Leukemia: Acute Lymphocytic Overview

This overview is based on the more detailed information in our document, *Leukemia--Acute Lymphocytic*. You can get this document and other information by calling 1-800-227-2345 or visiting our website at www.cancer.org.

What is cancer?

The body is made up of trillions of living cells. Normal body cells grow, divide to make new cells, and die in an orderly way. During the early years of a person's life, normal cells divide faster to allow the person to grow. After the person becomes an adult, most cells divide only to replace worn-out, damaged, or dying cells.

Cancer begins when cells in a part of the body start to grow out of control. There are many kinds of cancer, but they all start because of this out-of-control growth of abnormal cells.

Cancer cell growth is different from normal cell growth. Instead of dying, cancer cells keep on growing and form new cancer cells. These cancer cells can grow into (invade) other tissues, something that normal cells cannot do. Being able to grow out of control and invade other tissues are what makes a cell a cancer cell.

In most cases the cancer cells form a tumor. But some cancers, like leukemia, rarely form tumors. Instead, these cancer cells are in the blood and bone marrow.

When cancer cells get into the bloodstream or lymph vessels, they can travel to other parts of the body. There they begin to grow and form new tumors that replace normal tissue. This process is called *metastasis*.

No matter where a cancer may spread, it is always named for the place where it started. For instance, breast cancer that has spread to the liver is still called breast cancer, not liver cancer. Likewise, prostate cancer that has spread to the bone is called metastatic prostate cancer, not bone cancer.

Different types of cancer can behave very differently. For example, lung cancer and breast cancer are very different diseases. They grow at different rates and respond to different treatments. That is why people with cancer need treatment that is aimed at their own kind of cancer.

Not all tumors are cancerous. Tumors that aren't cancer are called *benign*. Benign tumors can cause problems-- they can grow very large and press on healthy organs and tissues. But they cannot grow into other tissues. Because of this, they also can't spread to other parts of the body (metastasize). These tumors are almost never life threatening.

What is acute lymphocytic leukemia?

Leukemia is a type of cancer that starts in cells that form new blood cells. These cells are found in the soft, inner part of the bones called the *bone marrow*.

Normal bone marrow, blood, and lymphoid tissue

To understand the different types of leukemia, it helps to know something about the blood and lymph systems. Any blood-forming cell can turn into a leukemia cell. Once that happens, the cell can grow and divide to form many new cancer cells. These cells can take over the bone marrow, spill out into the bloodstream, and spread to other organs.

Bone marrow

Bone marrow is the soft, spongy, inner part of bones such as the skull, shoulder blades, ribs, pelvis, and bones in the spine. All of the different types of blood cells are made in the bone marrow. Bone marrow is made up of a small number of blood stem cells, blood-forming cells, fat cells, and tissues that help the blood cells grow.

Blood stem cells go through a series of changes to make new blood cells. They can develop into 1 of the 3 main types of blood cell:

- Red blood cells
- White blood cells
- Platelets

Red blood cells

Red blood cells carry oxygen from the lungs to all other tissues of the body. They also carry away carbon dioxide, a waste product of cell activity.

White blood cells

White blood cells help the body fight infections. There are quite a few types of white blood cells. Each has a special role to play in protecting the body against infection. The 3 main types of white blood cells are granulocytes, monocytes, and lymphocytes.

Lymphocytes are the main cells that make up lymphoid tissue, which is a major part of the immune system. The 2 main types of lymphocytes are called *B cells* and *T cells*. Normal T cells and B cells do different jobs within the immune system. ALL starts in early forms of B cells or T cells.

Platelets

Platelets help stop bleeding by plugging up holes in blood vessels caused by cuts or bruises.

Acute lymphocytic leukemia

Acute lymphocytic leukemia (ALL) is also called *acute lymphoblastic leukemia*. The term *acute* means that the leukemia grows quickly, and if not treated, could be fatal in a few months. People with *chronic* leukemias can live years without treatment. *Lymphocytic* means it develops from early forms of lymphocytes, a type of white blood cell. This is different from acute myeloid leukemia (AML), which starts in other blood cell types found in the bone marrow. To learn about AML, please see our document, *Leukemia--Acute Myeloid*.

Other types of cancer that start in lymphocytes are known as *lymphomas* (non-Hodgkin lymphoma and Hodgkin disease). The main difference between these types of cancers is that the cancer cells in ALL are mainly in the bone marrow and blood (although they may spread to other places), while lymphomas are mainly in lymph nodes or other organs. For more information on lymphomas, see our documents, *Non-Hodgkin Lymphoma* and *Hodgkin Disease*.

After it starts, leukemia often moves quickly into the blood where it can spread to other parts of the body such as the lymph nodes, spleen, liver, central nervous system (brain and spinal cord), and other organs. In contrast, other types of cancer can start in these organs and then spread to the bone marrow (or elsewhere). Those cancers are *not* leukemia. Both children and adults can get leukemia.

ALL isn’t the only kind of leukemia. There are 4 main types of leukemia:

- Acute lymphocytic leukemia
- Acute myeloid leukemia
- Chronic lymphocytic leukemia

- Chronic myeloid leukemia

Knowing the exact type can help doctors better predict each patient's outlook (prognosis) and select the best treatment.

The rest of this document contains information on ALL of adults only. Chronic leukemias of adults and acute myeloid leukemia (AML) of adults are discussed in other American Cancer Society documents. For information about ALL in children, please see the separate document, *Childhood Leukemia.*

How many people get acute lymphocytic leukemia?

The American Cancer Society's estimates for acute lymphocytic leukemia (ALL) in the United States for 2014 are:

- About 6,020 new cases ALL (adults and children)
- About 1,440 deaths from ALL (adults and children)

The risk for getting ALL is highest in children under 5 years old. The risk then goes down slowly until the mid-20s, and begins to rise again slowly after age 50. Overall, about 1 case out of 3 of ALL is in adults.

The average person's lifetime risk of getting ALL is less than 1 in 750. The risk is slightly higher in males than in females and higher in whites than in African Americans.

While most cases of ALL occur in children, most deaths from ALL (about 4 out of 5) occur in adults. Children may do better because of differences between childhood and adult ALL in the disease itself, differences in treatment (children's bodies can often handle strong treatment better than adult's), or some combination of these.

