White Blood Cells Disorders

(Part 1)

Lecture: 17                          Dr. Saif Saadedeen

WBCs provide the primary defense against microbial infections and are critical for mounting an immune response. Defects in WBCs can manifest as delayed healing, infection, or mucosal ulceration. To ensure the health of the patient, the dentist should be able to detect WBCs abnormalities through history, clinical examination, and screening laboratory tests and should provide prompt referral to a physician for diagnosis and treatment before invasive dental procedures are performed.

Patients with known life-threatening disorders who are under medical care should not receive dental care until after the dentist has consulted with the patient’s physician.

The name "white blood cell" derives from the physical appearance of a blood sample after centrifugation. The scientific term leukocyte directly reflects its description. It is derived from the Greek roots leuk- meaning "white" and cyt- meaning "cell".

WBCs make up approximately 1% of the total blood volume in a healthy adult. However, this 1% of the blood makes a large difference to health, because immunity depends on it.

White blood cells are produced from cells in the bone marrow known as hematopoietic stem cells. All white blood cells have nuclei, which distinguishes them from the other blood cells, the anucleated red blood cells (RBCs) and platelets. WBCs are found throughout the body, including the blood and lymphatic system.
Three groups of WBCs are found in the peripheral circulation:

1. **Granulocytes**
   90% is composed of neutrophils; the remainder consists of eosinophils and basophils.

2. **Lymphocytes:** Circulating lymphocytes are of three types:
   - T lymphocytes
   - B lymphocytes
   - Natural killer cells

3. **Monocytes**

Granulocytes are distinguished from agranulocytes by their nucleus shape (lobed versus round, that is, polymorphonuclear versus mononuclear) and by their cytoplasm granules. Myeloid cells (neutrophils, eosinophils, basophils and monocytes) are distinguished from lymphoid cells (lymphocytes) by hematopoietic lineage (cellular differentiation lineage).

The primary function of **neutrophils** is to defend the body against certain infectious agents (primarily bacteria) through phagocytosis and enzymatic destruction. **Eosinophils** and **basophils** are involved in inflammatory allergic reactions and mediate these reactions through release of their cytoplasmic granules. Eosinophils also combat infection by parasites.

**T lymphocytes (T cells)** are involved with the delayed, or cellular, immune reaction, whereas **B lymphocytes (B cells)** play an important role in the immediate, or humoral, immune system involving the production of plasma cells and immunoglobulins (IgA, IgD, IgE, IgG, and IgM).

**Monocytes** have diverse functions that include phagocytosis, intracellular killing (especially of mycobacteria, fungi, and protozoa), and mediating of the immune and inflammatory response through the production of more than 100 substances, such as cytokines and growth factors, that increase the activity of lymphocytes.
In addition, monocytes serve as antigen-presenting cells and migrate into tissues. In tissue, these antigen-presenting cells are known as dendritic cells (in lymph nodes) or Langerhans cells (in skin and mucosa). Monocytes in tissue that phagocytose microbes are known as macrophages.

WBCs that circulate in the peripheral blood account for only 5% of the total WBC mass and form two pools of cells: a marginal one and a circulating one. Cells in the marginal pool adhere to vessel walls and are readily available. When infection threatens the body, the storage and marginal pools can be called on to help fight the invading organisms.

Lymphocytes localize primarily in three regions: lymph nodes, the spleen, and the mucosa-associated lymphoid tissue (MALT) lining the respiratory and gastrointestinal tracts. At these sites, microbial antigens are trapped and presented to B or T lymphocytes.

**Leukocytosis and Leukopenia**

The number of leukocytes in the blood is often an indicator of disease, and thus the WBC count is an important subset of the complete blood count.

The number of circulating WBCs normally ranges from 4400 to 11,000/μL in adults. The differential WBC count is an estimation of the percentage of each cell type per microliter of blood.

A normal differential count consists of:
- Neutrophils, 50% to 60%;
- Eosinophils, 1% to 3%;
- Basophils, less than 1%;
- Lymphocytes, 20% to 34%;
- Monocytes, 3% to 7%.
The term leukocytosis is defined as an increase in the number of circulating WBCs to more than 11,000/μL, and leukopenia as a reduction in the number of circulating WBCs (usually to less than 4400/μL).

Many causes of leukocytosis are known. Exercise, pregnancy, and emotional stress can lead to increased numbers of WBCs in the peripheral circulation. Leukocytosis resulting from these causes is called **physiologic** leukocytosis. **Pathologic** leukocytosis can be caused by infection, neoplasia, or necrosis.

