



# About Childhood Leukemia

## Overview and Types

If your child has been diagnosed with leukemia or you are worried about it, you likely have a lot of questions. Learning some basics is a good place to start.

- [What Is Childhood Leukemia?](#)

## Research and Statistics

See the latest estimates for new cases of childhood leukemia in the US and what research is currently being done.

- [What Are the Key Statistics for Childhood Leukemia?](#)
- [What's New in Childhood Leukemia Research and Treatment?](#)

# What Is Childhood Leukemia?

Cancer starts when cells start to grow out of control. Cells in nearly any part of the body can become cancer. To learn more about how cancers start and spread, see [What Is Cancer?](#) For information about the differences between childhood cancers and adult cancers, see [Cancer in Children](#).

Leukemia is a cancer that starts in early blood-forming cells found in the bone marrow, the soft inner part of certain bones. Most often, leukemia is a cancer of the white blood cells, but some leukemias start in other blood cell types.

Any of the blood-forming cells from the bone marrow can turn into a leukemia cell. Once this change takes place, the leukemia cells no longer mature in a normal way. Leukemia cells might reproduce quickly, and not die when they should. These cells build up in the bone marrow, crowding out normal cells. In most cases, the leukemia cells spill into the

bloodstream fairly quickly. From there they can go to other parts of the body such as the lymph nodes, spleen, liver, central nervous system (the brain and spinal cord), testicles, or other organs, where they can keep other cells in the body from doing their jobs.

Some other childhood cancers, such as [neuroblastoma](#) or [Wilms tumor](#), start in other organs and can spread to bone marrow, but these cancers are not leukemia.

## Normal bone marrow, blood, and lymphoid tissue

To understand the different types of leukemia, it helps to know about the blood and lymph systems.

### Bone marrow

Bone marrow is the soft inner part of bones. New blood cells (red blood cells, white blood cells, and platelets) are made there. In infants, active bone marrow is found in almost all bones of the body, but by the teenage years it is found mainly in the flat bones (skull, shoulder blades, ribs, and hip bones) and vertebrae (the bones that make up the spine).

Bone marrow is made up of a small number of blood stem cells, more mature blood-forming cells, fat cells, and supporting tissues that help cells grow. Blood stem cells go through a series of changes to make new blood cells. During this process, the cells develop into 1 of the 3 main types of blood cell components.

### Types of blood cells

**Red blood cells** carry oxygen from the lungs to all other tissues in the body, and take carbon dioxide back to the lungs to be removed. Having too few red blood cells in the body (*anemia*) can make you feel tired, weak, and short of breath because your body tissues are not getting enough oxygen.

**Platelets** are actually cell fragments made by a type of bone marrow cell called the *megakaryocyte*. Platelets are important in stopping bleeding by plugging up holes in blood vessels. Having too few platelets (*thrombocytopenia*) may cause you to bleed or bruise easily.

**White blood cells** help the body fight infections. Having too few white blood cells weakens your immune system and can make you more likely to get an infection.

## Types of white blood cells

**Lymphocytes** are mature, infection-fighting cells that develop from *lymphoblasts*, a type of blood stem cell in the bone marrow. Lymphocytes are the main cells that make up lymphoid tissue, a major part of the immune system. Lymphoid tissue is found in the lymph nodes, thymus (a small organ behind the breast bone), spleen, tonsils and adenoids, and bone marrow. It is also scattered through the digestive system and respiratory system. There are 2 main types of lymphocytes:

- **B lymphocytes** (B cells) help protect the body against germs such as bacteria and viruses. They make proteins called *antibodies* that attach to the germ, marking it for destruction by other parts of the immune system.
- **T lymphocytes** (T cells) also help protect the body against germs. Some types of T cells destroy germs directly, while others play a role in either boosting or slowing the activity of other immune system cells.