Some information about treatment success rates for adult ALL can be found in the section “Survival rates for acute lymphocytic leukemia.”

What are the risk factors for acute lymphocytic leukemia?

At this time we do not know the cause of most cases of acute lymphocytic leukemia (ALL). But some cases can be linked to certain *risk factors*. A risk factor is something that affects a person's chance of getting a disease. Some risk factors, like smoking, can be controlled. Others, such as a person's age, can't be changed.

But risk factors don't tell us everything. Having a risk factor, or even several risk factors, does not mean that you will get the disease. And many people who get the disease may have few or no known risk factors. Even if a person has one or more risk factors and gets cancer, it is often very hard to know what part they may have played in getting the cancer.

There are only a few known risk factors for ALL.

Radiation exposure

A high level of radiation exposure is a risk factor for both types of acute leukemia. People who survived the atomic bombs in Japan had a much higher risk of getting acute leukemia, usually within 6 to 8 years.

Lower levels of radiation, such as from radiation treatment, x-rays, or CT scans, might also increase the risk of leukemia. Still, since few studies have looked directly at this, the level of this risk it isn’t clear. It is also not clear how much the exposure of a fetus to radiation within the first months of development might increase the risk of leukemia. If there is a higher risk from lower levels it is likely to be small, but to be safe, most doctors try to limit a person's exposure to radiation as much as possible.

Chemicals

The risk of ALL may be increased by exposure to certain chemicals like benzene and certain chemotherapy drugs. Chemical exposure is more strongly linked to an increased risk of AML than to ALL.

Certain viral infections

Infection with a virus called HTLV-1 can cause a rare type of ALL. But this disease is not common in the United States.

The virus that causes "mono" (mononucleosis) is called *Epstein Barr Virus* or *EBV*. In Africa it has also been linked to a form of ALL.

Inherited syndromes

ALL does not seem to run in families, so a person's risk is not increased if a family member has the disease. But there are some inherited syndromes that seem to raise the risk of ALL. A syndrome is a group of signs and symptoms that together point to a certain disorder or disease. These include:

- Down syndrome
- Klinefelter syndrome
- Fanconi anemia
- Bloom syndrome
- Ataxia-telangiectasia
- Neurofibromatosis

Race/ethnicity

ALL is more common in whites than in African Americans, but the reasons for this are not clear.

Gender

ALL is slightly more common in males than in females. The reason for this is unknown.

Identical twin with ALL

Having an identical twin who was found to have ALL in the first year of life increases the risk of ALL in the other twin early in life.

Can acute lymphocytic leukemia be prevented?

Since most people with acute lymphocytic leukemia don't have any known risk factors that can be changed, there is no way to prevent leukemia at this time.

Signs and symptoms of acute lymphocytic leukemia

Certain signs and symptoms could suggest that a person might have acute lymphocytic leukemia. But tests always are needed to confirm this. And keep in mind that these symptoms are most often caused by something other than cancer.

General symptoms

General symptoms of ALL can include:

- Weight loss (without trying)
- Severe night sweats (that drench the sheets)
- Tiredness
- Fever
- Loss of appetite

Of course, ALL is not the only thing that causes these symptoms. They are most often caused by something other than cancer.

Problems caused by low blood cell counts

Most symptoms of ALL are caused by a shortage of normal blood cells, which happens when the leukemia cells crowd out normal blood-making cells in the bone marrow. As a result, the person doesn't have enough normal red blood cells, white blood cells, and platelets. These shortages show up on blood tests, and they can also cause symptoms.

- Anemia is a shortage of red blood cells. It can cause a person to feel tired, weak, dizzy, cold, lightheaded, or short of breath.
- A shortage of normal white blood cells increases the risk of infections. Although people with leukemia may have very high white blood cell counts, the cells are often not normal and cannot protect against infection. Fevers and other signs of infection are common symptoms of ALL.
- A shortage of blood platelets can lead to easy bruising, bleeding, frequent or severe nosebleeds, and bleeding gums.

Problems caused by spread or buildup of leukemia cells

Swelling in the belly: Leukemia cells may collect in the liver and spleen, causing them to swell. This may be noticed as a fullness or swelling of the belly.

Swollen lymph nodes: ALL can spread to lymph nodes. If the nodes are close to the surface of the body, they may be noticed as lumps under the skin. Lymph nodes inside the chest or belly (abdomen) may also swell, but these can only be seen on tests like CT or MRI scans.

Spread to other organs: Less often, ALL can spread outside of the bone marrow to other organs. If it spreads to the brain or spinal cord (central nervous system), it can cause symptoms like headaches, weakness, seizures, vomiting, trouble with balance, or blurred vision. ALL may also spread to the chest, where it can cause fluid build-up and trouble breathing.

Bone or joint pain: Some patients have bone pain or joint pain caused by the build-up of leukemia cells in bones or joints.

Spread to other organs: Less often, ALL will spread to other organs, where it may form tumors.

Symptoms from an enlarged thymus: One type of ALL (the T-cell subtype) often affects the thymus, which is a small organ in the middle of the chest behind the breastbone and in front of the windpipe. A swollen thymus can press on the windpipe, causing coughing or trouble breathing. A large vein, the superior vena cava (SVC) that carries blood from the head and arms back to the heart, also passes next to the thymus. If the thymus presses on the SVC, it can make the head and arms swell (this is called *SVC syndrome*). This can affect the brain and is life threatening. People with SVC syndrome need treatment right away.

How is acute lymphocytic leukemia found?

At this time there are no special tests that can find acute lymphocytic leukemia (ALL) early. The best way to find it early is to report any possible signs or symptoms of leukemia to the doctor right away.

Tests to find acute lymphocytic leukemia

Most of the symptoms seen in leukemia also can be caused by other problems like infections. For this reason, your doctor will focus on finding out if you really have leukemia.

Medical history and physical exam

The doctor will ask you questions about your health (take a medical history), such as how long you have had symptoms and whether or not you have any risk factors.

The doctor will do a physical exam to look for any swollen lymph nodes, any bleeding or bruising, or signs of infection. Blood tests will likely be done. If the results suggest leukemia, your doctor may refer you to a doctor who treats blood diseases (called a *hematologist*), and you may have one or more of the tests described below.

