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LEUKEMIA

BACKGROUND

Facts about leukemia

- Leukemia is a treatable cancer that comes in many forms.
- Leukemia is the most common cancer diagnosed in children. However, adults account for almost 90% of new cases of leukemia.
- The rate of new leukemia cases tends to cluster early in childhood, with a gradual rise in cases overall as people age.
- Leukemia occurs more frequently in males than in females. In most populations, leukemia occurs more frequently among white, non-Hispanics than among black, non-Hispanics.
- Although the rate of new leukemia cases has not changed dramatically over the past 50 years, people with some forms of the disease are living longer after diagnosis.
- There is no known way to prevent most cases of leukemia, but once diagnosed, it can be treated.

What is leukemia?

General information
Leukemia is a general term that includes different cancers that occur in the bone marrow, which is responsible for supplying blood cells.

- The cells formed in the bone marrow include: white blood cells, which fight infection; red blood cells, which deliver oxygen throughout the body; and platelets, which help with blood clotting.
- The white cells may be granulocytes, which are mostly involved with prevention of bacterial infections, or lymphoid cells (both T and B), which play a role in fighting infections.
- Leukemias are characterized by the abnormal, uncontrolled growth of blood-forming cells.

Specific Types

- The different types of leukemias are classified according to the length of the disease, the number of blood cells in the blood, and the specific type of blood cell involved.

- The four main types of leukemia are:
  1. acute myelogenous leukemia (AML)
  2. chronic myelogenous leukemia (CML)
  3. acute lymphoblastic leukemia (ALL)
  4. chronic lymphocytic leukemia (CLL)

- Acute leukemias can occur at any age and the disease development is rapid.
- Chronic leukemias usually occur in adults and the disease development tends to be slower than for acute leukemias.

What are the signs and symptoms of leukemia?

Symptoms of acute leukemia include:

- General weakness or fatigue
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- Weight loss
- Loss of appetite
- Fever
- Increased infections
- Increased or easy bruising
- Red dots in the skin, called *petechiae*, which occur when capillaries break
- Bleeding that occurs in the mouth, nose, and other mucosal areas (*mucosal bleeding*)
- Deficiency in red blood cells and oxygen getting to the body’s tissues (*anemia*)
- Enlarged spleen, liver, and/or lymph nodes
- Bone and/or joint pain

Symptoms of *chronic* leukemia include:
- Headache
- Fatigue
- A reduced tolerance for exercise
- Problems related to increased spleen size (pressure, gas, feeling full after a small meal, pain in upper left quadrant of the body, shoulder pain)
- Increased metabolism
- Night sweats
- Swollen lymph nodes

Chronic leukemia tends to be found during routine blood testing associated with other ailments.

Talk to your health care professional about any questions you may have.

**What are the risk factors for leukemia?**

Risk factors for leukemia include:
- Exposure to ionizing radiation (as might be given to treat another cancer)
- Exposure to benzene or certain other organic chemicals
- Previous treatment with chemotherapy drugs, especially alkylating agents, for other cancers or inflammatory conditions
- Certain genetic conditions, such as Down syndrome

Possible risk factors include exposure to low level solvent and metal mixtures and smoking.

### PREVENTION AND SCREENING

**How can I reduce the risk of leukemia?**

Although many types of cancer can be prevented by lifestyle changes that help in avoiding certain risk factors, there is currently no known way to prevent most cases of leukemia. Most leukemia patients have no known risk factors, however, at the present time there is no way to prevent these leukemias from developing.
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Screening for leukemia

For some types of leukemia, early diagnosis can make treatment more effective. At this time, no screening tests are routinely recommended for early detection of the four main types of leukemia.

The best way to find leukemia early is to report any symptoms to your health care professional right away.

# DIAGNOSIS AND TREATMENT

This site provides general information that may apply to your specific situation. You may choose to visit the National Cancer Institute's web site, [www.cancer.gov](http://www.cancer.gov), which is updated more frequently. Once there, you will be able to select from a full range of cancer topics. If you want to speak with a cancer information expert confidentially, you may choose to call 1-800-4CANCER (1-800-422-6237) between 9:00 AM - 4:30 PM.

It is always best to discuss your personal risk for cancer as well as your screening, diagnosis, and treatment needs with your health care provider before you commit to a course of action.

How is leukemia diagnosed?

Leukemia is diagnosed using several types of tests to get a most accurate diagnosis for the patient’s treatment plan. The type of leukemia is important since there are treatments that specifically target certain groups.

**Laboratory Tests**

- Leukemia is diagnosed using several blood tests that are done in a hospital or medical laboratory.
- One blood test is a complete blood count (CBC), which is done both automatically by an automated instrument and manually by a laboratory technician.
- The automated instrument will print out the counts and amount of red cells, white cells, and platelets in the sample.
- A manual examination of the blood cells on a slide is done in cases where infection, inflammation, or cancer is suspected. In this manual differential (manual count), the technician will directly examine the red cells shape as well as count the different types of white cells. In the case of leukemia, the white cells often appear not fully formed or immature (termed blasts).
- Other tests are done to check whether the clotting components in the blood are functioning normally. The tests determines the prothrombin time (PT) and the activated partial thromboplastin time (aPTT) by making the clotting components in the plasma (the fluid part of the blood) create a clot and timing how long it takes to make a clot.

