Treating Acute Lymphocytic Leukemia (ALL)

If you've been diagnosed with acute lymphocytic leukemia (ALL), your cancer care team will discuss your treatment options with you. Your options may be affected by the ALL subtype, as well as certain other prognostic factors, as well as your age and overall state of health.

(Note: This information is about acute lymphocytic leukemia (ALL) in adults. To learn about ALL in children, see Leukemia in Children*.)*

How is acute lymphocytic leukemia treated?

The main types of treatment used for ALL include:

- Chemotherapy for Acute Lymphocytic Leukemia (ALL)
- Targeted Therapy for Acute Lymphocytic Leukemia (ALL)
- Immunotherapy for Acute Lymphocytic Leukemia (ALL)
- Surgery for Acute Lymphocytic Leukemia (ALL)
- Radiation Therapy for Acute Lymphocytic Leukemia (ALL)
- Stem Cell Transplant for Acute Lymphocytic Leukemia (ALL)

Common treatment approaches

Treatment of ALL typically lasts for about 2 years. It is often intense, especially in the first few months of treatment, so it's important that you are treated in a center that has experience with this disease.

The treatment approach for children with ALL can be slightly different from that used for adults. It's discussed separately in Treatment of Children With Acute Lymphocytic

Leukemia (ALL).

- Typical Treatment of Acute Lymphocytic Leukemia (ALL)

Who treats ALL?

Based on your treatment options, you may have different types of doctors on your treatment team. These doctors could include:

- A **hematologist:** a doctor who treats disorders of the blood
- A **medical oncologist:** a doctor who treats cancer with medicines

You might have many other specialists on your treatment team as well, including physician assistants, nurse practitioners, nurses, nutrition specialists, social workers,

Thinking about taking part in a clinical trial

Clinical trials are carefully controlled research studies that are done to get a closer look at promising new treatments or procedures. Clinical trials are one way to get state-of-the art cancer treatment. In some cases they may be the only way to get access to newer treatments. They are also the best way for doctors to learn better methods to treat cancer.

If you would like to learn more about clinical trials that might be right for you, start by asking your doctor if your clinic or hospital conducts clinical trials.

- Clinical Trials

Considering complementary and alternative methods

You may hear about alternative or complementary methods to relieve symptoms or treat your cancer that your doctors haven't mentioned. These methods can include vitamins, herbs, and special diets, or other methods such as acupuncture or massage, to name a few.

Complementary methods are treatments that are used **along with** your regular medical care. **Alternative** treatments are used **instead of** standard medical treatment. Although some of these methods might be helpful in relieving symptoms or helping you feel better, many have not been proven to work. Some might even be harmful.

Be sure to talk to your cancer care team about any method you are thinking about using. They can help you learn what is known (or not known) about the method, which can help you make an informed decision.

- Complementary and Integrative Medicine

Help getting through cancer treatment

People with cancer need support and information, no matter what stage of illness they may be in. Knowing all of your options and finding the resources you need will help you make informed decisions about your care.

Whether you are thinking about treatment, getting treatment, or not being treated at all, you can still get supportive care to help with pain or other symptoms. Communicating with your cancer care team is important so you understand your diagnosis, what treatment is recommended, and ways to maintain or improve your quality of life.

Leukemia (ALL)

*(**Note:** This information is about treating acute lymphocytic leukemia (ALL) in adults. To learn about ALL in children, see* Leukemia in Children[1]*.)*

Chemotherapy (chemo) is the use of drugs to treat cancer. Chemo drugs travel through the bloodstream to reach cancer cells all over the body. This makes chemo useful for cancers such as leukemia that has spread throughout the body.

Chemo is the main treatment for just about all people with acute lymphocytic leukemia (ALL). Because of its potential side effects, chemo might not be recommended for patients in poor health, but advanced age by itself is not a barrier to getting chemo.

How is chemo given?

Chemo treatment for ALL is typically divided into 3 phases:

Most chemo drugs have trouble reaching the area around the brain and spinal cord, so chemo may need to be injected into the cerebrospinal fluid (CSF) to kill cancer cells in that area. This is called **intrathecal chemo**. Intrathecal chemo can be given during a spinal tap[2] or by using a special catheter called an Ommaya reservoir.

