

Leukemia Perspective in Current Practice

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Abstract

Leukemia is cancer that affects the blood formation in the bone marrow, which is characterized by an increase in the number of leucocytes (leukocytosis) in the blood and bone marrow. Leukemia has four major types, which include acute myeloid leukemia (AML), acute lymphoid leukemia (ALL), chronic myeloid leukemia (CML), and chronic lymphoid leukemia (CLL). Hematopoiesis is a process in which the stem cells differentiate into erythrocytes, megakaryocytes, and immune cells of myeloid, and lymphoid, in bone marrow or lymphatic tissues. The blood is made up of fluid called plasma and three types of cells and each type has special functions. White blood cells (also called WBCs or leukocytes) help the body fight infections and other diseases. Red blood cells (also called RBCs or erythrocytes) carry oxygen from the lungs to the body's tissues and take carbon dioxide from the tissues back to the lungs. The red blood cells give blood its color. Platelets (also called thrombocytes) help form blood clots

that control bleeding. Leukemias can affect any age and the incidence is different between each type. The Clinical presentation of leukemia cells may be mature, such as in chronic myeloid leukemia, and it may come in precursor form such as in acute myeloid leukemia It can also come in two forms (precursor and mature) such as chronic myeloid leukemia. Many risk factors have been identified, such as Klinefelter, Down syndromes, ataxia telangiectasia, Bloom syndrome, Viral infections from Epstein Barr virus, Human T-lymphotropic virus, ionizing radiation exposure, radiation therapy, environmental exposure with benzene, and smoking history. There is a strong relationship between nutrition status and leukemia which strongly affect the overall survival rate. This article aims to provide a brief introduction and the signs and symptoms of leukemia, its causes, epidemiology, nutrition profile, treatment prevention and good practice management advice.

Keywords: Leukemia, Acute Myeloid Leukemia, Acute Lymphoid Leukemia, Chronic Myeloid Leukemia. Chronic Lymphoid Leukemia

Introduction

Leukemia is a common name for multiple blood malignant disorders. Leukemia is cancer that affects the blood formation in the bone marrow, which is characterized by an increase in the number of leucocytes (leukocytosis) in the blood and bone marrow. Leukemia has four major types, which include acute myeloid leukemia (AML), acute lymphoid leukemia (ALL), chronic myeloid leukemia (CML), chronic lymphoid leukemia (CLL), and other less common variants such as mature B-cell and T-cell leukemias, and NK cell-related leukemias. The incidence rate of leukemia is high, with around 474,519 cases in North America (1-3). Leukemias may present at all ages, from the neonate to the old person, but different forms have very different age distributions (4). Leukemia can spread through a cascade of molecular events entailing intravasation, extravasation, and tissue colonization (5-8). A widespread disease such as leukemia is challenging to treat and can easily fuel future relapse (9, 10).

Hemopoiesis

Hematopoiesis is a process in which the stem cells differentiate into erythrocytes, megakaryocytes, and immune cells of myeloid, and lymphoid, in bone marrow or lymphatic tissues. The blood is made up of fluid called plasma and three types of cells and each type has special functions. White blood cells (also called WBCs or leukocytes) help the body fight infections and other diseases. Red blood cells (also called RBCs or erythrocytes) carry oxygen from the lungs to the body's tissues and take carbon dioxide from the tissues back to the lungs. The red blood cells give blood its color. Platelets (also called thrombocytes) help form blood clots that control bleeding. Blood cells are formed in the bone marrow, the soft, spongy center of bones. New (immature) blood cells are called blasts. Some blasts stay in the marrow to mature. Some travel to other parts of the body to mature. Normally, blood cells are produced in an orderly, controlled way, as the body needs them. This process helps keep us healthy (11-13).

Epidemiology

The most common presentation of leukemia cells may be mature such as in chronic myeloid leukemia, and may come in precursor form such as in acute myeloid leukemia. It can also come in two forms (precursor and mature) such as in chronic myeloid leukemia (14). Leukemia can affect any age and the incidence different between each type. Acute myeloid leukemia mainly affects adult patients rather than neonates or child patients while acute lymphoblastic leukemia affects childhood patients rather than the adult. Chronic Myeloid and Lymphocytic leukemia mainly affect the adult patient with a median age at diagnosis above 70 years. The incidence rate of leukemia in the United States is more in Whites (15 persons in 100,000), than Blacks (11 persons in 100,000), and Hispanics (10.6 persons in 100,000), while the lowest incidence among Asian/Pacific Islanders is around (7.8 persons in 100,000) (11, 14).

Types Of Leukemia

1 Acute Lymphoblastic Leukemia

It mostly affects the child population, and is around 80% of all types of leukemia in children. The disease occurs due to the arrest of lymphoid precursor cells called Lymphoblasts in the early stage of development. The significance of this disease is by it decreasing the normal blood cells due to the invasion of bone marrow by lymphoblasts. Also, lymphoblasts may invade other organs such as the liver, spleen, and lymph nodes. Clinical pictures for the patient are mainly fever, infection, marked neutropenia and thrombocytopenia, anemia, bone pain, and lymphadenopathy (15-17).

