



Journal of Innovations in Applied Pharmaceutical Science [JIAPS]

Content available at: www.saap.org.in ISSN: 2455-5177



A REVIEW ON LEUKEMIA: ADVANCES IN DIAGNOSIS, TREATMENT AND PROGNOSIS

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Article History

Received: 14-12-2024

Revised: 05-01-2025

Accepted: 24-01-2025

Keywords:

Blood cancer, types, leukaemia, risk factor, epidemiology, patophysiology, diagnosis, drugs.

Abstract

Cancer is a disease of altered signalling and metabolism, causing uncontrolled division and survival of transformed cells. A host of molecules, factors, and conditions have been designated as underlying causes for the inception and progression of the disease. An enormous amount of data is available, system-wide interaction networks of the genes and proteins are generated over the years and have now reached up to a level of saturation, where we need to shift our focus to the more advanced and comprehensive methods and approaches of data analysis and visualization. Even with the availability of enormous literature on this one of the most pressing pathological conditions, a successful cure of the disease seems to be obscure. New treatment plans, like immunotherapy and precision medicine, are being employed for different studies. Nevertheless, their actual benefits to the patients would be known only after the evaluation of clinical data over the next few years. Therefore, we need to look at few fundamental challenges that should be addressed in more depth before we could devise better, rigorous and comprehensive treatment plans and may successfully reach a possible cure of the disease. This article aims at bringing attention towards some fundamental gaps in our approach towards the disease that leads to failure in devising successful therapeutics.


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 <https://doi.org/10.37022/jiaps.v10i1.650>

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Introduction

Cancer

Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body. Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and multiply (through a process called cell division) to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place [1].

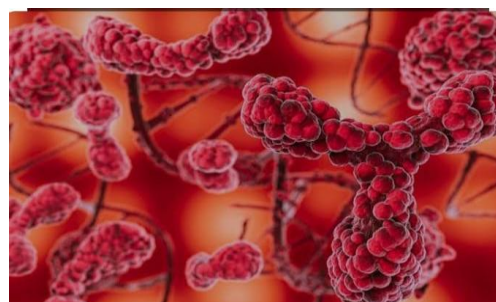


Figure: 1 Bloods Cancer

Blood Cancer

Blood cancer represents a large group of different malignancies. This group includes cancers of the bone marrow, blood, and lymphatic system, which includes lymph nodes, lymphatic vessels, tonsils, thymus, spleen, and digestive tract lymphoid tissue. Leukemia and myeloma, which start in the bone marrow, and lymphoma, which starts in the lymphatic system, are the most common types of blood cancer [1].

Blood cancers affect the production and function of your blood cells. Most of these cancers start in your bone marrow where blood is produced. Stem cells in your bone marrow mature and develop into three types of blood cells: red blood cells, white blood cells, or platelets. In most blood cancers, the normal blood cell development process is interrupted by uncontrolled growth of an abnormal type of blood cell. These abnormal blood cells, or cancerous cells, prevent your blood from performing many of its functions, like fighting off infections or preventing serious bleeding.

Blood Cancer Refers To A Group Of Cancers Affects The Blood, Bone Marrow And Lymphatic System.

Blood Cancer Caused By Changes [Mutations] In The DNA With In Blood Cells This Cause The Blood Cells To Start Behaving Abnormally.

These Are Also Types Called [MPN] Myeloproliferative Neoplasms {MDS} Myelodysplastic Syndrome.

Some Types of Blood Cancer Affect Children .Symptoms And Treatment Can Be Different between Children and Adults'.

Over 40,000 People Diagnosed With A Blood Cancer Each Year In The Uk And Over 25.0000

People Are Currently Living With Blood Cancer.

Most Blood Cancers, Also Called Hematologic Cancers, Start In The Bone Marrow Where Blood Cells Are Produced.^{3,4}

1. Early and Accurate Diagnosis

Developing improved diagnostic techniques, including advanced imaging and biomarker identification, to detect leukemia at an early stage.

Enhancing genetic and molecular profiling to enable more precise differentiation between various subtypes of leukemia (e.g., acute lymphoblastic leukemia (ALL), chronic myelogenous leukemia (CML), acute myeloid leukemia (AML))

2. Innovative Treatment Strategies

Advancing targeted therapies: Research into drugs and biologics that specifically target leukemia cells while minimizing damage to healthy cells, such as monoclonal antibodies, tyrosine kinase inhibitors, and CAR-T cell therapies

3. Improved Prognostication and Monitoring

Refining prognostic models that incorporate genetic mutations, biomarkers, and patient-specific factors to predict the course of the disease more accurately.