Which chemo drugs are used to treat ALL?

Chemo for ALL uses a combination of anti-cancer drugs. The most commonly used chemo drugs include:

- Vincristine or liposomal vincristine (Marqibo)
- Daunorubicin (daunomycin) or doxorubicin (Adriamycin)
- Cytarabine (cytosine arabinoside, ara-C)
- L-asparaginase or PEG-L-asparaginase (pegaspargase or Oncaspar)
- 6-mercaptopurine (6-MP)
- Methotrexate
- Cyclophosphamide
- Prednisone
- Dexamethasone
- Nelarabine (Arranon)

People typically get several of these drugs at different times during the course of treatment, but they do not get all of them.

Possible side effects

Chemo drugs can affect some normal cells in the body, which can lead to side effects. The side effectsof chemo depend on the type and dose of drugs given and the length of time they are taken. Common side effects can include:

- Hair loss
- Mouth sores
- Loss of appetite
- Nausea and vomiting
- Diarrhea or constipation

Chemo drugs also affect the normal cells in bone marrow, which can lower blood cell counts. This can lead to:

- Increased risk of infections (from having too few normal white blood cells)
- Easy bruising or bleeding (from having too few blood platelets)
- Fatigue and shortness of breath (from having too few red blood cells)

Most side effects from chemo go away once treatment is finished. Low blood cell counts can last weeks, but then should return to normal. There are often ways to lessen chemo side effects. For example, drugs can be given to help prevent or reduce nausea and vomiting. Be sure to ask your cancer care team about medicines to help reduce side effects, and let your doctor or nurse know when you do have side effects so they can be managed effectively.

Low white blood cell counts: Some of the most serious side effects of chemo are caused by low white blood cell counts.

You may get **antibiotics** and drugs that help prevent fungal and viral infections before before you have signs of infection or at the earliest sign that an infection may be developing (such as a fever).

Drugs known as **growth factors**, such as filgrastim (Neupogen), pegfilgrastim (Neulasta), and sargramostim (Leukine), are sometimes given to increase the white blood cell counts after chemo, to help lower the chance of infection. However, it's not clear if they have an effect on treatment success.

There are also steps that you can take to lower your risk of infection, such as washing your hands often. These are discussed in Infections in People With Cancer[3].

Low platelet counts: If your platelet counts are low, you may be given drugs or platelet transfusions to help protect against bleeding.

Low red blood cell counts: Shortness of breath and extreme fatigue caused by low red blood cell counts (anemia) may be treated with drugs or with red blood cell transfusions.

Decisions about when a patient can leave the hospital are often influenced by their blood counts. Some people find it helpful to keep track of their counts. If you are interested in this, ask your doctor or nurse about your blood cell counts and what these numbers mean.

Side effects of specific drugs: Certain drugs might cause specific side effects. For example:

- **Cytarabine** (ara-C), especially when used at high doses, can cause dryness in the eyes and can affect certain parts of the brain, which can lead to problems with coordination and balance.
- **Vincristine** can damage nerves, which can lead to numbness, tingling, or weakness in hands or feet.
- Anthracyclines (such as **daunorubicin** or **doxorubicin**) can damage the heart, so the total dose needs to be watched closely, and these drugs might not be used in someone who already has heart problems.

Other organs that could be damaged by certain chemo drugs include the kidneys, liver, testicles, ovaries, and lungs. Doctors and nurses carefully monitor treatment to reduce the risk of these side effects as much as possible. If serious side effects occur, the chemo may have to be reduced or stopped, at least for a time.

Second cancers: One of the most serious side effects of ALL therapy is an increased risk of getting acute myeloid leukemia[4] (AML) at a later time. This occurs in a small portion of patients after they have received certain chemo drugs. Less often, people cured of leukemia may later develop non-Hodgkin lymphoma[5] or other cancers. Of course, the risk of getting these second cancers[6] must be balanced against the obvious benefit of treating a life-threatening disease such as leukemia with chemotherapy.