Acute lymphocytic (lymphoblastic) leukemia (ALL), the most common type of childhood leukemia, develops from early forms of lymphocytes. It can start in either early B cells or T cells at different stages of maturity. Although both B cells and T cells can develop into leukemia, B-cell leukemias are much more common than T-cell leukemias. For more information, see the section “ [How is childhood leukemia classified?](#)”

**Granulocytes** are mature, infection-fighting cells that develop from *myeloblasts*, a type of blood-forming cell in the bone marrow. Granulocytes have granules that show up as spots under the microscope. These granules contain enzymes and other substances that can destroy germs, such as bacteria. The 3 types of granulocytes – *neutrophils*, *basophils*, and *eosinophils* – are distinguished under the microscope by the size and color of their granules.

**Monocytes** develop from blood-forming monoblasts in the bone marrow and are related to granulocytes. After circulating in the bloodstream for about a day, monocytes enter body tissues to become macrophages, which can destroy some germs by surrounding and digesting them. Macrophages also help lymphocytes recognize germs and start making antibodies to fight them.

## Types of leukemia in children

Leukemia is often described as being either acute (fast growing) or chronic (slow growing). Almost all childhood leukemia is acute.

## Acute leukemias

The main types of acute leukemia are:

- **Acute lymphocytic (lymphoblastic) leukemia (ALL):** About 3 out of 4 childhood leukemias are ALL. This leukemia starts from early forms of lymphocytes in the bone marrow.
- **Acute myelogenous leukemia (AML):** This type of leukemia, also called *acute myeloid leukemia*, *acute myelocytic leukemia*, or *acute non-lymphocytic leukemia*, accounts for most of the remaining cases. AML starts from the myeloid cells that form white blood cells (other than lymphocytes), red blood cells, or platelets.
- **Hybrid or mixed lineage leukemia:** In these rare leukemias, the cells have features of both ALL and AML. In children, they are generally treated like ALL and usually respond to treatment like ALL.

Both ALL and AML can be further divided into different subtypes. For more on these subtypes, see the section “ [How is childhood leukemia classified?](#)”

## Chronic leukemias

Chronic leukemias are much more common in adults than in children. They tend to grow more slowly than acute leukemias, but they are also harder to cure. Chronic leukemias can be divided into 2 types.

- **Chronic myelogenous leukemia (CML):** This leukemia rarely occurs in children. Treatment is similar to that used for adults (see “ [Treatment of children with chronic myelogenous leukemia](#)”). For more detailed information on CML, see [Leukemia--Chronic Myeloid](#).
- **Chronic lymphocytic leukemia (CLL):** This leukemia is extremely rare in children. For more information on CLL, see [Leukemia--Chronic Lymphocytic](#).

## Juvenile myelomonocytic leukemia (JMML)

This rare type of leukemia is neither chronic nor acute. It begins from myeloid cells, but it usually doesn't grow as fast as AML or as slow as CML. It occurs most often in young children (under age 4). Symptoms can include pale skin, fever, cough, easy bruising or bleeding, trouble breathing (from too many white blood cells in the lungs), and an enlarged spleen and lymph nodes.

- [References](#)

[See all references for Leukemia in Children](#)

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## What Are the Key Statistics for Childhood Leukemia?

Leukemia is the most common cancer in children and teens, accounting for almost 1 out of 3 cancers. Overall, however, childhood leukemia is a rare disease.

About 3 out of 4 leukemias among children and teens are acute lymphocytic leukemia (ALL). Most of the remaining cases are acute myelogenous leukemia (AML).

ALL is most common in early childhood, peaking between 2 and 4 years of age. Cases of AML are more spread out across the childhood years, but this type of leukemia is slightly more common during the first 2 years of life and during the teenage years.

ALL is slightly more common among Hispanic and white children than among African-American and Asian-American children, and it is more common in boys than in girls. AML occurs about equally among boys and girls of all races.

Chronic leukemias are rare in children. Most of these are chronic myelogenous leukemia (CML), which tends to occur more in teens than in younger children.

Juvenile myelomonocytic leukemia (JMML) usually occurs in young children, with an average age of about 2.

Visit the [American Cancer Society's Cancer Statistics Center](#) for more key statistics.

