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# Complete Blood Count

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## Introduction

The Complete Blood Count (CBC) is one of the most commonly ordered lab tests—it is fundamental because it offers insights into many medical conditions that can have psychiatric implications. As psychiatrists we often order and review CBCs, but we may not remember how to interpret the various abnormalities. This fact sheet will guide you through the essentials of the CBC, including when to order it, how to interpret its elements, and its relevance in psychiatry.

## Elements of the CBC: A basic review

- **White blood cells (WBC).**
  - **Function:** WBCs are crucial for the immune response. Normal range: 4,000 to 10,000 WBCs per microliter of blood.
  - **Differential.** Lists types of WBCs both as percentages of the total count and absolute numbers.
    - **Neutrophils** (~60% of WBC): Elevated in bacterial infections.
      - Neutrophils are typically the first WBCs that the bone marrow produces when battling an infection. You'll often hear terms thrown around like "bands", "segs", and "shift to the left". A "band" means an immature neutrophil, in which the nucleus looks like a simple band or U-shape. A segmented neutrophil (a "seg") is a regular mature cell, with a nucleus that is segmented into several lobes. A "shift to the left" means that there are more bands than normal, in other words lots of new neutrophils are being produced to fight infection.
    - **Lymphocytes** (~20%): Elevated in viral infections or tuberculosis.
    - **Monocytes** (~5%): Also higher in viral infections and TB
    - **Eosinophils:** Elevated in allergic reactions and parasitic infections. Significant increases might suggest a drug reaction in psychiatric patients, especially if accompanied by symptoms like rash or itching.
- **Red Blood Cells (RBC)**
  - **Function:** RBCs transport oxygen. The CBC offers several indices for evaluating RBCs:
  - **Hematocrit (Hct):** This measures the proportion of blood volume that is made up of RBCs. Normal ranges vary by sex, typically 38-48% for males and 35-45% for females.
  - **Hemoglobin (Hgb):** Hemoglobin is the protein in RBCs that carries oxygen. Normal values are usually between 14 to 17 g/dL for males and 12 to 15 g/dL for females.
  - **Others:**
    - **MCV** (Mean Corpuscular Volume): Average volume of individual red blood cells. Useful in classifying anemias as microcytic, normocytic, or macrocytic.
    - **MCH** (Mean Corpuscular Hemoglobin) and **MCHC** (Mean Corpuscular Hemoglobin Concentration): Average hemoglobin amount and concentration in RBCs, aiding in anemia diagnosis.
    - **RDW** (Red Cell Distribution Width): Variability in RBC size, differentiating anemia causes.

- **Platelets**
  - **Function:** Critical for blood clotting. Normal range: 150,000 to 450,000 platelets per microliter
  - **Thrombocytopenia (low count):** May result from medication effects (e.g., valproic acid), viral infections, autoimmune diseases. Presents with easy bruising/bleeding.
  - **Thrombocytosis (high count):** Often reactive to inflammation or infection. Elevated counts suggest underlying processes that might affect psychiatric status.

#### A note on terminology

- **Leukopenia:** Overarching term meaning a low WBC count, generally below 4 (4000 cells per microL). This doesn't specify which type of WBC is low—for that, you have to look at the differential.
- **Neutropenia:** Lower than normal neutrophil count (below 1500). In drug induced neutropenia, the total WBC count may be normal even in the presence of neutropenia.
- **Agranulocytosis:** Severe version of neutropenia, in which there are essentially no neutrophils in the blood.
- **Pancytopenia:** Reduction in *all* types of blood cells, including WBCs, RBCs, and platelets. It is usually caused by bone marrow suppression.
- **Bone marrow suppression:** Can be caused by various psychiatric medications and can lead to various hematological problems.

#### Reasons to order CBC in psychiatry

- Rule out hidden medical issues that may be masquerading or contributing to psychiatric symptoms
- Investigate physical symptoms and general health status in a newly admitted psychiatric patient, especially those who have had poor outpatient medical followup.
- Detect hematological side effects of psychiatric medications, eg., neutropenia due to clozapine or carbamazepine

#### How to interpret the CBC in inpatient psychiatry

- **WBC Abnormalities**
  - **Leukocytosis (Elevated WBC)**
    - **Infection.** A WBC count over 10,000 per  $\mu\text{L}$  could indicate an infection. Assess the differential for a "shift to the left," signifying a higher percentage of immature WBC forms (bands), which occurs in response to infection.
      - Common signs of infection include fever, urinary symptoms, upper respiratory symptoms, and skin changes indicative of cellulitis.
      - Common infections that you may see in your psychiatric inpatients include:
        - Urinary tract infections: A frequent cause of delirium, especially in patients with dementia.
        - Upper Respiratory Infections: Such as bronchitis, potentially progressing to pneumonia.
        - Cellulitis: Often resulting from IV drug use or self-injury.
        - Sinusitis
  - **Lithium.** Lithium therapy can cause benign leukocytosis.
  - **Steroid use.** Steroid use (such as for COPD exacerbations) can cause leukocytosis.
  - **Dehydration.** Apparent leukocytosis due to hemoconcentration. Factors like homelessness or reduced food and fluid intake from depression might lead to dehydration in newly admitted patients. This usually resolves with adequate hydration.
  - **Psychological stress.** The stress associated with psychiatric illness can induce leukocytosis through cortisol and catecholamine release, prompting the release of WBCs from the bone marrow.