Tumor lysis syndrome: This side effect of chemo is most common in patients who have large numbers of leukemia cells in the body, so it is seen most often in the first (induction) phase of treatment. When chemo kills the leukemia cells, they break open and release their contents into the bloodstream. This can overwhelm the kidneys, which aren't able to get rid of all of these substances at once. Excess amounts of certain minerals can also affect the heart and nervous system. This can often be prevented by giving extra fluids during treatment and by giving certain drugs, such as bicarbonate, allopurinol, and rasburicase, which help the body get rid of these substances.

More information about chemotherapy

For more general information about how chemotherapy is used to treat cancer, see Chemotherapy[7].

To learn about some of the side effects listed here and how to manage them,

Hyperlinks

1. www.cancer.org/cancer/types/leukemia-in-children.html
2. www.cancer.org/cancer/types/acute-lymphocytic-leukemia/detection-diagnosis-staging/how-diagnosed.html
3. www.cancer.org/cancer/managing-cancer/side-effects/infections.html
4. www.cancer.org/cancer/types/acute-myeloid-leukemia.html
5. www.cancer.org/cancer/types/non-hodgkin-lymphoma.html

Targeted Therapy for Acute Lymphocytic Leukemia (ALL)

*(**Note:** This information is about treating acute lymphocytic leukemia (ALL) in adults. To learn about ALL in children, see Leukemia in Children[1].)*

Targeted therapy drugs work by attacking specific parts of cancer cells. They are different from standard chemotherapy (chemo) drugs. They sometimes work when chemo doesn't, and they often have different side effects. Some of these drugs can be useful in certain cases of acute lymphocytic leukemia (ALL).

Targeted drugs for ALL with the Philadelphia chromosome (Ph+ ALL)

In about 1 out of 4 adult patients with ALL, the leukemia cells have the **Philadelphia chromosome**. This is an abnormal chromosome formed by the swapping of genetic material between chromosomes 9 and 22, which creates a new gene called *BCR-ABL*. Cells with the *BCR-ABL* gene make an abnormal protein that helps the cells grow.

Drugs called **tyrosine kinase inhibitors** (**TKIs**) have been developed to attack this protein. Examples include:

- Imatinib (Gleevec®)
- Dasatinib (Sprycel®)
- Nilotinib (Tasigna®)
- Ponatinib (Iclusig®)
- Bosutinib (Bosulif®)

In patients with Ph+ ALL, adding a TKI to chemo helps increase the chance that the leukemia will go into remission. Continuing on one of these drugs can also help keep

Common **side effects** include diarrhea, nausea, muscle pain, fatigue, and skin rashes. These are generally mild. A common side effect is swelling around the eyes or in the hands or feet. Other possible side effects include lower red blood cell and platelet counts at the start of treatment. All of these side effects can get worse at higher than usual doses of the drug. Other, more serious side effects can occur as well, depending on which drug is used.

Immunotherapy drugs for ALL

Some of the immunotherapy drugs used to treat ALL might also be considered forms of targeted therapy, because they work by attaching to specific parts of leukemia cells. Examples include:

- Blinatumomab (Blincyto)
- Inotuzumab ozogamicin (Besponsa)

For more information on these drugs, see Immunotherapy for Acute Lymphocytic Leukemia (ALL).

More information about targeted therapy

To learn more about how targeted drugs are used to treat cancer, see Targeted Cancer Therapy[2].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[3].

Hyperlinks

Jain N, Gurbuxani S, Rhee C, Stock W. Chapter 65: Acute Lymphoblastic Leukemia in Adults. 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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Terwilliger T, Abdul-Hay M. Acute lymphoblastic leukemia: A comprehensive review and 2017 update. *Blood Cancer J*. 2017;7(6):e577.

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Immunotherapy for Acute Lymphocytic Leukemia (ALL)

*(**Note:** This information is about treating acute lymphocytic leukemia (ALL) in adults. To learn about ALL in children, see* Leukemia in Children[1]*.)*

Immunotherapy is the use of medicines to help a person's own immune system recognize and destroy cancer cells more effectively. Some types of immunotherapy are now being used to treat acute lymphocytic leukemia (ALL) in certain situations.