Laboratory tests

Blood cell counts and other blood tests: Often, the first test is a blood count. This test looks at the numbers of the different types of blood cells and at how they look under the microscope. Changes in these things can suggest leukemia.

Most people with ALL have too many white blood cells, not enough red cells, and not enough platelets. Many of the white cells will be *blasts*, a type of immature cell not normally found in the bloodstream. These cells don't work the way they should. These findings may suggest a person has leukemia, but usually a sample of bone marrow cells must be looked at to be sure.

People already known to have leukemia have these tests to see how well treatment is working.

Often, patients also have other tests to measure the amount of certain chemicals in the blood to help tell how well their kidneys and liver are working and to make sure the blood is clotting as it should.

Bone marrow tests: Bone marrow aspiration and biopsy is used to take samples of bone marrow. These tests are used to tell whether a person has leukemia. They may also be done during treatment to see how well the treatment is working.

The samples are usually taken from the back of the hip (pelvic) bone. The patient usually lies on his or her stomach and the skin over the area is cleaned. Before the samples are taken, the skin and the surface of the back of the hip bone are numbed with medicine. Then the doctor makes a small cut in order to put in the needle.

For aspiration, a thin needle is used to draw up a small amount of liquid bone marrow. This is often painful for a moment. After that needle is removed, a slightly larger needle is moved through the bone with a twisting motion. Most patients feel this as pressure, not pain. The larger needle is used to remove a small cylinder of bone and marrow (about ½ inch long). After the biopsy is done, pressure will be put on the site to help prevent bleeding.

A doctor with special training in blood diseases looks at the bone marrow under a microscope. The doctor looks at the size and shape of the cells as well as other features to

classify the cells into specific types. An important goal of this process is to see if the cells look mature or not. The most immature cells are called *blasts*. The number of blasts in the bone marrow is important in telling whether a person has leukemia. Normally, blasts are never more than 5% of bone marrow cells. A person with ALL has at least 20% to 30% blasts in their bone marrow.

Sometimes doctors can't tell what type of leukemia someone has just by counting and looking at the cells. Other special tests that look at the cells (and even their DNA) help the doctor decide which type of leukemia a person has. You might hear some of the following terms used: cytochemistry, flow cytometry, cytogenetics, PCR, and FISH. These are complex medical and chemical tests. Your doctor can tell you which of these you might need. You can learn more about these tests in our detailed document, *Leukemia: Acute Lymphocytic.*

Spinal fluid: A lumbar puncture (or spinal tap) is done to look for leukemia cells in the cerebrospinal fluid (CSF), which is the liquid around the brain and spinal cord. For this test, the patient is usually lying on their side. The doctor first numbs an area in the lower back over the spine. A small needle is then put through the skin and between the bones of the spine and into the area around the spinal cord. Then some of the liquid is taken out. The fluid is looked at to see if it has leukemia cells in it. A lumbar puncture can also be used to put drugs into the CSF to try to prevent or treat the spread of leukemia to the spinal cord and brain.

Imaging tests

Imaging tests make pictures of the inside of the body. Because leukemia does not usually form tumors, imaging tests are not always as helpful as they are for other types of cancer. For people with ALL, these tests are done more often to look for infections or other problems rather than for the leukemia itself.

X-rays: The chest may be x-rayed to see if a person has a lung infection. The x-ray can also show swollen lymph nodes in the chest.

CT (computed tomography) scans: This is a special kind of x-ray test in which a beam moves around the body, taking pictures from different angles. A computer combines the pictures to show a slice of the body. This test can help tell if any lymph nodes or organs in your body are swollen.

A CT scanner has been described as a large donut, with a narrow table in the middle opening. You will need to lie still on the table while the scan is being done. CT scans take longer than regular x-rays, and you might feel a bit confined by the ring while the pictures are being taken.

Before the test, you may get an injection of a contrast dye, or you may be asked to drink some contrast material. This helps doctors tell normal areas from abnormal ones. A second set of pictures is then taken.

The injection can make you feel flushed or warm, in the face or elsewhere. Some people get hives (itchy bumps). A few may have more serious allergic reactions like trouble breathing, feeling dizzy, or passing out. Be sure to tell the doctor before the scan if you have ever had allergies or a reaction to any contrast material used for x-rays.

Sometimes a test that combines the CT scan with a PET scan (PET/CT scan) is done. For a PET scan, glucose (a form of sugar) that has a radioactive atom is injected into the bloodstream. The amount of radioactivity used is very low. Cancer cells in the body absorb large amounts of the sugar. A special camera can then create a picture of areas of radioactivity in the body. The doctor can then compare areas of higher radioactivity on the PET scan with the more detailed appearance of that area on the CT.

MRI (magnetic resonance imaging): MRI scans are very helpful in looking at the brain and spinal cord. These scans use strong magnets and radio waves instead of x-rays to make detailed pictures of the body. MRI scans take longer than CT scans. You may be placed inside a tube, which can feel confining. Newer, more open MRI machines may sometimes be another option. The MRI machine makes loud buzzing and thumping noises that you may find disturbing. Some places give you headphones to block this noise out.

Ultrasound: Ultrasound uses sound waves to make images of the organs. It can help show whether the kidneys, liver, or spleen are enlarged. It can also be used to look at lymph nodes. This is an easy test to have. For most ultrasounds you simply lie on a table and a kind of wand (transducer) is moved over the part of your body being examined.

Gallium scan and bone scan: These tests look at a slightly radioactive chemical that is put into the blood. The chemical collects in areas of cancer or infection. These areas, called "hot spots," can be picked up by a special camera. These tests are not often done in people with ALL, but they can be useful when a person has bone pain that might be caused by either infection or cancer in the bones.

How is acute lymphocytic leukemia classified?

Most types of cancer are assigned a numbered stage based on the size of the tumor and how far it has spread. But leukemia does not usually form tumors, and it already involves the bone marrow and, in many cases, has also spread to other organs. The outlook for the person with acute lymphocytic leukemia (ALL) depends on other information, such as the subtype of ALL, the age of the patient, and lab test results.

The older French, American, and British (FAB) system to classify ALL was based only on the way the leukemia cells looked under the microscope after routine staining. This system has largely been replaced, as newer lab tests now allow doctors to better classify ALL.

These lab tests provide more detailed information about the subtype of ALL and the patient's outlook. They let doctors divide ALL into groups based on the type of lymphocyte (B cell or T cell) the leukemia cells come from and how mature the leukemia cells are.