Survival statistics for childhood leukemia are in [another section](#) of this document.

- [References](#)

[See all references for Leukemia in Children](#)

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# What's New in Childhood Leukemia Research and Treatment?

Researchers are now studying the causes, diagnosis, and treatment of leukemia at many medical centers, university hospitals, and other institutions.

## Genetics

As noted in the section “[Do we know what causes childhood leukemia?](#)” scientists are making progress in understanding how changes in the DNA inside bone marrow stem cells can cause them to develop into leukemia cells. Understanding these gene changes (such as translocations or extra chromosomes) can help explain why these cells may grow out of control, and why they don't develop into normal, mature cells. Doctors are now looking to use these changes to help them determine a child's outlook and whether they should receive more or less intensive treatment.

This progress has already led to vastly improved and very sensitive tests for detecting leukemia cells in blood or bone marrow samples. The *polymerase chain reaction* (PCR) test, for example, can identify very small numbers of leukemia cells based on their chromosome translocations or other rearrangements. This test is useful in determining how completely the leukemia has been destroyed by treatment, and whether a relapse will occur if further treatment is not given.

## Clinical trials

Most children with leukemia are treated at major medical centers, where treatment often means taking part in [clinical trials](#) to get the most up-to-date care. Several important questions are now being studied in clinical trials. Among them are:

- Why do some children with acute lymphocytic leukemia (ALL) relapse after

treatment, and how can this be prevented?

- Are there other prognostic factors that will help identify which children need more or less intensive treatment?
- Can chemotherapy drug resistance in acute myelogenous leukemia (AML) be reversed?
- Are there better drugs or combinations of drugs for treating the different types of childhood leukemia?
- When exactly should a stem cell transplant be used to treat leukemia?
- How effective are stem cell transplants in children who don't have a brother or sister who is a good tissue type match?
- Can a second stem cell transplant help children who relapse after a first stem cell transplant?
- What are the best treatment approaches for children with less common forms of leukemia, such as juvenile myelomonocytic leukemia (JMML) and chronic myeloid leukemia (CML)?

## **Immunotherapy to treat childhood leukemia**

Immunotherapies are treatments that boost a child's own immune system to help fight leukemia. Some types of immunotherapy have shown a lot of promise in treating ALL, even when other treatments are no longer working.

### **Chimeric antigen receptor (CAR) T-cell therapy**

In this treatment, immune cells called *T cells* are removed from the child's blood and genetically altered in the lab to have specific receptors (called *chimeric antigen receptors*, or CARs) on their surface. These receptors can attach to proteins on the surface of leukemia cells. The T cells are then multiplied in the lab and given back into the child's blood, where they can seek out the leukemia cells and launch a precise immune attack against them.

This technique has shown very encouraging results in early clinical trials against some advanced, hard-to-treat cases of ALL. In many children the leukemia could no longer be detected after treatment, although it's not yet clear if these children have been cured.

Some children have had serious side effects from this treatment, including very high fevers and dangerously low blood pressure in the days after it's given. Doctors are learning how to manage these side effects.

Doctors are still improving how they make the T cells and are learning the best ways to use them. CAR T-cell therapy is only available in clinical trials at a handful of major medical centers at this time.

## Monoclonal antibody therapy

Antibodies are proteins made by the body's immune system to help fight infections. Man-made versions, called *monoclonal antibodies*, can be designed to attack a specific target, such as a protein on the surface of leukemia cells.

An example is blinatumomab (Blinicyto), a special kind of monoclonal antibody that can attach to 2 different proteins at the same time. One part of blinatumomab attaches to a protein found on B cells (the cells that become leukemia cells in most cases of ALL). Another part of the antibody attaches to a protein on immune cells called *T cells*. By binding to both of these proteins, this drug brings the leukemia cells and immune cells together, which is thought to cause the immune system to attack the cancer cells. Early results with this drug against B-cell ALL have been promising, although so far it has been studied more in adults than in children.

- [References](#)

[See all references for Leukemia in Children](#)

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