Monoclonal antibodies

Antibodies are proteins made by the body's immune system to help fight infections. Man-made versions of these proteins, called monoclonal antibodies[2], can be designed to attack a specific target, such as a protein on the surface of leukemia cells.

Blinatumomab (Blincyto)

Blinatumomab is a special kind of monoclonal antibody known as a **bispecific T-cell engager (BiTE)**. It can attach to 2 different proteins at the same time. One part of blinatumomab attaches to the CD19 protein, which is found on B cells, including some leukemia and lymphoma cells. Another part attaches to CD3, 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 helps the immune system attack the leukemia cells.

This drug is used to treat some types of B-cell ALL. For example:

- It might be used as part of the second (consolidation) phase of treatment in some people with ALL.
- It might be used to treat ALL that comes back or that is no longer responding to other treatments.

Doctors are also looking at using this drug as part of the first (induction) phase of treatment for some people with ALL.

Blinatumomab is given into a vein (IV) as a continuous infusion over 28 days. It may be repeated again for more cycles with 2 weeks off in between. Because of certain serious side effects that occur more often during the first few times it is given, a person usually needs to be treated in a hospital or clinic for the beginning of at least the first 2 cycles.

The most common **side effects** are fever, headache, swelling of the feet and hands, nausea, tremor, rash, constipation, and low blood potassium levels. It can also cause low white blood cell counts, which increase the risk of serious infection.

This drug can also cause **nervous system problems**, such as seizures, trouble speaking or slurred speech, passing out, confusion, and loss of balance.

Some people have serious infusion reactions[3] while getting this drug. Symptoms can include feeling lightheaded or dizzy (due to low blood pressure), headache, nausea, fever or chills, shortness of breath, and/or wheezing. Let your healthcare team know if you develop any of these symptoms, as this reaction can be life-threatening. If you do have a reaction, the drug will be stopped while the reaction is treated.

Inotuzumab ozogamicin (Besponsa)

This is an **antibody-drug conjugate (ADC)**, made up of an anti-CD22 antibody linked to a chemotherapy drug. B cells (including some leukemia cells) usually have the CD22 protein on their surface. The antibody acts like a homing device, bringing the chemo drug to the leukemia cells, where it enters the cells and kills them when they try to

divide into new cells.

This drug is used to treat some types of B-cell ALL, typically after chemotherapy has been tried. It is given as an infusion into a vein (IV), once a week for 3 or 4 weeks in a row. This may be repeated for more cycles.

The most common **side effects** are low levels of blood cells (with increased risks of infection, bleeding, and fatigue), fever, nausea, headache, abdominal (belly) pain, and high blood levels of bilirubin (a substance in bile).

Less common but more serious side effects can include:

- Severe liver damage, including veno-occlusive disease (blockage of veins in the liver)
- Reactions during the infusion (similar to an allergic reaction). You will likely be given medicines before each infusion to help prevent this.
- Serious or life-threatening infections, especially in people who have already had a stem cell transplant
- Changes in the rhythm of the heart

CAR T-cell therapy

For this treatment, immune cells called **T cells** are removed from the person'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 leukemia cells. The T cells are then multiplied in the lab and given back into the blood, where they can seek out the leukemia cells and attack them.

To make this treatment, T cells are removed from the blood during a process called *leukapheresis*. Blood is removed through an IV line and goes into a machine that removes the T cells. The remaining blood then goes back into the body. This typically takes a few hours, and it might need to be repeated. The cells are then frozen and sent to a lab, where they are turned into CAR T cells and are multiplied. This can take a few weeks.

For the treatment itself, the patient typically gets chemo for a few days to help prepare the body. Then they get the CAR T cells as an infusion into a vein (IV). Because this treatment can have serious side effects (see below), it is only given in medical centers that have special training with this treatment.

It's very important to report any side effects to the health care team right away, as there are often medicines that can help treat them.

To learn more about this type of treatment, see CAR T-Cell Therapies[4].

More information about immunotherapy

To learn more about how drugs that work on the immune system are used to treat cancer, see Cancer Immunotherapy[5].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[6].