4. Enhanced Supportive Care and Long-Term Outcomes

Reducing treatment-related side effects by refining supportive care, such as better management of infections, anemia, and graft-versus-host disease (GVHD) in transplant patients.

Types of Blood Cancer

The Three Main Types Of Blood And Bone Marrow Cancer Are Leukemia, Lymphoma And Myeloma.

Leukemia:-

Is A Blood Cancer That Originates In The Blood And Bone Marrow.

It Occurs When the Body Creates Too Many Abnormal White Blood Cell And Interferes With The Bone marrow Ability To Make Red Blood Cell And Platelets.

Non -Hodgkin Lymphoma:

Is A Blood Cancer That Develops In The Lymphatic System From Cell Called Lymphocytes A Type Of White Blood Cell That Helps The Body Fight Infections.

Hodgkin Lymphoma:-

IS A Blood Cancer That Develops In The Lymphatic System From Cell Called Lymphocytes. Hodgkin Lymphoma Is Character Zed By The Presence Of An Abnormal Lymphocyte Called The Reed –Stenberg Cell

Multiple Myeloma

Is A Blood Cancer That Begins In The Blood S Plasma Cell, A Type Of White Blood Cell Made In The Bone Marrow, Learn About Stages Of Multiple Myeloma.

Myeloproliferative Neoplasms {MPNS}

These Rare Blood Cancers Occurs When The Body Over Produces White Blood Cell, Red Blood Cells Or Platelets, The Three Main Subcategories Are Essential.

Myeloproliferative Neoplasms {MPNS}

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Thrombocytopenia (ET), Myelofibrosis (MF) and Polycythemia Vera (PV)

Amyloidosis

There Rare Disorder, Characterized By The Build-up Of An Abnormal Protein Called Amyloid Not A Form Of Cancer But It Is Closely Associated With Multiple Myeloma.

Waldenstrom Macroglobulinemia

This is a rare type of non-Hodgkin lymphoma that start in B-cells

Aplastic Anemia

This Rare Condition Occurs When Key Stem Cells Are Damaged and Can Only Be Treated With A Bone Marrow Transplant.²

Symptoms of Blood Cancer

Blood Cancer Symptoms Vary Based On Blood Cancer Type, But There Some Symptoms All Three Have In Common.

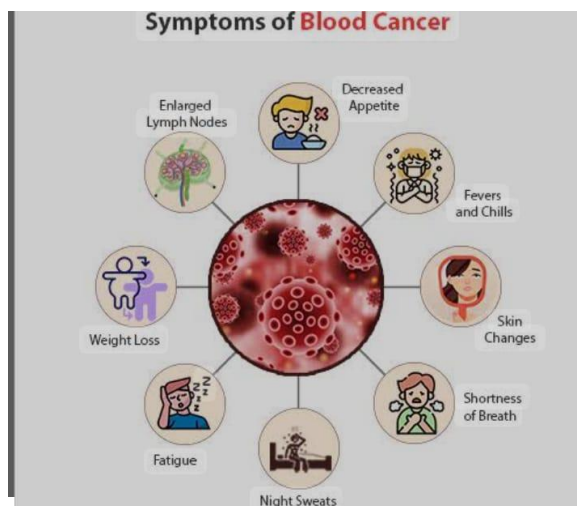


Figure: 2 Symptoms of Blood Cancer

1. Fatigue

This Is Feeling So Tired You Can't Manage Your Daily Activities You May Also Feel Weak.

2. Persistent Fever

A Fever Is A Sign Your Body Is Fighting Infection Or Responding To Abnormal Cancer Cells.

3. Drenching Night Sweats

This Is Sweating That Comes on Suddenly While You're Sleeping, Disturbing Your Sleep and Drenching Your Bedding and Clothes.

4. Unusual Bleeding (OR) BRUI Journal of Emerging Technologies and Innovative Research (JETIR) www.jetir.org DING

Everyone Has Bumps, Bruises And Injuries That Make Us Bleed Unusual Bleeding Or Bruising Is Bleeding That Doesn't Stop And Bruises That Don't Heal After Two Weeks.

5. Unexpected or Unexplained Weight Loss

Unexpected Weight Loss Of 10 Pounds Over A Six To 12 Month Period Is Considered Unexplained Weight Loss.

