC) measures the average haemoglobin concentration in a volume of blood, and it usually ranges between 32%-36%.
6. Red cell distribution width (RDW) measures the variability in the red blood cells' size and shape and usually ranges between 11 to 15. (Gauhar, 2015).

Other names for a full blood count (FBC) are; complete blood count, blood cell count, haemogram.

Clinical Significance Of Full Blood Count

Many illnesses, diseases or infections other than the ones listed below can cause an abnormal full blood count result. Abnormalities of the blood sample may include:

1. **Red blood cells and haemoglobin –** low levels (anaemia) may suggest too little iron in the diet, blood loss or certain chronic diseases (such as kidney disease). High levels (polycythaemia) may suggest polycythaemiavera, kidney disease, chronic lung disease or physiological changes due to living in areas of high altitude (David and DPhil, 2021).
2. **Red blood cell to plasma ratio –** a lower-than-normal ratio of red blood cells to plasma suggests the person may have anaemia. The opposite finding suggests that the person may be dehydrated or has too many red cells (polycythaemia) (Michael and John, 2017).
3. **White blood cells –** low levels (leucopenia) may suggest the person has a viral infection, bone marrow disease or has been exposed to chemo- or radiotherapy. High levels (leucocytosis) may suggest bacterial infection, an inflammatory disease or bone marrow disease (Deborah and Rachel, 2020).
4. **Platelets –** low levels (thrombocytopenia) may be the result of taking some medications, viral infection, bone marrow disorders, or an autoimmune disorder. High levels (thrombocythaemia) may suggest the presence of a bone marrow disease or an inflammatory condition (Michael and John, 2017).

If any of the levels are abnormal, it doesn't always mean that one has medical condition that needs treatment. Diet, activity level, medicines, a menstrual period, not drinking enough water, and other factors can affect the results. Talk to a laboratory practitioner to learn what your results mean.

A complete blood count is only one tool your health care provider uses to learn about your health. Your provider will consider your medical history, symptoms, and other factors to make a diagnosis. You may also need additional tests (Siamak and Nabili, 2020).

Blood smear

A 'blood smear' is when a thin film of your blood sample is examined under a microscope (Stacy and Lydia, 2018). A blood smear can reveal:

1. A range of diseases including red blood cell disorders (such as sickle cell anaemia).
2. The presence of blood-borne parasites such as malaria
3. A white blood cell disorder such as lymphoma or leukaemia (Colin and Adrian, 2018).

Treatment Of Abnormal Blood Count

If your blood count is low, it is a sign that your bone marrow is not producing adequate amounts of one type of blood cells. A low blood count can be referred to as cytopaenia (Naomi et al., 2020).

Low blood counts can have many causes, including vitamin deficiencies, bleeding, cancer, cancer treatment and rare bone marrow failure diseases like aplastic anaemia (Sabrina, 2020).

Improvement of Full Blood Count

If someone is feeling weak or fatigued, symptoms of anaemia is experienced. Anaemia occurs when red blood cell (RBC) count is low. If red blood cell (RBC) count is low, the body must work harder to deliver oxygen throughout the body (Sabrina, 2020).

There are five nutrients that may improve blood count:

1. **Iron:** Foods rich in iron include red meat, beans, legumes, egg yolks, prunes and raisins.
2. **Folic acid:** Consuming enriched cereals and breads, spinach, kale, lentils, peas and nuts can help increase folic acid levels.
3. **Vitamin B-12:** Foods high in vitamin B-12 include beef, fish, milk, cheese and eggs.
4. **Copper:** To add copper in diet, poultry, shellfish, liver, beans, cherries and nuts can be consumed.
5. **Vitamin A:** Great sources for vitamin A include sweet potatoes, squash, carrots, red peppers, watermelon, grapefruit and cantaloupe (Sarika, 2021).

While low white blood cell counts (leukopaenia) can occur during chemotherapy, these counts will most often return to normal before the following round of chemotherapy, or after chemo treatments are complete (Carolyn, 2019).

Control of Elevated Full Blood Count

High blood cell counts can always be controlled. But, there are things that can be done to lower the risk. For example:

1. Drinking lots of water.
2. Avoiding coffee, soda and other diuretics.
3. To quit smoking.
4. Exercise.
5. Taking iron supplements should be avoided.
6. Taking anabolic steroids or other performance-enhancing drugs should be avoided.
7. Use of appropriate medical devices, such as a Continuous Positive Airway Pressure (CPAP), in a case of sleep apnea.
8. In the case of heart failure, treatment given by laboratory practitioner should be followed strictly (Stephanie and Brunilda, 2020).

If more than phlebotomy and aspirin is needed, a doctor may prescribe hydroxyurea, a pill that lowers the red blood count and relieves symptoms (Alberto et al., 2008).

Full Blood Count And Accuracy

The full blood count test is not foolproof and errors sometimes occur. If this happens, a laboratory practitioner will want to repeat the test (Farhan, 2014). Errors may include:

1. Failure of the equipment – for example, the blood clots in the vial

2. Incorrect labelling of the sample
3. Incorrect handling of the specimen – for example the sample is left in the sun and deteriorates
4. Contamination of the sample
5. Alcohol in the blood (Ozayet al., 2006).

Conclusion:-

Blood is composed of a fluid portion, called plasma and cellular portion that contains white blood cells, red blood cells and platelets, which play very important functions in the body. A full blood count is useful to evaluate the overall health status of a person. There are very low to absolutely no risks associated with a full blood count test. The blood test only involves taking a sample of blood from the patient. As a target test, full blood count is performed in patients who have or are suspected to have anaemia, polycythaemia, infection, leukaemia, or thrombophilia, among various conditions. Laboratory test results including full blood count tests, might be influenced by many various controllable factors, such as alcohol consumption, smoking, physical activity and diet as well as whether and for how long patients have fasted before specimen collection. Patients should always be informed of how they should prepare for blood specimen collection for laboratory tests. A full blood count is typically not a definitive diagnostic test. Depending on the reason a doctor recommended this test, results outside the normal range may or may not require follow-up. Your doctor may need to look at the results of a full blood count along with results of other blood tests, or additional tests may be necessary.

Recommendation:-

Full blood count is the most commonly performed laboratory test. It is recommended to be performed in every healthy person as a screening test once per year. It is routinely conducted in patients that are admitted to the hospital and is frequently performed in patients that attend a general practice. A doctor may suggest a full blood count if one is experiencing weakness, fatigue, fever, inflammation, bruising or bleeding. A full blood count may help diagnose the cause of these signs and symptoms. If your doctor suspects that you have an infection, the test can also help confirm that diagnosis. Therefore, full blood count test is recommended for everybody, both young and old.

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