Hyperlinks

1. www.cancer.org/cancer/types/leukemia-in-children.html
2. www.cancer.org/cancer/managing-cancer/treatment-types/immunotherapy/monoclonal-antibodies.html
3. www.cancer.org/cancer/managing-cancer/side-effects/infusion-immune-reactions.html
4. www.cancer.org/cancer/managing-cancer/treatment-types/immunotherapy/car-t-cell1.html
5. www.cancer.org/cancer/managing-cancer/treatment-types/immunotherapy.html
6. www.cancer.org/cancer/managing-cancer/side-effects.html

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Jain N, Gurbuxani S, Rhee C, Stock W. Chapter 65: Acute Lymphoblastic Leukemia in Adults. 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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Terwilliger T, Abdul-Hay M. Acute lymphoblastic leukemia: A comprehensive review and 2017 update. *Blood Cancer J*. 2017;7(6):e577.

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Surgery for Acute Lymphocytic Leukemia (ALL)

*(**Note:** This information is about treating acute lymphocytic leukemia (ALL) in adults. To learn about ALL in children, see Leukemia in Children[1].)*

Surgery has a very limited role in the treatment of acute lymphocytic leukemia (ALL). Because leukemia cells are spread widely throughout the bone marrow and blood, it isn't possible to cure this type of cancer with surgery. Aside from a possible lymph node biopsy[2], surgery rarely has a role even in the diagnosis of ALL, as this is typically done with a bone marrow aspiration and biopsy[3].

The main role for surgery in ALL is to insert catheters (tubes) into the body to make it easier to give chemotherapy (chemo), which is the main treatment for ALL.

Placement of a central venous catheter

Often before chemo is about to start, surgery is often needed to insert a small plastic tube, called a central venous catheter[4] (CVC), central line, or venous access device (VAD), into a large vein (usually in the chest). The end of the tube stays just under the skin or sticks out in the chest area or upper arm.

The CVC is left in place during treatment (often for many months) to give intravenous (IV) drugs such as chemo and to take blood samples. This lowers the number of needle sticks needed during treatment. It is very important to learn how to care for the device to keep it from getting infected.

Placement of an Ommaya reservoir

Giving chemo directly into the fluid that surrounds the brain and spinal cord (cerebrospinal fluid or CSF) is often a part of the treatment of ALL. In this treatment, called **intrathecal chemo**, the medicines can be given through a lumbar puncture (spinal tap) or through an Ommaya reservoir.

An Ommaya reservoir is a dome-like device attached to a catheter, which is put in place

during a surgical procedure. The dome part sits under the skin of the scalp, with the catheter going through a small hole in the skull and into one of the spaces (ventricles) in the brain.

Intrathecal chemo can be given by placing a needle through the skin and into the dome . The chemo goes through the catheter and into the CSF in the ventricle, and then circulates through the area around the brain and spinal cord.

An Ommaya reservoir allows a person to get intrathecal chemo without having to get repeated spinal taps. CSF can also be withdrawn from the Ommaya reservoir to check for leukemia cells and signs of infection.

Hyperlinks

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Radiation Therapy for Acute Lymphocytic Leukemia (ALL)

*(**Note:** This information is about treating acute lymphocytic leukemia (ALL) in adults. To learn about ALL in children, see Leukemia in Children[1].)*

Radiation therapy uses high-energy radiation to kill cancer cells. It is not usually part of the main treatment for people with acute lymphocytic leukemia (ALL), but it is used in certain situations:

- Radiation is sometimes used to treat leukemia that has spread to the brain and spinal fluid, or to the testicles.
- Radiation to the whole body is often an important part of treatment before a bone marrow or peripheral blood stem cell transplant (see High-dose Chemotherapy and Stem Cell Transplant for Acute Lymphocytic Leukemia).
- Radiation is used (rarely) to help shrink a tumor if it is pressing on the trachea (windpipe) and causing breathing problems. But chemotherapy is often used instead, as it may work more quickly.
- Radiation can also be used to reduce pain in an area of bone invaded by leukemia, if chemotherapy hasn't helped.