6. Frequent Infections

Frequent Infections May Be A Sign Something Is Affecting Your Immune System [16].

7. SWOLLEN LYMPH NODES OR AN ENLARGED LIVER (OR) SPLEEN

There Symptoms May Be Signs Of Leukemia Or Lymphoma.

8. Bone Pain

Myeloma And Leukemia May Cause Bone Pain Or Tender Spots Or Your Bones.

9. Fever, loss of weight, Night sweats, joint pain, abdominal discomfort, Headache. Shortness of breath, Itchy skin^{3,4}.

Causes of Blood Cancer

Blood Cancers Are Caused By Mutations In The Genetic Material-The DNA-Of Blood Cell Other Risk Factors Vary Based On The Specific Type Of Blood Cancer²

1. Risk Factors For Developing Hadgkin Lymphoma Include

- ❖ History of infection with EPSTEIN BARR VIRUS [EBV] which causes infection mononucleosis [mono].
- ❖ Advancing age
- ❖ Gender.
- ❖ Family history of Hodgkin lymphoma
- ❖ Compromised immune system

2. Risk Factors For Developing Non-Hodgkin Lymphoma Include

- ❖ Exposure to certain industrial chemicals, herbicides and insecticides
- ❖ History of chemotherapy
- ❖ Radiation exposure
- ❖ Compromised immune system
- ❖ History of autoimmune disease such as rheumatoid arthritis or lupus

3. Risk Factors For Developing Multiple Myeloma

- ❖ Advancing age
- ❖ Gender
- ❖ Race higher risk among African American.
- ❖ Obesity or extra body weight²

Diagnosis

A Diagnosis Often starts with a Physical Examination to Check the Patient's general Health the Care Term Reviews the Patient's Health History Examines His or Her Body and Lymph Nodes, And Looks For Sign Of Infection Or Bruising.

Different Types Of Tests And Procedures May Be Used To Diagnose Blood Cancer.

1. Biopsies

A Biopsy Is A Test That Collects Sample Of Cell For Examination By A Pathologist In A Laboratory. For Some Types Of Blood Cancer Like Lymphoma, The Patient May Need A Lymph node Biopsy That Obtains A Sample Of Lymph Tissue Or An Entire Lymph Node.²

2. COMPLETE BLOOD COUNT (CBC):-

This Test Measures And Counts Your Blood Cells. For Example If Your Health Care Provider Suspects You Have. Leukaemia, They Look For High White Blood Cell Counts And Lower Than Hammered Blood Cell And Platelet Counts.

3. BLOOD CHEMISTRY TEST:-

This Test Measures Chemicals And Other Substances In Your Blood. In Some Cases, Your Health Care Provider May Order Specific Blood.

4. COMPUTED TOMOGRAPHY (CT)SCAN :-

This Test, Uses A Series Of X- Rays And A Computer To Create Three Dimensional Images To Your Soft Tissue And Bone If Your Health Care Provider Suspect You Have Myeloma, They May Order A Ct Scan To Look For Bone Damage.

5. MAGNETIC RESONANCE IMAGING (MR) SCAN:-

Your Health Care Provider May Order, To Look For Signs Of Leukemia Or Lymphoma Complications Affecting Your Spine^{3,4}.

6. POSITRON EMISSION TOMOGRAPHY(PET) SCAN:-

This Test Producer Images Of Your Organs And Tissue At Work Look For Signs Of Myeloma.

7. BONE MARROW BIOPSIES:-

Health Cell Providers May Do Bone Marrow Biopsies To Analyze The Percentage Of The Many Also Test Your Bone Marrow Sample For Changes In Your DNA/That May Drive Cancer Growth.

8. BLOOD CELL EXAMINATION

Healthcare Providers May Take Blood Samples So They Can Examine Them Under A Microscope To Look For Example, They Might Order Peripheral Smear Test To Look For Signs Of Leukemia Or Lymphoma.^{3,4}

Treatme:-

Blood Cancer Treatment Isn't One-Size Fits-All. Some Blood Cancer Types Respond Well To Specific Treatments. Have Significant Side Effects. Healthcare Providers Consider Factors, Including Your Age, Your Overall Health, The Kind Of Blood Cancer You Have And Specific Treatment Side Effects, Before Recommending Treatments For Blood Cancer Include.

1. Chemotherapy

Chemotherapy Is A Primary Blood Cancer Treatment, Killing Cancer Cells To Either Slow Down The Disease's Progress Or Eliminate The Cancer. Health Care Providers Use Different Drug Types For Different Blood Cancers.