The subtypes of ALL each carry a slightly different outlook, so ask your doctor what type you have and how it may affect your treatment.

Prognostic factors

As leukemia treatment has improved over the years, research has focused on why some patients have a better chance for cure than others. Certain features of the disease separate patients who are likely to have a good response to treatment from those likely to have a poor response. These are called *prognostic factors.* These features include

- The patient's age
- White blood cell count,
- ALL subtype, certain test results
- How the ALL responds to treatment

The American Cancer Society has detailed information about these subtypes and prognostic factors in a separate document (called *Leukemia: Acute Lymphocytic*). You can get it by calling our toll-free number or read it on our Web site.

Survival rates for acute lymphocytic leukemia

Some people with cancer may want to know the survival rates for their type of cancer. Others may not find the numbers helpful, or may even not want to know them. If you would rather not read the survival rates, skip to the next section.

In general, about 80% to 90% of adults with acute lymphocytic leukemia (ALL) will have complete remissions after treatment. That means leukemia cells can no longer be seen in their bone marrow. But in about half of these patients the cancer will come back (relapse), so the overall cure rate is around 40%. Again, these rates vary depending on the subtype of ALL and other prognostic factors. Cure rates tend to be higher in younger patients and lower in older patients.

Numbers provide an overall picture, but keep in mind every person is unique and statistics can't predict exactly what will happen in your case. Talk with your cancer care team if you have questions about your own chances of a cure, or how long you might survive your cancer. They know your situation best.

How is acute lymphocytic leukemia treated?

This information represents the views of the doctors and nurses serving on the American Cancer Society's Cancer Information Database Editorial Board. These views are based on their interpretation of studies published in medical journals, as well as their own professional experience.

The treatment information in this document is not official policy of the Society and is not intended as medical advice to replace the expertise and judgment of your cancer care team. It is intended to help you and your family make informed decisions, together with your doctor.

Your doctor may have reasons for suggesting a treatment plan different from these general treatment options. Don't hesitate to ask him or her questions about your treatment options.

Adult acute lymphocytic leukemia (ALL) is not one disease. It is really a group of diseases, and people with different subtypes vary in how they respond to treatment. Treatment choices are based on the subtype as well as on the prognostic features in the section "How is acute lymphocytic leukemia classified."

The treatments used most often for ALL are:

- Chemotherapy
- Targeted therapy
- Stem cell transplant

Some patients may also have surgery and radiation. The treatment of ALL often lasts for about 2 years. It can be intense, especially in the first few months of treatment, so it is important that you are treated in a center that has experience with this disease.

You might have different types of doctors involved in your care as well. The doctor in charge of your team will most likely be a hematologist, a doctor who treats blood diseases, including leukemia.

It is important to discuss your treatment options, including their goals and possible side effects, with your doctors to help decide on one that best fits your needs. Treatment for ALL usually needs to start very soon after it is found, but if time permits, it is often a good idea to get a second opinion. This can give you more information and help you feel good about your chosen treatment plan.

The next few sections have general comments about types of treatments used for acute lymphocytic leukemia (ALL). After this you will find a review of the typical treatment plan for ALL in adults.

Chemotherapy for acute lymphocytic leukemia

Chemotherapy (chemo) is the use of drugs to kill cancer cells. Usually the drugs are given into a vein or by mouth. Once the drugs enter the bloodstream, they spread

throughout the body. But most chemo drugs don't reach the area around the brain and spinal cord. That's why they may need to be put right into the cerebrospinal fluid to kill cancer cells in that area.

If you have acute lymphocytic leukemia (ALL) and are being treated with chemo, you will be given several drugs over a long period of time (often about 2 years). Treatment is separated into phases (see below).

Side effects of chemo

Chemo drugs kill fast-growing cells such as cancer cells, but in the process they also damage other normal cells that grow fast.

The side effects of chemo depend on the type and dose of drugs given and how long they are taken. Common side effects might include:

- Hair loss
- Mouth sores
- Higher risk of infection (from low white blood cells)
- Easy bruising or bleeding (from low blood platelets)
- Tiredness (from low red blood cells)
- Loss of appetite
- Nausea
- Vomiting
- Diarrhea

Most side effects usually go away after treatment ends. Be sure to talk to your doctor if you are having trouble with side effects because there are often ways to manage them during treatment. For example, there are drugs that can be taken along with the chemo to help prevent or reduce nausea and vomiting. Drugs called *growth factors* are sometimes given to keep your blood counts higher and reduce the chance of infection.

If your white blood cell counts are very low during treatment, you can help reduce your risk of infection by avoiding germs. During this time, your doctor or nurse may tell you to:

- Wash your hands often.
- Avoid fresh, uncooked fruits and vegetables and other foods that might carry germs.
- Avoid fresh flowers and plants because they may carry mold.

- Make sure other people wash their hands when they come in contact with you.
- Avoid large crowds and people who are sick (wearing a surgical mask can help protect you).

During and after treatment, you might also get antibiotics or other drugs as added protection. If your platelet counts are low, you might get platelet transfusions to keep you from bleeding. Low red blood cell counts, causing shortness of breath and tiredness, can be treated with drugs or with blood transfusions.

Organs that could be damaged by chemo include the kidneys, liver, testicles, ovaries, brain, heart, and lungs. By watching you carefully, the doctor may be able to prevent much of the damage. If serious side effects happen, the drugs may have to be reduced or stopped. Be sure to tell your doctor about any problems you have.

One of the most serious side effects of chemo for ALL is the increased risk of getting acute myelogenous leukemia (AML) later. Less often, people cured of leukemia may later get non-Hodgkin lymphoma or other cancers. Of course, the risk of getting these second cancers must be balanced against the clear need to treat a life-threatening disease such as leukemia with chemo.

Tumor lysis syndrome is a side effect caused by the rapid breakdown of large numbers of leukemia cells. This sometimes happens when treatment is started, but it is not a concern later on (when there are fewer leukemia cells). When leukemia cells die, they break open and release their contents into the bloodstream. This cell waste can affect the kidneys, heart, and nervous system. Giving extra fluids or certain drugs can help the body get rid of these substances.