External beam radiation therapy, in which a machine delivers a beam of radiation to a specific part of the body, is the type of radiation used most often for ALL. Before your treatment starts, the radiation team will take careful measurements to determine the correct angles for aiming the radiation beams and the proper dose of radiation. This planning session, called **simulation**, usually includes getting imaging tests[2] such as CT or MRI scans.

Radiation treatment is much like getting an x-ray, but the radiation is much stronger. The procedure itself is painless. Each treatment lasts only a few minutes, although the setup time – getting you into place for treatment – usually takes longer. The number of

treatments you get depends on the reason radiation therapy is being used.

Side effects

The **possible sideeffects** of radiation therapy depend on where the radiation is aimed. They include:

- Fatigue (tiredness)
- Skin changes in the treated area, which can range from mild redness to burning and peeling
- Hair loss in the area being treated
- Nausea and vomiting (if the head or belly is being treated)
- Diarrhea (if the belly or pelvis is being treated)
- Mouth sores and trouble swallowing (if the head and neck area are being treated)
- Headaches (if the head is being treated)
- Lowered blood cell counts, which can lead to fatigue and shortness of breath (from low red blood cell counts), bleeding or bruising (from low platelet counts), and an increased risk of infection (from low white blood cell counts)

More information about radiation therapy

To learn more about how radiation is used to treat cancer, see Radiation Therapy[3].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[4].

Hyperlinks

1. www.cancer.org/cancer/types/leukemia-in-children.html
2. www.cancer.org/cancer/diagnosis-staging/tests/imaging-tests/imaging-radiology-tests-for-cancer.html
3. www.cancer.org/cancer/managing-cancer/treatment-types/radiation.html
4. www.cancer.org/cancer/managing-cancer/side-effects.html

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JO, Dorshow JH, Kastan MB, Tepper JE, eds. *Abeloff's Clinical Oncology*. 5th ed. Philadelphia, Pa. Elsevier: 2014.

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National Comprehensive Cancer Network. NCCN Practice Guidelines in Oncology:

Stem Cell Transplant for Acute Lymphocytic Leukemia (ALL)

blood are used.

Types of stem cell transplants

The main types of stem cell transplants are:

- **Allogeneic** stem cell transplant, in which the stem cells **come from someone else**. This is the preferred type of transplant when treating ALL.
- **Autologous** stem cell transplant, in which the patient **gets back their own cells**

Allogeneic transplant: A donor's tissue type (also known as the HLA type) needs to closely match the patient's tissue type to help prevent the risk of major problems with the transplant. The best donor is often a close relative, such as a brother or sister, if they have the same tissue type as the patient. If there are no siblings with a good match, the cells may come from an HLA-matched, unrelated donor – a stranger who has volunteered to donate their cells. Some patients cannot have this kind of transplant because a matching donor isn't available.

The use of allogeneic transplant is also limited by its side effects, which are often too severe for people who are older or who have other health problems. One option that may help patients who can't have an allogeneic transplant because of age or health issues is to use lower doses of chemo and radiation that don't completely destroy the cells in their bone marrow. This is known as a **non-myeloablative** or **reduced-intensity transplant**.This kind of SCT relies on the donor cells to kill the leukemia cells, instead of the chemo and radiation. This is not a standard treatment for ALL, and is being studied to determine how useful it may be.

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may recognize any remaining leukemia cells as being foreign to them and attack them. This effect doesn't happen with an autologous SCT.

Practical points

A stem cell transplant is an intensive and complex treatment that can cause life-threatening side effects. If your doctor thinks you might benefit from a transplant, you should discuss what kind you will have, the possible side effects, and how long it may take for you to recover. Stem cell transplants should be done at a hospital where the staff has experience with the procedure and with managing the recovery phase.

More information about stem cell transplant

To learn more about stem cell transplants, including how they are done and their potential side effects, see Stem Cell Transplant for Cancer[3].

For more general information about side effects and how to manage them, see Managing Cancer-related Side Effects[4].