2. Radiation Therapy

Health Care Provider May Use Radiation To Treat Leukaemia, Lymphoma Or Myeloma. Radiation Targets Abnormal Cell, Damaging Their DNA So They Can't Reproduce Often Combine Radiation Therapy With Other Treatments. They May Use Radiation To Ease Some Symptoms.

3. Immunotherapy

This Treatment Uses Your Immune System To Fight Cancer, Your Immunotherapy May Help Your Body Make More Immune Cells Or Help Your Existing Immune Cell Find And Kill Cancer Cell.

4. Targeted Therapy For Cancer

This Cancer Treatment Targets Genetic Changes Or Mutations That Turn Healthy Cell Into Abnormal Cell.

5. Car T-Cell Therapy

In Car T-Cell Therapy, Healthcare Providers Turn T-Cell Lymphocytes- A Type Of White Blood Cell-Into More Effective

Cancer Treatment Healthcare Providers May Use Car T- Cell Therapy To Treat B-Cell Acute Lymphoblastic Leukemia, Multiple Myeloma And Several Types Of Non-Hodgkin's Lymphoma If Other Treatments Haven't Worked.

6. autologous stem cell transplant:-

Health Care Providers Can Collect and Store Bone Marrow Stem Cells Before Administering High Doses Of Chemotherapy. Once Chemotherapy Is Done, They'll Replace The Protected Stem Cells. This Way, People Having Antilogous Stem Cell Implants Can Avoid Chemotherapy Side Effects.

7. Allogeneic Stem Cell Transplant:

- Sometimes, Damaged Bone Marrow Need To Be Replaced With Healthy Bone Marrow. Healthcare Providers Identify a Suitable Bone Marrow Donor and Use the Donor's Cell To Replace Your Damaged One. This Is An Effective But Dangerous Procedure.

8. Stem Cell Transplantation:-

A Stem Cell Transplant Infuses Healthy Blood-Forming Stem Cell Into The Body. Stem Cell May Be Collected FROM THE BONE Marrow, Circulating Blood And Umbilical Cord Blood.^{3,4}

Survival Rates for Blood Cancer:

Survival Rates Are Estimates Based On Averages. Your Healthcare Provider May Share Five-Year Survival Rates As A Way Of Explaining How You Blood Cancer May Affect your Health Five Years After Diagnosis. Survival Rates Are Different For Each Of The Three Blood Cancer Types, But Many People Who Have Blood Cancer Can Expect To Survive.²

Drugs Used In Blood Cancer

1. Jaypirca [pirtobrutinib]
2. Brukinsa [Zanubrutinib]
3. Arsenic trioxide
4. Cyclophosphamide
5. Ibrutinib
6. Daunorubicin hydrochloride
7. mercaptopurine

Leukemia:

Leukemia is a cancer of the blood or bone marrow, which produces blood cells. Leukemia occurs due to a problem with blood cell production. It usually affects the leukocytes, or white blood cells.

- Leukemia more often affects people aged over 55 years Trusted Source, but it is also the most common cancer in those aged under 15 years.
- Hematopoietic is characterized by a rapid, continuous turnover of cells. Normal, production of specific blood cells from their stem cells precursors is carefully regulated according to body's need. If the mechanisms that control the production of these cells are disrupted, the cells can proliferate excessively. Hematopoietic malignancies are often classified by cells involved. LEUKEMIA is a neoplastic proliferation of one particular cell type (granulocytes, monocytes, lymphocytes, or infrequently RBCs

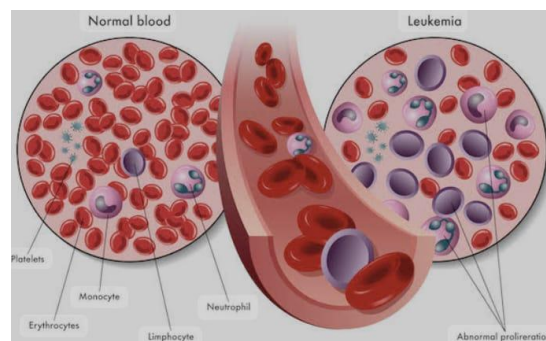


Figure: 3 Luekemia

Types of leukaemia:

There are four main types of leukemia

1. Acute lymphocytic leukemia (ALL):- is the most common type of leukemia in children, teens and young adults up to age 39. ALL can affect adults of any age.
2. Acute myelogenous leukemia (AML):- he most common type of acute leukemia in adults. It's more common in older adults (those over 65). AML also occurs in children.
3. Chronic lymphocytic leukemia (CLL):- is the most common chronic leukemia in adults (most common in people over 65). Symptoms may not appear for several years with CLL.
4. Chronic myelogenous leukemia (CML):- is more common in older adults (most common in people over 65) but can affect adults of any age. It rarely occurs in children. Symptoms may not appear for several years with CML.