Chemo treatment phases for acute lymphocytic leukemia

For acute lymphocytic leukemia (ALL), chemotherapy (chemo) treatments are given in the phases described below. The total treatment usually takes about 2 years. Treatment may be more or less intense, depending on the subtype of ALL and other factors.

Remission induction (sometimes just called induction)

The purpose of the first phase is to bring about a remission. A remission means leukemia cells are no longer found in bone marrow samples, even after the normal marrow cells return and the blood counts become normal. But this is not the same as a cure, as leukemia cells are likely to still be hiding somewhere in the body.

More than one chemo drug will be used and high doses will be given. This phase usually lasts for a month or so. Treatment to keep the leukemia cells from spreading to the central nervous system is often started at this time. This could include high-doses of certain chemo drugs, chemo put right into the spinal fluid, or radiation to the brain and spinal

cord. If the ALL cells have a certain gene change, a targeted therapy drug is a part of treatment.

Treatment in this phase can often have serious side effects, including life-threatening infections. For this reason, the doctor will watch you closely and prescribe drugs like antibiotics if needed. You may spend some or much of this time in the hospital.

Consolidation

If the patient goes into remission, the next phase is often a treatment over the next few months with chemo (sometimes with targeted therapy) using many of the same drugs that were used before. This may include chemo into the spinal fluid. This treatment phase is often easier to take than induction.

Doctors may suggest a stem cell transplant (SCT) for patients who are at a high risk of the leukemia coming back. Patients looking at a SCT might think about having it done as part of a clinical trial at a center that has done a lot of SCT procedures. Please see the section, "Stem cell transplant for acute lymphocytic leukemia" for more details

Maintenance

The last phase of treatment, called maintenance, is meant to help keep the leukemia from coming back. It uses lower doses of chemo drugs given over about 2 years. For people whose ALL cells have a certain gene change, maintenance often includes a targeted therapy drug. Chemo may also continue to be given into the spinal fluid.

Targeted therapy for acute lymphocytic leukemia

In recent years, new drugs that target certain parts of cancer cells have been developed. These targeted therapies work differently from standard chemotherapy (chemo) drugs and often have different and less severe side effects.

Sometimes acute lymphocytic leukemia (ALL) cells have a certain gene change that is similar to the gene change seen in chronic myeloid leukemia (CML) cells. When they do have this gene change, some of the targeted drugs used to treat CML are useful in treating ALL. These drugs can help more ALL patients go into a remission and may help keep the leukemia from coming back.

A common side effect of targeted therapy drugs is swelling around the eyes or in the hands or feet. Other possible side effects include diarrhea, nausea, muscle pain, extreme tiredness (fatigue), and skin rashes, as well as lower red blood cell and platelet counts at the start of treatment.

Surgery for acute lymphocytic leukemia

Surgery plays a very small part in the treatment of acute lymphocytic leukemia (ALL). Because leukemia cells spread widely throughout the bone marrow and to many other organs, it is not possible to cure this type of cancer by surgery.

Surgery can be used to help give treatment. For example, a plastic tube can be placed in a large vein. The tube, called a *venous access device*, is for drugs to be given and blood samples removed. This lowers the number of needle sticks needed during treatment. The patient must learn how to take care of the venous access device to prevent it from getting infected.

Another device that can be placed to aid treatment is called an *Ommaya reservoir*. It is used to give chemotherapy into the fluid surrounding the brain and spinal cord (the cerebrospinal fluid or CSF). It is made up of a small dome-like device attached to a small tube. The dome part sits under the skin of the scalp, with the tube going through a hole in the skull and into the CSF in one of the cavities of the brain. This device can also be used to remove samples of CSF for testing (instead of doing a lumbar puncture/spinal tap). This device stays in place until treatment is done.

Radiation therapy for acute lymphocytic leukemia

Radiation therapy is the use of high energy x-rays to kill cancer cells. It is sometimes used to treat leukemia that has spread to the brain and spinal cord or to the testicles. It might also be used to reduce pain when the leukemia has spread to a bone if chemo hasn't helped

Radiation to the whole body is often done as part of a stem cell transplant (see the section “Stem cell transplant for acute lymphocytic leukemia”). It is also used, though rarely, in an emergency to shrink a tumor if it is pressing on the windpipe. But more often chemo is used instead.

The possible side effects of radiation depend on where it is aimed. There may be sunburn-like skin changes in the treated area. Radiation to the belly (abdomen) can sometimes cause nausea, vomiting, or diarrhea. For radiation that includes large parts of the body, the effects may include lowered blood cell counts, which can lead to extreme tiredness (called *fatigue*) and an increased risk of infection.

Stem cell transplant for acute lymphocytic leukemia

Very high doses of chemotherapy (chemo) drugs might work better to kill acute lymphocytic leukemia (ALL) cells, but they can severely damage normal bone marrow cells, which could be life-threatening. Stem cell transplants (SCT) offer a way for doctors to use high doses of chemo. Although the drugs destroy the patient's bone marrow, transplanted stem cells can restore the bone marrow's ability to make blood.

Stem cells for a transplant come from either the blood or from the bone marrow. They can also come from the umbilical cord of a newborn baby.

Types of transplants

The stem cells can come from either the patient (an *autologous* transplant) or from someone else (an *allogeneic* transplant). There is a good reason to use stem cells from someone else for the transplant. These cells can help fight any remaining leukemia cells through an immune reaction. This is called a *graft-versus-leukemia* reaction.

Allogeneic stem cell transplant: In an *allogeneic* transplant, the stem cells come from someone else – usually a donor whose tissue type matches the patient's. The best donor is often a close relative, such as a brother or sister if they are a good match. If no relatives match, sometimes an unrelated donor may be used, but this is more risky. An allogeneic transplant is preferred for ALL when it is available.

"Mini-transplant": Some patients over the age of 55 might not be able to have a regular transplant that uses high doses of chemo. But some may be able to have what is sometimes called a "mini-transplant" (also called a *non-myeloablative transplant* or *reduced-intensity transplant*), where they get lower doses of chemo and radiation that don't destroy all the cells in their bone marrow. They then are given the donor stem cells. These cells enter the body and form a new immune system, which may see the leukemia cells as foreign and attacks them (a *graft-versus-leukemia* effect). This is not a standard treatment for ALL, and is being studied to find out how useful it may be.