2 Acute Myelogenous Leukemia

It mostly affects the adult population. It is a maturational arrest of hematopoietic precursors which is characterized by 20% blasts in the bone marrow. As a result, the bone marrow will be infiltrated by leukemia cells and this will reduce the normal bone marrow cells and the proliferation process in the blood and liver, and spleen. Symptoms may include infection, fatigue, bleeding, and shortness of breath (15, 18, 19).

3 Chronic Lymphocytic Leukemia

It is the most common type of leukemia that affects the adult population; median age affected is around 50 to 60 years. It is discriminated from other types by an accumulation of mature and immunocompetent lymphocytes in the bone marrow and lymphoid organs. The clinical picture is mainly asymptomatic and sometimes it comes with generalized fatigue and it may develop organomegaly such as splenomegaly. In severe cases, it may lead to death because of the progression of the disease to diffuse large cell lymphoma, and this type of lymphoma is called Richter syndrome (15, 20, 21).

4 Chronic Myelogenous Leukemia

This type of leukemia is characterized by the proliferation of granulocytes and their precursors. The main cause of this type of leukemia is chromosomal translocation. This chromosome is called the Philadelphia chromosome. Clinical Picture is mainly asymptomatic such as chronic lymphocytic leukemia but it may develop malaise, splenomegaly, and anemia (15, 22, 23).

Pathophysiology

Leukemia affects the pluripotent hematopoietic stem cell transformation and makes it malignant (may give myeloid and lymphoid precursors). The characteristics of acute leukemias are the cell mainly shows poorly differentiated, immature formation and abnormal leukocytes (blasts) that can either be lymphoblasts or myeloblasts. These blasts may undergo clonal expansion and proliferation, leading to replacement and interference with the development and function of normal blood cells, which will lead to clinical symptoms (24, 25).

1. Acute Leukemia

In acute lymphoblast the most common chromosomal translocation number which can lead to mutation in precursors lymphoid cells include t(12;21) and t(9;22). In acute myeloid lymphoblasts, chromosomal rearrangements, loss, gain, and translocations may lead to mutations and abnormal formation of myeloblasts (24, 26).

2. Chronic Leukemia

The most common pathophysiology of chronic leukemia is the abnormalities in the hematopoietic stem cell's chromosome. The chromosomal abnormalities involve deletions, translocations, and extra chromosomes. The most common translocation is t(9;22) which affects granulocytes in chronic myeloid and affects lymphocytes in chronic lymphocytosis. The main characteristic of these cells is that they show as partially mature, do not function, and the division rate is high, not like acute leukemias. They occupy peripheral blood and lymphoid organs, which can lead to anemia and thrombocytopenia, and leukopenia (24, 27).

Diagnosis

The most common tests that should be done to diagnose leukemia include a complete blood count, comprehensive metabolic panel, liver function tests, and coagulation panel, which are often followed by a peripheral blood smear evaluation and a bone marrow biopsy and aspiration. In some situations, leukemia can be diagnosed by histology alone such as acute myeloid leukemia can be diagnosed by the presence of Auer rods on a peripheral smear (28-30)

Signs and Symptoms

The most common symptoms shown in a leukemic patient may include frequent or severe infections, weight loss, persistent fatigue and weakness, fevers or chills, abdominal pain, and bleeding issues such as recurrent nosebleeds (24, 31-33).

Management

The treatment mainly depends on the type of cell lineage and whether the patient has acute or chronic leukemia. In acute leukemia, mainly the best choice is systemic chemotherapy, while the actual drugs used vary by the leukemia type. In severe cases and poor prognosis of leukemia, the patient may receive a stem cell transplant. For chronic leukemias, the therapy is indicated only in case patients develop decreasing platelet counts or red cells. Patients with B-cell chronic leukemias can be treated with non-toxic targeted therapy with anti-B-cell antibodies (rituximab). In chronic myeloid leukemia, the specific genetic alteration (the Philadelphia chromosome) makes the cells sensitive to a class of drugs that inhibit the tyrosine kinase activity of the abnormal protein produced by the Philadelphia chromosome (imatinib, dasatinib, and nilotinib). These drugs are very effective at eliminating

the abnormal cells in this disorder, so where patients previously would be considered for stem cell transplants, now patients can live successfully for many years without taking the risks involved with a stem cell transplant (34-37).

Risk Factors

Many risk factors that can cause leukemia have been identified, such as Klinefelter and Down syndromes, ataxia telangiectasia, Bloom syndrome, Viral infections from Epstein Barr virus, Human T-lymphotropic virus, ionizing radiation exposure, radiation therapy, environmental exposure with benzene, smoking history, and history of chemotherapy with alkylating agents (14, 24).

Special Cases

1 COVID-19 patients

The patient with leukemia has a higher risk to become infected by the COVID-19 Virus. Lymphoid types have a higher risk to get COVID-19 infection because of the impairment of humoral response caused by disease or treatment-related hypogammaglobulinemia. Patients with leukemia and who are immunocompromised with COVID-19 infection can also be at higher risk of superimposed bacteria or fungal pneumonia (38).