Stages of Leukemia

- Stage 0 – A patient has high levels of white blood cells, but no other physical symptoms.
- Stage 1 – A patient has high levels of white blood cells and enlarged lymph nodes.
- Stage 2 – A patient has high levels of white blood cells and is anemic. He or she may also have enlarged lymph nodes.
- Stage 3 – A patient has high levels of white blood cells and is anemic. He or she may also have enlarged lymph nodes and/or an enlarged liver or spleen.
- Stage 4 – A patient has high levels of white blood cells and low platelets. He or she may also be anemic, have enlarged lymph nodes and have an enlarged liver or spleen

Diagnosis

Results from routine blood work can alert your healthcare provider that you may have an acute or chronic form of leukaemia that requires further testing. Or they may recommend a workup if you have leukaemia symptoms.

Diagnostic exams and tests may include

1. Physical exam

Your healthcare provider will ask about your symptoms and feel for swollen lymph nodes and an enlarged spleen or liver. They may also inspect your gums for bleeding and swelling. They may look for a skin rash associated with leukaemia that may appear red, purple or brown.

2. Complete blood count (CBC)

This blood test lets your healthcare provider know if you have abnormal levels of red blood cells, white blood cells and platelets. If you have leukaemia, you'll likely have higher than normal counts of white blood cells.

3. Blood cell examination

Your healthcare provider may take additional blood samples to check for markers that indicate the presence of leukaemia cells or a specific type of leukaemia. Flow cytometry and peripheral blood smear are additional tests your healthcare provider may order

4. Imaging and other tests:-

Your doctor may order a chest X-ray, CT scan, or magnetic resonance imaging (MRI) scan if symptoms indicate leukaemia has affected your bones, organs or tissue. The leukaemia cells don't show up on imaging.

5. Lumbar puncture (spinal tap)

Your healthcare provider may test a sample of spinal fluid to see if leukaemia has spread to the spinal fluid surrounding your brain and spinal cord.¹¹

Treatment of leukaemia

- Treatments for leukemia depend on the type of leukemia you have, your age and overall health, and if the leukemia has spread to other organs or tissues.
- Common treatments often include a combination of the following:

1. Chemotherapy

Chemotherapy is the most common form of leukaemia treatment. It involves using chemicals to kill leukaemia cells or keep them from multiplying. During treatment, you may receive the chemicals (medication) as a pill, an injection into a vein or a shot under your skin. Usually, you'll receive a combination of chemotherapy drugs.

2. Immunotherapy

This treatment uses certain drugs to boost your body's defence system — your immune system — to fight leukaemia. Immunotherapy helps your immune system identify cancer cells and produce more immune cells to fight them.

3. Targeted therapy

This treatment uses drugs designed to attack specific parts of a leukaemia cell (like a protein or gene) that are causing them to overtake normal blood cells. Targeted therapies may prevent leukaemia cells from multiplying, cut off the cells' blood supply or kill them directly.

4. Radiation therapy

This treatment uses strong energy beams or X-rays to kill leukemia cells or stop them from growing. During treatment, a machine directs radiation to the exact spots in your body where the cancer cells are or distributes radiation over your whole body. Distributing radiation throughout your body may happen before a hematopoietic cell

5. Cell or bone marrow transplant Hematopoietic cell transplant (stem):

This treatment replaces the cancerous blood-forming cells killed by chemotherapy and/or radiation therapy with new, healthy hematopoietic cells. Your healthcare provider may remove these healthy cells from your blood or bone marrow before chemo and radiation, or they may come from a donor. The healthy new cells multiply, forming new bone marrow and blood cells that become the red blood cells, white blood cells and platelets your body needs [11]

Conclusion

Leukemia research has made significant progress in recent years, leading to improved diagnosis, treatment and prognosis. Advances in genetic testing, targeted therapies and immunotherapy's have transformed the treatment landscape. However, challenges remain, including the need for more effective treatments for certain types of leukemia and improved access to care for underserved populations. Continued research and collaboration are essential to further improve outcomes for leukemia patients

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