Autologous stem cell transplant: In an autologous transplant, a patient's own stem cells are removed from his or her bone marrow or blood. They are frozen and stored while the person gets treatment (high-dose chemo and/or radiation). The stem cells are then given back to the patient after treatment.

One problem with autologous transplants is that it is hard to separate normal stem cells from leukemia cells in the bone marrow or blood. Even after treating the stem cells in the lab to try to kill or remove any leukemia cells, there is the risk of returning some leukemia cells with the stem cell transplant.

The transplant process

The transplant process works like this: stem cells are collected from the bloodstream or bone marrow and are frozen and stored. The patient is then given very high doses of chemo while in in the hospital to kill the cancer cells. The patient may also get total body radiation to kill any cancer cells that the chemo might miss. After treatment, the stored stem cells are given to the patient as a blood transfusion. The stem cells settle into the patient's bone marrow over the next several days and start to grow and make new blood cells.

People who get a donor's stem cells are given drugs to prevent rejection as well as other medicines if needed to prevent infections. Usually within a couple of weeks after the stem cells are given, they start making new white blood cells. Then they begin making platelets, and finally, red blood cells.

Patients having SCT have to be kept away from germs as much as possible until their white blood cell count is at a safe level. They are often kept in the hospital until part of the white cell count called the *ANC* (absolute neutrophil count) reaches a certain number, usually around 1,000. After they go home, they will be seen in the outpatient clinic often, sometimes almost every day for several weeks. After that, they may be able to space out their doctor visits.

Some things to keep in mind

A stem cell transplant is a complex treatment that can cause life-threatening side effects. If the doctors think that a person with leukemia might be helped by this treatment, it is important that it be done at a hospital where the staff has experience with the procedure.

A stem cell transplant costs a lot, often well over $100,000. It may mean a long hospital stay. Insurance may not pay for all types of transplants. Even if they do cover the transplant, your co-pays or other costs could easily amount to tens of thousands of dollars. It is important to find out what your insurer will cover and what you might have to pay before deciding to have a transplant.

Side effects of stem cell transplant

Stem cell transplants can have severe side effects.

Early side effects are much the same as those caused by any other type of chemo, such as nausea, vomiting, loss of appetite, mouth sores, and hair loss. Because of the high doses of chemo used, these can sometimes be severe.

One of the most common and serious short-term effects is the greater risk of infection. Antibiotics are often given to try to prevent these infections. Other side effects, like low red blood cell and platelet counts, may mean the patient will need transfusions.

A rare but serious side effect of stem cell transplant is called *veno-occlusive disease of the liver* (VOD).The high doses of chemo given for the transplant damage the liver. Symptoms include weight gain (from fluid collecting), liver swelling, and yellowing of the skin and eyes (jaundice). When severe, it can lead to liver failure, kidney failure, and even death.

Graft-versus-host disease (GVHD) is one of the main problems of a donor stem cell transplant. It happens when the patient's immune system is taken over by that of the donor. The donor’s immune system then starts to attack the patient's other tissues and organs.

Symptoms can include severe skin rashes with itching and severe diarrhea. The liver and lungs may also be damaged. The patient may also become tired and have aching muscles. If bad enough, the disease can be fatal. Drugs that weaken the immune system may be given to try to control GVHD. On the plus side, this disease may also cause any remaining leukemia cells to be killed by the donor immune system.

Some other side effects can occur later but can last for a long time. These can include damage to any organ, such as the lungs, liver, or kidneys. Ask your doctor what side effects you can expect.

To learn more about stem cell transplants and their side effects, see our document, *Stem Cell Transplant (Peripheral Blood, Bone Marrow, and Cord Blood Transplants).*

What if the leukemia doesn't respond or comes back after treatment?

If the leukemia doesn't go away with the first treatment then newer drugs or stronger doses may be tried, although they are less likely to work. A stem cell transplant may be tried if the leukemia can be put into at least partial remission. Clinical trials of new treatment approaches may also be an option.

If the leukemia goes into remission with the first treatment but then comes back (recurs), it will most often do so in the bone marrow and blood. Once in a while, the brain or spinal fluid will be the first place it returns. In these cases, more chemotherapy (chemo) might put the disease back into remission, although this is not likely to last. If a second remission can be achieved, most doctors will suggest some type of stem cell transplant if possible.

If the leukemia keeps coming back or doesn't go away, over time chemo will not be very helpful. If a stem cell transplant is not an option, a clinical trial might be an option.

Some people want to keep on having treatment to fight the leukemia as long as they can. It is a good idea, though, to think about the odds of more treatment doing any good before making the decision to continue. Some people are tempted to try more chemo, for example, even when their doctors say that the odds of benefit are less than 1 in 100. In these cases, it is important to think about and understand your reasons for choosing this plan.

Palliative treatment

If a clinical trial is not an option, or if it becomes clear that further treatment, even in clinical trials, is very unlikely to cure the leukemia, then it may be time to focus on relieving symptoms. This is known as *palliative treatment*. The doctor may suggest milder chemo to try to slow the growth of the leukemia in order to reduce symptoms.

If there is pain, it's important to treat it. Pain-killing medicines or radiation may be helpful. Sometimes medicines or blood transfusions are needed to correct low blood counts and tiredness. Nausea and loss of appetite may be helped by medicines and high-calorie food supplements. Antibiotics may be needed to treat infection.

To learn more about palliative treatment, please see the section, "If treatment for acute lymphocytic leukemia stops working."

Clinical trials for acute lymphocytic leukemia

You may have had to make a lot of decisions since you've been told you have leukemia. One of the most important decisions you will make is deciding which treatment is best for you. You may have heard about clinical trials being done for your type of cancer. Or maybe someone on your health care team has mentioned a clinical trial to you.

Clinical trials are carefully controlled research studies that are done with patients who volunteer for them. They are done to get a closer look at promising new treatments or procedures.

If you would like to take part in a clinical trial, you should start by asking your doctor if your clinic or hospital conducts clinical trials. You can also call our clinical trials matching service for a list of clinical trials that meet your medical needs. You can reach this service at 1-800-303-5691 or on our Web site at www.cancer.org/clinicaltrials. You can also get a list of current clinical trials by calling the National Cancer Institute's Cancer Information Service toll-free at 1-800-4-CANCER (1-800-422-6237) or by visiting the NCI clinical trials Web site at www.cancer.gov/clinicaltrials.

