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.

- Key Statistics for Childhood Leukemia
- What's New in Childhood Leukemia Research?

What Is Childhood Leukemia?

Cancer starts when cells in the body start to grow out of control. Cells in nearly any part of the body can become cancer. To learn more about cancer and how it starts and spreads, see What Is Cancer?[1] For information about the differences between childhood cancers and adult cancers, see Cancer in Children[2].

Leukemias are cancers that start in cells that would normally develop into different types of blood cells. Most often, leukemia starts in early forms of white blood cells, but

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.

White blood cells

White blood cells (WBCs)help the body fight infections. There are different types of white blood cells:

- **Lymphocytes** are mature WBCs that develop from lymphoblasts, a type of blood-forming cell in the bone marrow. Lymphocytes are the main cells that make up lymph tissue, a major part of the immune system. Lymph 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 cells** and **T cells**. (ALL, the most common type of childhood leukemia, can start in either B cells or T cells.) For more information, see Childhood Leukemia Subtypes[8].
- **Granulocytes** are mature WBCs 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.

Start and spread of leukemia

Leukemia starts in the bone marrow. The leukemia cells can build up there, crowding out normal cells. Most often, the leukemia cells spill into the bloodstream fairly quickly. Some types of leukemia can also spread 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.

Some other childhood cancers, such as neuroblastoma[9] or rhabdomyosarcoma[10], start in other organs and can spread to bone marrow, but these cancers are not leukemia.

Hyperlinks

1. www.cancer.org/treatment/understanding-your-diagnosis/what-is-cancer.html
2. www.cancer.org/cancer/cancer-in-children.html
3. www.cancer.org/cancer/leukemia-in-children/detection-diagnosis-staging/how-classified.html
4. www.cancer.org/cancer/leukemia-in-children/treating/children-with-cml.html
5. www.cancer.org/cancer/chronic-myeloid-leukemia.html
6. www.cancer.org/cancer/chronic-lymphocytic-leukemia.html
7. www.cancer.org/cancer/leukemia-in-children/treating/children-with-jmml.html
8. www.cancer.org/cancer/leukemia-in-children/detection-diagnosis-staging/how-classified.html
9. www.cancer.org/cancer/neuroblastoma.html
10. www.cancer.org/cancer/rhabdomyosarcoma.html

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Rabin KR, Gramatges MM, Margolin JF, Poplack DG. Chapter 19: Acute Lymphoblastic Leukemia. In: Pizzo PA, Poplack DG, eds. *Principles and Practice of Pediatric Oncology*. 7th ed. Philadelphia Pa: Lippincott Williams & Wilkins; 2016.

Rabin KR, Margolin JF, Kamdar KY, Poplack DG. Chapter 100: Leukemias and Lymphomas of Childhood. In: DeVita VT, Lawrence TS, Rosenberg SA, eds. *DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology*. 10th ed. Philadelphia, Pa: Lippincott Williams & Wilkins; 2015.

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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 myeloid leukemia (AML)**.

- ALL is most common in early childhood, peaking between 2 and 5 years of age.
- AML tends to be more spread out across the childhood years, but it's 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 myeloid leukemia (CML)**, which tends to occur more in teens than in younger children.

Juvenile myelomonocytic leukemia (JMML) is also rare. It usually occurs in young children, with an average age of about 2. It is slightly more common in boys than in girls.

Visit the American Cancer Society's Cancer Statistics Center[1] for more key statistics.

Caywood EH, Kolb EA. Juvenile myelomonocytic leukemia. UpToDate. 2018. Accessed at www.uptodate.com/contents/juvenile-myelomonocytic-leukemia on November 29, 2018.

Rabin KR, Gramatges MM, Margolin JF, Poplack DG. Chapter 19: Acute Lymphoblastic Leukemia. In: Pizzo PA, Poplack DG, eds. *Principles and Practice of Pediatric Oncology*. 7th ed. Philadelphia Pa: Lippincott Williams & Wilkins; 2016.

Rabin KR, Margolin JF, Kamdar KY, Poplack DG. Chapter 100: Leukemias and Lymphomas of Childhood. In: DeVita VT, Lawrence TS, Rosenberg SA, eds. *DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology*. 10th ed. Philadelphia, Pa: Lippincott Williams & Wilkins; 2015.