## Leukopenia (Low WBC) in psychiatry

- **Medication side effect.**
  - **Clozapine.** In about 3% of patients, clozapine can cause a low neutrophil count. If your patient's absolute neutrophil count (ANC) is at least 1500, you can start clozapine and then follow standard monitoring guidelines (see Clozapine fact sheet). Neutropenia is defined as an ANC below 1500. "Agranulocytosis" is a very severe form of neutropenia implying near absence of neutrophils. (By the way, "granulocytes" are so named because these types of WBCs have visible granules in the cytoplasm—granules which contain substances crucial for fighting bacteria. While two other types of WBCs are also called granulocytes—eosinophils and basophils—neutrophils are the most abundant and important granulocytes.)
  - **Carbamazepine.** Can rarely cause neutropenia, anemia, and pancytopenia.
  - **Valproic Acid.** Can cause general bone marrow suppression, often initially indicated by thrombocytopenia (low platelet count).
- **Drug or alcohol use disorder.** Chronic drug or alcohol use disorder can lead to various hematological changes, including the potential for bone marrow suppression. The mechanisms involve direct toxicity to the bone marrow, nutritional deficiencies (such as folate or vitamin B12 deficiency), and the harmful effects of substances or their metabolites on the production of white blood cells.
- **RBC abnormalities**
  - **Decreased (Anemia)**
    - **Iron Deficiency Anemia**
      - **Characteristics:** Iron deficiency anemia is classified as microcytic, meaning the red blood cells (RBCs) are smaller than normal. It is diagnosed with a low hematocrit (Hct) and hemoglobin (Hgb) levels. Key laboratory findings include a low Mean Corpuscular Volume (MCV) typically below 80 fL, Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) within or below the lower limits of normal (MCH: 27-32 pg, MCHC: 31-36 g/dL).
      - **Causes:** The most common causes include chronic blood loss (e.g., from gastrointestinal bleeding or heavy menstrual periods), dietary iron deficiency, or malabsorption syndromes (e.g., celiac disease).
      - **Standard Follow-up Labs:** To confirm iron deficiency and its severity, standard follow-up labs include serum ferritin, serum iron, Total Iron Binding Capacity (TIBC), and transferrin saturation. A low serum ferritin is the hallmark of iron deficiency. Additional tests may include stool occult blood test to rule out gastrointestinal bleeding as a cause.
    - **Vitamin B12 or Folate Deficiency Anemia (Megaloblastic Anemia)**
      - **Characteristics:** This type of anemia is known as megaloblastic due to the presence of unusually large RBCs, with an elevated MCV (>100 fL), indicating a macrocytic anemia. The hemoglobin (Hgb) and hematocrit (Hct) are usually low, and the Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) can be elevated or within the upper limits of normal.
      - **Causes:** B12 deficiency can result from poor dietary intake, malabsorption (as seen in pernicious anemia or after gastric surgery), or certain medications. Folate deficiency is often due to dietary deficiency, malabsorption, or increased need (as in pregnancy).
      - **Standard Follow-up Labs:** To distinguish between B12 and folate deficiencies, the following labs are recommended: serum vitamin B12 level, red cell folate level, and homocysteine and methylmalonic acid levels (elevated in B12 deficiency).

- o **Elevated (Polycythemia)**

- **Primary Polycythemia (Polycythemia Vera):** A rare condition that results in increased RBC production due to abnormalities in the bone marrow. This condition requires specialist management.
- **Secondary Polycythemia:** More common in the psychiatric setting, can be caused by chronic hypoxia or smoking. It may also be induced by testosterone replacement therapy. Symptoms include headaches, dizziness, and an increased risk of blood clots.
- **Dehydration:** Similar to leukocytosis, apparent high RBC count can be due to hemoconcentration. It's reversible with proper hydration.

- **Platelets (Thrombocytes)**

- o **Function:** Platelets play a crucial role in hemostasis, the process of blood clotting to prevent excessive bleeding. Their normal range is typically between 150,000 to 450,000 platelets per microliter of blood.
- o **Thrombocytopenia (Low Platelet Count)**
  - **Causes:** Can result from bone marrow suppression due to medication effects (e.g., valproic acid, some antipsychotics), viral infections, autoimmune diseases, or as a part of pancytopenia.
  - **Psychiatric Relevance:** Patients with low platelet counts may present with easy bruising or bleeding, which can be concerning and require medical evaluation. Monitoring platelet counts is essential when initiating or managing treatment with medications known to impact bone marrow.
- o **Thrombocytosis (High Platelet Count)**
  - **Causes:** Often a reactive process due to inflammation, infection, or as an acute phase reactant. Less commonly, it can be due to a primary hematological disorder.
  - **Psychiatric Relevance:** Elevated platelet counts may indicate an underlying inflammatory or infectious process that could be affecting the patient's psychiatric status or response to treatment.