You must meet certain requirements to take part in any clinical trial. If you do qualify for a clinical trial, you get to decide whether or not to enter (enroll in) it.

Clinical trials are one way to get state-of-the art cancer treatment. Sometimes they may be the only way to get access to some newer treatments. They are also the only way for doctors to learn better methods to treat cancer. Still, they are not right for everyone.

You can get a lot more information on clinical trials, in our document called *Clinical Trials: What You Need to Know*. You can read it on our Web site or call our toll-free number and have it sent to you.

Complementary and alternative therapies for acute lymphocytic leukemia

When you have leukemia you are likely to hear about ways to treat your cancer or relieve symptoms that your doctor hasn't mentioned. Everyone from friends and family to Internet groups and websites may offer ideas for what might help you. These methods

can include vitamins, herbs, and special diets, or other methods such as acupuncture or massage, to name a few.

What are complementary and alternative therapies?

It can be confusing because not everyone uses these terms the same way, and they are used to refer to many different methods. We use *complementary* to refer to treatments that are used along with your regular medical care. *Alternative treatments* are used instead of a doctor's medical treatment.

Complementary methods: Most complementary treatment methods are not offered as cures for cancer. Mainly, they are used to help you feel better. Some examples of methods that are used along with regular treatment are meditation to reduce stress, acupuncture to help relieve pain, or peppermint tea to relieve nausea. Some complementary methods are known to help, while others have not been tested. Some have been proven not to be helpful, and a few are even harmful.

Alternative treatments: Alternative treatments may be offered as cancer cures. These treatments have not been proven safe and effective in clinical trials. Some of these methods may be harmful, or have life-threatening side effects. But the biggest danger in most cases is that you may lose the chance to be helped by standard medical treatment. Delays or interruptions in your medical treatments may give the cancer more time to grow and make it less likely that treatment will help.

Finding out more

It is easy to see why people with cancer think about alternative methods. You want to do all you can to fight the cancer, and the idea of a treatment with few or no side effects sounds great. Sometimes medical treatments like chemotherapy can be hard to take, or they may no longer be working. But the truth is that most of these alternative methods have not been tested and proven to work in treating cancer.

As you think about your options, here are 3 important steps you can take:

- Look for "red flags" that suggest fraud. Does the method promise to cure all or most cancers? Are you told not to have regular medical treatments? Is the treatment a "secret" that requires you to visit certain providers or travel to another country?
- Talk to your doctor or nurse about any method you are thinking of using.
- Contact us at 1-800-227-2345 to learn more about complementary and alternative methods in general and to find out about the specific methods you are looking at.

If you want to use a non-standard treatment, learn all you can about the method and talk to your doctor about it. With good information and the support of your health care team,

you may be able to safely use the methods that can help you while avoiding those that could be harmful.

What are some questions I can ask my doctor about acute lymphocytic leukemia?

It is important to have open discussions with your doctor. Feel free to ask any question you have, no matter how small it might seem. Here are some questions you might want to ask. Be sure to add your own questions as you think of them. Nurses, social workers, and other members of the treatment team may also be able to answer many of your questions.

- Would you please write down the exact type of leukemia I have?
- What factors might affect my outlook?
- Are there other tests that need to be done before we can decide on treatment?
- Are there other doctors I need to see?
- How much experience do you have treating this type of leukemia?
- Should I get a second opinion before starting treatment? Can you suggest someone?
- What are my treatment choices?
- Which treatment do you recommend, and why?
- Should we consider a stem cell transplant? When?
- How soon do we need to start treatment?
- Should we think about a stem cell transplant? When?
- What risks and side effects are there to the treatments you recommend?
- What can I do to help reduce the side effects I may have from the chemo?
- How long will treatment last? What will it be like? Where will it be done?
- How will treatment affect my daily activities?
- What are the chances that my leukemia will come back once I am in remission?
- What is my outlook?
- What will we do if the treatment doesn't work or if the leukemia comes back?
- What type of follow-up will I need after treatment?

Add your own questions below:

Moving on after treatment for acute lymphocytic leukemia

For some people with acute lymphocytic leukemia (ALL), treatment may get rid of the cancer. Completing treatment can be both stressful and exciting. You may be relieved to finish treatment, but find it hard not to worry about the leukemia coming back. (When leuekmia comes back after treatment, it is called *recurrence*.) This is a very common concern in people who have had leukemia.

It may take a while before your recovery begins to feel real and your fears are somewhat relieved. You can learn more about what to look for and how to learn to live with the chance of cancer coming back in *Living With Uncertainty: The Fear of Cancer Recurrence*.

For other people, the leukemia may not go away completely. These people may get regular treatments with chemo, radiation, or other treatments to help keep the leukemia in check for as long as possible. Learning to live with cancer that does not go away can be hard and very stressful. It has its own type of uncertainty. Our document, *When Cancer Doesn't Go Away*, talks more about this.

Follow-up care

Treatment for ALL can last for years. Even if you have finished treatment, your doctors will still want to watch you closely. It is very important to go to all of your follow-up doctor visits. During these visits, your doctors will ask questions about any problems you may have and do an exam. Often, blood tests will be checked to look for signs of leukemia or treatment side effects.

Almost any cancer treatment can have side effects. Some may last for a few weeks or months, but others can be permanent. Please tell your cancer care team about any symptoms or side effects that bother you so they can help you manage them. Use this time to ask your health care team questions and discuss any concerns you might have.

If the leukemia does come back, it usually happens during treatment or shortly after treatment ends. It is unusual for the leukemia to return if there are still no signs of the disease 5 years after treatment.

It is also important to keep health insurance. While you hope your cancer won't come back, it could happen. If it does, you don't want to have to worry about paying for treatment. Should your cancer come back, our document *When Your Cancer Comes Back: Cancer Recurrence* helps you manage and cope with this phase of your treatment.

Seeing a new doctor

At some point after your leukemia is found and treated, you may find yourself in the office of a new doctor. It is important that you be able to give your new doctor the exact details of your diagnosis and treatment. Gathering these details soon after treatment may be easier than trying to get them at some point in the future. Make sure you have this information handy and always keep copies for yourself:

- A copy of your pathology report from any biopsy or surgery
- If you had surgery, a copy of your operative report
- If you stayed in the hospital, a copy of the discharge summary that the doctor wrote when you were sent home
- If you had radiation treatment, a copy of your treatment summary
- If you had chemotherapy or targeted therapy drugs, a list of your drugs, drug doses, and when you took them

The doctor may want copies of this information for his records, but always keep copies for yourself.