Wei MC, Dahl GV, Weinstein HJ. Chapter 61: Acute Myeloid Leukemia in Children. In: Hoffman R, Benz EJ, Silberstein LE, Heslop H, Weitz J, Anastasi J, eds. *Hematology: Basic Principles and Practice*. 6th ed. Philadelphia, Pa. Elsevier; 2013.

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What's New in Childhood Leukemia Research?

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

Genetics

Scientists are making progress in understanding the changes in the DNA inside bone marrow stem cells[1] that can cause them to develop into leukemia cells. Understanding these gene and chromosome changes can help explain why these cells may grow out of control, and why they don't develop into normal, mature blood cells. Doctors are now looking to use these changes to help them determine a child's outlook and to determine what treatment is likely to be best.

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 changes. This test is useful in determining how completely the leukemia has been destroyed by treatment, and whether a relapse is likely if further treatment isn't given. Newer tests known as **next generation sequencing (NGS)** tests, which are just now coming into use, might be able to help with this even more.

Causes, and possibly prevention

Researchers continue to look for possible causes of leukemia in children, which might include a combination of both genetics and environmental exposures.

For example, one theory that has gained some ground in recent years is that some childhood leukemias might be caused by a combination of certain gene changes that happen very early in life (even before birth), along with being exposed to certain germs (particularly viruses) later than normal. This “delayed infection” (after the first year or so of life) might affect the immune system in a way that leads to a second gene change, which in turn might lead to leukemia.

This might help explain why some studies have found that the risk of childhood leukemia seems to be lower in children who were in daycare during their first year of life (which would have exposed them to common infections earlier).

More research is needed to confirm this theory. But if it is confirmed, it might be possible to lower childhood leukemia risk by ensuring children are exposed to certain germs very early in life.

Clinical trials

Most children with leukemia are treated at major medical centers, where treatment is often given in clinical trials[2] to help ensure children 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[3] 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 should a stem cell transplant[4] 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)[5] and chronic myeloid leukemia (CML)[6]?

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 childhood leukemia, 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 help them attack leukemia cells. The T cells are then given back into the child's blood, where they can seek out the leukemia cells throughout the body.

This technique has shown very encouraging results in 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.

Doctors are still improving how they make the T cells and are learning the best ways to

leukemia cells. This drug can be used to treat some types of B-cell ALL.

For more on these treatments, see Immunotherapy for Childhood Leukemia[7].

Other types of immunotherapy are now being studied as well.

New targeted drugs to treat AML

As researchers have learned more about the gene changes that drive the growth of leukemia cells, they've begun to develop drugs that can target these gene changes. For example, several newer types of targeted drugs are now being used to treat adults with AML, and many of these are now being tested for use in children as well.

FLT3 inhibitors: These drugs attack cells with a mutated *FLT3* gene. Examples include midostaurin (Rydapt) and gilteritinib (Xospata).

IDH inhibitors: These drugs target leukemia cells that have mutations in the *IDH1* or *IDH2* gene. Examples include ivosidenib (Tibsovo) and enasidenib (Idhifa).

BCL-2 inhibitors: These drugs attack BCL-2, a protein that can help leukemia cells live longer. An example is venetoclax (Venclexta).

Childhood Cancer Research Highlights[8]

The American Cancer Society is committed to finding new answers to help every child and family affected by cancer--see some of our latest research.

Hyperlinks

1. www.cancer.org/cancer/leukemia-in-children/causes-risks-prevention/what-causes.html
2. www.cancer.org/treatment/treatments-and-side-effects/clinical-trials.html
3. www.cancer.org/cancer/leukemia-in-children/detection-diagnosis-staging/prognostic-factors.html
4. www.cancer.org/cancer/leukemia-in-children/treating/bone-marrow.html
5. www.cancer.org/cancer/leukemia-in-children/treating/children-with-jmml.html
6. www.cancer.org/cancer/leukemia-in-children/treating/children-with-cml.html
7. www.cancer.org/cancer/leukemia-in-children/treating/immunotherapy.html
8. www.cancer.org/research/acs-research-highlights/childhood-cancer-research-highlights.html

References

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