2 Pregnancy

In pregnant patients, there is an increase in the risk of spontaneous abortions, low neonate weight, and preterm birth in some populations. Unfortunately, nowadays we have little data to support counseling patients on perinatal death, uterine rupture, premature birth etiology in pregnancy, and newer therapies' effect on maternal and fetal health. A patient who has leukemia during pregnancy may put the patient and the treating physician in a serious situation, as weighing the risk of chemotherapy that should be given versus cancer itself is a very tough issue (39, 40).

Nutrition and Breast Cancer

There is a strong relationship between nutrition status and leukemia which affects the overall survival rate. In acute lymphoid leukemia, children and adolescents who live in low or middle-socioeconomic countries have poorer survival rates than those in high-socioeconomic countries. On the contrary, in acute myeloid leukemia, children and adolescents who live in high socioeconomic countries have poor survival rates (41).

1 Breastfeeding and Childhood Leukemia Incidence

Systematic review and meta-analysis study shows the encouragement of pregnant mothers to breastfeed their child for the first 6 months or more may lower the incidence of childhood leukemia, in addition to the benefit of breastfeeding on general health (42).

Prognosis of Leukemia

The prognosis and survival rate vary based on leukemia subtype, cytogenetic and molecular findings, patient age, and comorbid conditions. Broadly, the 5-year cancer survival rate for leukemia has increased from 33% in 1975 to 59% in 2005 (43).

Complications

1 Tumor Lysis Syndrome

In Tumor lysis syndrome the cells die very quickly and this occurs as a side effect of chemotherapy medications. This destruction of the cells releases a high quantity of intracellular content in the bloodstream and this overwhelms the kidney and results in dangerously high serum levels of potassium, phosphorus, and uric acid (44).

2 Disseminated Intravascular Coagulation

In Disseminated Intravascular Coagulation the proteins that control the blood clotting process become dysfunctional, leading to both thrombosis and hemorrhage, Disseminated Intravascular Coagulation is mainly associated with acute promyelocytic leukemia but can be seen in other subtypes of leukemia as well (28).

3 Cancer

Survivors of leukemia are at an increased risk of subsequent cancers (45).

3 Infection

Immunosuppression from chemotherapy, stem cell transplantation, or leukemia itself increases the risk of dangerous infections (46).

Conclusion

Hematopoiesis is a process in which the stem cells differentiate into erythrocytes, megakaryocytes, and immune cells of myeloid, and lymphoid, in bone marrow or lymphatic tissues. Leukemia is cancer that affects the blood formation in the bone marrow, which is characterized by an increase in the number of leucocytes (leukocytosis) in the blood and bone marrow. Leukemia mostly affects the child population; around 80% of all types of leukemia are in children. The most common tests that should be done to diagnose leukemia include a complete blood count, comprehensive metabolic panel, liver function tests, and coagulation panel, which are often followed by a peripheral blood smear evaluation and a bone marrow biopsy and aspiration. Many risk factors that can cause leukemia have been identified, such as Klinefelter and Down syndromes, ataxia telangiectasia, and Bloom syndrome. The most common symptom in a leukemic patient is frequent or severe infections. The treatment mainly depends on the type of cell lineage and whether the patient has acute or chronic leukemia. Patients with leukemia have a higher risk of being infected by the COVID-19 Virus. In pregnant patients, there is an increase in the risk of spontaneous abortions, low neonate weight, and preterm birth in some populations. The 5-year cancer survival rate for leukemia has increased from 33%

in 1975 to 59% in 2005. Complications include: Tumor lysis syndrome, Disseminated Intravascular Coagulation, Cancer and Infection.

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AUTHORS' CONTRIBUTIONS

'H. Karrar' supervised the team and directed the research. 'M. Nouh' wrote the introduction, epidemiology, complication, and Conclusion paragraph. 'A. Aljuman' wrote the introduction. 'M. Almutiri' wrote the introduction. 'L. Alqudairy' wrote the introduction. 'A. Aljameeli' wrote the Normal Hematopoiesis. 'A. Aljameeli' wrote the Normal Hematopoiesis. 'A. Alabdullatif' wrote the Epidemiology. 'K. Alsuqayh' wrote the Pathophysiology. 'A. Alhuthayli' wrote the Classification of acute leukemia. 'M. Alkredees' wrote the Classification of chronic leukemia. 'A. Alriyaa' wrote the diagnosis. 'M. Alaithan' wrote the Management. 'B. Alshmrany' wrote the risk factor. The authors had full access to the data and take full responsibility for the integrity of the data. All the authors gave their approval for the submission of the final manuscript.

DEFINITIONS, ACRONYMS, ABBREVIATIONS

AML; ACUTE MYELOID LEUKEMIA.
ALL; ACUTE LYMPHOID LEUKEMIA.
CML; CHRONIC MYELOID LEUKEMIA.
CLL; CHRONIC LYMPHOID LEUKEMIA.