The blood tests look for:

- Anemia
- An abnormal increase in the number of lymphoid or myeloid white blood cells, sometimes with an increase in very immature forms of these cells
- Decrease in clotting components
- The distribution of blood cell types

**Bone Marrow Biopsy**

A bone marrow examination is also necessary if immature or unusual amounts of cells are found in the blood tests to help confirm a diagnosis.

- The bone marrow is taken from the posterior superior iliac crest (back of the hip bone) in adults and the upper end of the tibia bone (upper end of the shin bone) in infants.
- The patient may be under general anesthesia (children), conscious sedation (sleepy but awake) or fully awake, and the specific area to be biopsied is numbed using lidocaine.
- An aspiration needle is used to penetrate the bone cavity to get to the bone marrow.
- The bone marrow is suctioned out of the bone using a syringe. This creates a vacuum that draws the bone marrow out, which may cause discomfort.
- The bone marrow sample is spread on a slide that can be examined microscopically to determine which cells are the most numerous in the bone marrow.

The bone marrow biopsy looks for:

- An unusual increase in one type of white blood cell
- Chemical characteristics of the leukemic (white) cells (cytochemistry)
- Specific immunological markers (biological markers that can be measured and identify types of cells)
- Evidence of damaged chromosomes (chromosome analysis or karyotype) in the bone marrow cells

**Spinal Tap**

Sometimes a spinal tap will be done to determine if the leukemia cells are also present in the cerebrospinal fluid (the fluid surrounding the spinal cord and brain).

- A spinal tap is done using a sterile procedure.
- The patient is asked to lie down or lean over to allow the back bone to stretch, giving the doctor easier access to the area between the 3rd and 4th or 4th and 5th lumbar vertebrae (the lower back bones).
- Lidocaine is used to numb the skin and the lower back area.
- A needle is inserted between the vertebrae, with the end of the needle in the space that contains the spinal fluid.
- The spinal fluid will be collected into three or four vials, which will be sent to the laboratory for evaluation.
- The needle will be taken out and a bandage will be placed over the area.

**Cytochemistry**

- The cytochemistry of the cells is determined by using special stains that can help identify chemical components in the cells such as enzymes or lipids.
- These chemical components are specific to the maturity (level of development) of the cell and the cell path line (type of cells being affected).
- The stains can be used on blood taken either from the arm or the bone marrow.

**Flow Cytometry**

- Flow cytometry is an immunofluorescent method that can be used to detect protein surface markers on the cell membrane. A specific antibody or antigen used to detect a specific protein is tagged with a dye that will fluoresce (light up) under certain wavelengths to help identify the cell type.
The proteins are used to determine the cell path line (type of cells being affected) and the cell stage (level of development) since the proteins on cells change as cells mature.

The cells can be taken from either the blood or the bone marrow.

**Cytogenetics**
The cytogenetics analysis is done to look at the individual chromosomes within the leukemic (white) cell.

- Some patients' leukemic (white) cells have a normal complement of chromosomes (46XX in females and 46XY in males).
- Others have changed chromosomes that provide important information concerning cell type and particular prognosis (how the disease might develop over time). These changes can influence the choice of treatment.
- Fluorescent *in situ* hybridization (FISH) and polymerase chain reaction (PCR) are other techniques that can provide the same type of information as cytogenetics if needed. Finally, in some situations, specific mutations (unusual chromosome material) are checked using PCR and DNA sequencing.

**How is leukemia treated?**

**Acute leukemias** are treated with therapies such as:
- A combination of chemotherapy drugs, which are often given in a hospital setting
- Monoclonal antibodies that target the specific leukemias
- Bone marrow or peripheral blood stem cell transplantation
- Radiation in combination with other treatments

**Philadelphia chromosome positive ALL**
- One type of acute lymphoid leukemia called “Philadelphia chromosome positive ALL,” which has a specific chromosome defect, can be treated with a targeted cancer drug called imatinib mesylate (Gleevec).
- Imatinib mesylate (Gleevec) blocks a protein made by a defective chromosome that carries a message to a cell telling it to divide and grow. This prevents the cancer cells from making more cells and causes them to die.
- A second target therapy drug called dasatinib is being used if the cells become resistant to imatinib.
- Chemotherapy is often used along with imatinib or dasatinib in treating this leukemia.