Hyperlinks

1. www.cancer.org/cancer/types/leukemia-in-children.html

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Typical Treatment of Acute Lymphocytic Leukemia (ALL)

*(**Note:** This information is about treating acute lymphocytic leukemia (ALL) in adults. To learn about ALL in children, see* Leukemia in Children[1]*.)*

The main treatment for acute lymphocytic leukemia (ALL) in adults is typically long-term chemotherapy (chemo). Sometimes other types of drugs, such as targeted drugs or immunotherapy, might be part of the treatment as well.

In recent years, doctors have begun to use more intensive treatments, which has led to more leukemias going into remission. But this is also more likely to cause side effects, such as low white blood cell counts. People may need to get other drugs to help prevent or treat these side effects.

Treatment of ALL typically takes place in 3 phases:

- **Induction (remission induction)**
- **Consolidation (intensification)**
- **Maintenance**

This first month of treatment is intensive and requires frequent visits to the doctor. You may spend some or much of this time in the hospital, because serious infections or other complications can occur. It's very important to take all medicines as prescribed. Sometimes complications can be serious enough to be life-threatening, but with recent advances in supportive care (nursing care, nutrition, antibiotics, growth factors, red blood cell and platelet transfusions[7] as needed, etc.), these are much less common than in the past.

Most often, leukemia goes into remission with induction chemotherapy. But because leukemia cells may still be hiding somewhere in the body, further treatment is needed.

CNS treatment or prophylaxis: Treatment needs to be given either to keep the leukemia cells from spreading to the CNS (CNS prophylaxis), or to treat the leukemia if it has already spread to the CNS. This is often started during induction and continued through the other phases of treatment. It may include one or more of the following:

- Chemo injected directly into the CSF (called **intrathecal chemotherapy**). The drug used most often is methotrexate, but sometimes cytarabine or a steroid such as prednisone may be used as well. Intrathecal chemo can be given during a lumbar puncture[8] (spinal tap) or through an Ommaya reservoir (as discussed in the surgery section).
- High-dose IV methotrexate, cytarabine, or other chemo drugs
- Radiation therapy to the brain and spinal cord

Consolidation (intensification)

If the leukemia goes into remission, the next phase often consists of another fairly short course of chemo, using many of the same drugs that were used for induction therapy. This typically lasts for a few months. Usually the drugs are given in high doses so that the treatment is still fairly intense. CNS prophylaxis/treatment is typically continued at this time.

A targeted drug like imatinib is also continued for people whose leukemia cells have the Philadelphia chromosome.

For some people with ALL, the immunotherapy

Instead of standard chemo, doctors may suggest an allogeneic stem cell transplant (SCT) at this time, especially for those who have a brother or sister who would be a good donor match. An autologous SCT may be another option. The pros and conss of a stem cell transplant need to be weighed carefully for each person, as it's not clear that they are helpful for everyone. People considering this procedure should think about having it done at a center that has done a lot of stem cell transplants.

Maintenance

After consolidation, people generally get maintenance chemotherapy with methotrexate and 6-mercaptopurine (6-MP). In some cases, this may be combined with other drugs such as vincristine and prednisone.

For people with ALL whose leukemia cells have the Philadelphia chromosome, a targeted drug like imatinib is often included as well.

Maintenance usually lasts for about 2 years. CNS prophylaxis/treatment is typically continued at this time.

Response rates to ALL treatment

In general, about 80% to 90% of adults will have complete remissions at some point during these treatments. This means leukemia cells can no longer be seen in their bone marrow. Unfortunately, about half of these patients relapse, so the overall cure rate is in the range of 40%. Again, these rates can vary a lot, depending on the subtype of ALL and other prognostic factors[9]. For example, cure rates tend to be higher in younger patients.

If the leukemia doesn't respond or if it comes back after treatment

If the leukemia is **refractory** – that is, if it doesn't go away with the first treatment (which happens in about 10% to 20% of people with ALL) – then newer or more intensive

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Written by

The American Cancer Society medical and editorial content team (https://www.cancer.org/cancer/acs-medical-content-and-news-staff.html)

Our team is made up of doctors and oncology certified nurses with deep knowledge of cancer care as well as editors and translators with extensive experience in medical writing.