Pyogenic infections induce a type of leukocytosis that is characterized by an increased number of **neutrophils**. Tuberculosis, syphilis, and viral infections produce a type of leukocytosis that is characterized by increased numbers of **lymphocytes**. Protozoal infections often produce a type of leukocytosis that increases the numbers of **monocytes**. Allergies and parasitic infections increase the numbers of circulating **eosinophils**. **Leukemia** (cancer of the WBCs) is characterized by a great increase in the numbers of circulating immature leukocytes. Acute bleeding also can result in leukocytosis.

Many causes of deficient numbers of leukocytes (less than 4400/μL) in the blood are evident. **Leukopenia** occurs during agranulocytosis (reduction of granulocytes) and pancytopenia (decreased WBCs and RBCs) that result from toxic effects of drugs and chemicals. Leukopenia is a common complication that results from the use of chemotherapeutic (anticancer) drugs.

Patients with leukocytosis or leukopenia may have bone marrow abnormalities that can cause thrombocytopenia. Examination of the patient’s bone marrow aspirate is important for making the final diagnosis.
Leukemia and Lymphoma

Leukemia and malignancies of lymphoid cells (lymphoma and multiple myeloma). These patients become gravely ill if they are not properly identified and do not receive appropriate medical care. In addition, patients are usually immunosuppressed as a result of the disease itself or because of the treatment used to control it. Hence, they are prone to develop serious infection and often bleed easily because of thrombocytopenia.

Leukemia

Leukemia is cancer of the WBCs that affects the bone marrow and circulating blood. It involves exponential proliferation of a clonal myeloid or lymphoid cell and occurs in both acute and chronic forms. Acute leukemia is a rapidly progressive disease that results from accumulation of immature, functionless WBCs in the marrow and blood. Chronic leukemia have a slower onset, which allows production of larger numbers of more mature, functional cells.

There are four common types of leukemia:
(1) Acute lymphoblastic leukemia (ALL)
(2) Acute myeloid leukemia (AML)
(3) Chronic lymphoblastic leukemia (CLL)
(4) Chronic myeloid leukemia (CML)

Myeloproliferative disorders
- Acute myeloid leukemia: immature neoplastic malignancy of myeloid cells
- Chronic myeloid leukemia: mature neoplastic malignancy of myeloid cells

Lymphoproliferative disorders
- Acute lymphoblastic leukemia: immature neoplastic malignancy of lymphoid cells
• Chronic lymphocytic leukemia: mature neoplastic malignancy of lymphoid cells

Leukemia occurs in all races, at any age, at an incidence of 12 per 100,000. All types of leukemia are somewhat more common in men. Leukemia is much more common in adults than in children, with more than half of all cases occurring after age 65 years. The most common types of leukemia in adults are acute myeloid leukemia and chronic lymphoblastic leukemia. The most common form of leukemia among people younger than 19 years of age is acute lymphoblastic leukemia.

The cause of leukemia remains unknown. Increased risk is associated with large doses of ionizing radiation, certain chemicals (benzene), and infection with specific viruses (e.g., Epstein-Barr virus [EBV]). Cigarette smoking and exposure to electromagnetic fields also have been proposed to be causative.

**Lymphomas**

Lymphoma is cancer of the lymphoid organs and tissues that presents as discrete tissue masses. Lymphomas represent the seventh most common malignancy worldwide.

Lymphomas are classified by **cell type** (B cell, T cell, MALT, plasma cell), **appearance** (small or large cell, cleaved or non-cleaved nucleus), and **clinical behavior** (of low, intermediate, and high grade); higher grades have been noted to be more aggressive. Of more than 20 types, the four most common lymphomas are Hodgkin lymphoma, non-Hodgkin lymphoma and Burkitt’s lymphoma.

These diseases are of importance in dental management because initial signs often occur in the mouth (e.g., Waldeyer’s ring) and in the head and neck region, and precautions must be taken before any dental treatment is provided.
Lymphomas
• Hodgkin lymphoma: malignant growth of B lymphocytes, primarily in lymph nodes

• Non-Hodgkin lymphoma: B or T cell malignant neoplasms, many types and locations; most are of B cell lineage
  • Burkitt lymphoma—non-Hodgkin B cell lymphoma involving bone and lymph nodes

<The end>

❖ Denis Parsons Burkitt (1911–1993), an Irish surgeon who first described the disease (Burkitt lymphoma) in 1958 while working in equatorial Africa

❖ Hodgkin’s lymphoma was first described in an 1832 report by Thomas Hodgkin (1798–1866); a British physician and one of the most prominent pathologists.