**Chronic lymphoid leukemias** are treated with therapies such as:
- Chemotherapy drugs such as chlorambucil (Leukeran) and fludarabine (Fludara), which can be used alone or in combination
- Monoclonal antibodies such as alemtuzumab (Campath) and rituximab (Rituxan), which target specific leukemias
- Bone marrow or peripheral blood stem cell transplantation

**Chronic myeloid leukemias** are treated using:
- The targeted therapy imatinib mesylate (Gleevec) (the main treatment for CML)
- Interferon therapy using interferon-alpha
- Stem cell marrow transplantation
- Chemotherapeutic agents such as hydroxyurea or ara-C
There are clinical trials being conducted to see how the combination of chemotherapy and target therapy interacts and puts the leukemia into remission.

**STATISTICS**

**How many people are diagnosed with leukemia? How many people die from it?**

- The American Cancer Society (ACS) estimates that in 2009 there will be about 44,790 new cases of leukemia (all kinds) diagnosed in the United States. There will be an estimated 1,000 new cases of leukemia diagnosed in Massachusetts in 2009.

- The American Cancer Society also estimates that in 2009 there will be about 21,870 deaths from leukemia (all kinds) in the United States. There will be an estimated 490 deaths from leukemia in 2009 in Massachusetts.

- National five-year relative survival rates for 1999-2005 show that 54.7% of men and 53.1% of women survive five years after a diagnosis of leukemia. These rates vary by type of leukemia, however.

- In Massachusetts between 2002 and 2006, the age-adjusted incidence rate of leukemia in men was 15.2 cases per 100,000 and in women was 9.6 cases per 100,000. Men are 1.6 times more likely to develop leukemia than women.

- The age-adjusted mortality rate of leukemia was higher in Massachusetts males (9.0 deaths per 100,000 males) than in Massachusetts females (5.5 deaths per 100,000 females) between 2002 and 2006. Men are 1.6 times more likely to die from leukemia than women.

- The age-adjusted incidence rate of leukemia for men is 5.0% lower in Massachusetts than nationally and for females is the same in Massachusetts as nationally (based on data from the North American Association of Central Cancer Registries, 2002-2006).

- The age-adjusted mortality rate of leukemia for men is 8.2% lower in Massachusetts than nationally and for females is the same in Massachusetts as nationally (based on data from the North American Association of Central Cancer Registries, 2002-2006).

For additional statistics on leukemia in Massachusetts, see Massachusetts Community Health Information Profile (MassCHIP) Instant Topics – Cancer: Leukemia [http://masschip.state.ma.us/InstantTopics/affiliate.htm]. Please click on an affiliation, select Cancer in the Instant Topic list, and then select Cancer: leukemia.

**DPH PROGRAMS AND INFORMATION**

**DPH leukemia programs**
The Massachusetts Department of Public Health’s Comprehensive Cancer Prevention and Control Program focuses on reducing cancer risk, incidence, morbidity, and mortality by promoting a healthy lifestyle, early diagnosis, treatment, rehabilitation, and access to care. The Department’s programs address the impact of genetics, tobacco, and environmental and occupational hazards on cancer. The Department is working to decrease both new cases of cancer and death from most forms of cancer through strategies designed to reduce risk factors related to cancer.

There are currently no programs at the Massachusetts Department of Public Health that are focused exclusively on leukemia. The lack of prevention measures makes program development for the leukemias difficult.

**Publications and Materials**

**Reports**
The following reports can be obtained from the Massachusetts Cancer Registry website at [http://www.mass.gov/dph/mcr](http://www.mass.gov/dph/mcr):

- **Statewide Reports:** *Cancer Incidence and Mortality in Massachusetts – Statewide Report 2001-2005*
- **City and Town Series:** *Cancer Incidence in Massachusetts – City and Town Supplement 2001-2005*
- **Special Reports:** *Childhood Cancer in Massachusetts, 1990-1999*

Also -

**Pamphlets, Brochures and Videos**

No materials are available exclusively on leukemia.

**References**


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RELATED LINKS

Background/General Links

American Cancer Society (ACS)

The Leukemia & Lymphoma Society
[http://www.leukemia.org/hm_lls]

National Cancer Institute (NCI)

Prevention and Screening Links

None at this time.

Diagnosis and Treatment Links

American Cancer Society (ACS)
  - Leukemia - Acute Lymphocytic (ALL)
  - Leukemia - Acute Myeloid (AML)
  - Leukemia - Chronic Myeloid (CML)

National Cancer Institute (NCI)
- Clinical Trials [http://www.cancer.gov/clinical_trials/]
- Leukemia Trial Results [http://www.cancer.gov/clinicaltrials/leukemia-updates]

Statistics Links

American Cancer Society (ACS)
- Cancer Facts and Figures 2008
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Centers for Disease Control and Prevention (CDC) and National Cancer Institute (NCI)
- *United States Cancer Statistics*

National Cancer Institute (NCI)
- *Surveillance, Epidemiology and End Results (SEER) Cancer Statistics Review, 1975-2005*
- SEER Cancer Stat Fact Sheets – Leukemia

North American Association of Central Cancer Registries (NAACCR)
- *Cancer in North America 2001-2005*
  http://www.naaccr.org/index.asp?Col_SectionKey=11&Col_ContentID=50