Lifestyle changes after treatment for acute lymphocytic leukemia

You can't change the fact that you have had leukemia. What you can change is how you live the rest of your life – making choices to help you stay healthy and feel as well as you can. This can be a time to look at your life in new ways. Maybe you are thinking about how to improve your health over the long term. Some people even start during cancer treatment.

Make healthier choices

For many people, a diagnosis of cancer helps them focus on their health in ways they may not have thought much about in the past. Are there things you could do that might make you healthier? Maybe you could try to eat better or get more exercise. Maybe you could cut down on alcohol, or give up tobacco. Even things like keeping your stress level under control may help. Now is a good time to think about making changes that can have

positive effects for the rest of your life. You will feel better and you will also be healthier.

You can start by working on those things that worry you most. Get help with those that are harder for you. For instance, if you are thinking about quitting smoking and need help, call us at 1-800-227-2345.

Eating better

Eating right can be hard for anyone, but it can get even tougher during and after cancer treatment. Treatment may change your sense of taste. Nausea can be a problem. You may not feel like eating and lose weight when you don't want to. Or you may have gained weight that you can't seem to lose. All of these things can be very frustrating.

If treatment caused weight changes or eating or taste problems, do the best you can and keep in mind that these problems usually get better over time. You may find it helps to eat small portions every 2 to 3 hours until you feel better. You may also want to ask your cancer team about seeing a dietitian, an expert in nutrition who can give you ideas on how to deal with these treatment side effects.

One of the best things you can do after treatment is to put healthy eating habits into place. You may be surprised at the long-term benefits of some simple changes. Getting to and staying at a healthy weight, eating a healthy diet, and limiting your alcohol intake may lower your risk for a number of types of cancer, as well as having many other health benefits.

Fatigue and exercise

Feeling very tired (fatigue) is a very common problem during and after cancer treatment. This is not a normal type of tiredness but a "bone-weary" exhaustion that doesn't get better with rest. For some people, fatigue lasts a long time after treatment and can keep them from staying active. But exercise can actually help reduce fatigue and the sense of depression that sometimes comes with feeling so tired.

If you were very ill or weren't able to do much during treatment, it is normal that your fitness, staying power, and muscle strength declined. You need to find an exercise plan that fits your own needs. Talk with your health care team before starting anything. Get their input about your exercise plans. Then, try to find an exercise buddy so you're not doing it alone. Having family or friends involved when starting a new exercise program can give you that extra boost of support to keep you going when the push just isn't there.

If you are very tired, though, you will need to balance activity with rest. It is OK to rest when you need to. To learn more about fatigue, please see our document, *Fatigue in People With Cancer*.

Exercise can improve your physical and emotional health.

- It improves your cardiovascular (heart and circulation) fitness.
- It can help you stay at a healthy weight.
- It makes your muscles stronger.
- It reduces fatigue.
- It can help lower anxiety and depression.
- It can make you feel happier.
- It can help you feel better about yourself.

Long term, we know that getting regular physical activity plays a role in helping to lower the risk of some cancers, as well as having other health benefits.

Can I lower my risk of the leukemia progressing or coming back?

Most people want to know if there are certain lifestyle changes they can make to reduce their risk of cancer growing or coming back. Unfortunately, for most cancers there is little solid evidence to guide people. This doesn't mean that nothing will help – it's just that for the most part this is something that hasn't been well studied. Most studies have looked at lifestyle changes as ways of preventing cancer in the first place, not slowing it down or keeping it from coming back.

At this time, not enough is known about acute lymphocytic leukemia to say for sure if there are things you can do that will be helpful. Healthy behaviors such as not smoking, eating well, and staying at a healthy weight may help, but no one knows for sure. But we do know that these types of changes can have positive effects on your health that can extend beyond your risk of leukemia or other cancers.

How does having acute lymphocytic leukemia affect your emotional health?

During and after treatment, you may be surprised by the flood of emotions you go through. This happens to a lot of people. You may find that you think about the effect of your cancer on things like your family, friends, and career. You may take a new look at your relationships with those around you. Money may be a concern as the medical bills pile up. Unexpected issues may also cause concern – for instance, as you get better and need fewer doctor visits, you will see your health care team less often. This can be hard for some people.

This is a good time to look for emotional and social support. You need people you can turn to. Support can come in many forms: family, friends, cancer support groups, church or spiritual groups, online support communities, or private counselors.

The cancer journey can feel very lonely. You don't need to go it alone. Your friends and family may feel shut out if you decide not to include them. Let them in – and let in anyone else who you feel may help. If you aren't sure who can help, call your American Cancer Society at 1-800-227-2345 and we can put you in touch with a group or resource that may work for you.

If treatment for acute lymphocytic leukemia stops working

When a person has had many different treatments and the cancer has not been cured, over time the cancer tends to resist all treatment. At this time you may have to weigh the possible benefits of a new treatment against the downsides, like treatment side effects.

This is likely to be the hardest time in your battle with cancer – when you have tried everything within reason and it's just not working anymore. Your doctor may offer you new treatment, but you will need to talk about whether the treatment is likely to improve your health or change your outlook for survival.

No matter what you decide to do, it is important for you to feel as good as possible. Make sure you are asking for and getting treatment for pain, nausea, or any other problems you may have. This type of treatment is called *palliative treatment*. It helps relieve symptoms but is not meant to cure the cancer.

At some point you may want to think about hospice care. Most of the time hospice care is given at home. Your cancer may be causing symptoms or problems that need to be treated. Hospice focuses on your comfort. You should know that while getting hospice care often means the end of treatments such as chemo and radiation, it doesn't mean you can't have treatment for the problems caused by your cancer or other health issues. It just means that the purpose of your care is to help you live life as fully as possible and to feel as well as you can. You can learn more about this in our document, *Hospice Care*.

Staying hopeful is important, too. Your hope for a cure may not be as bright, but there is still hope for good times with family and friends – times that are filled with happiness and meaning. Pausing at this time in your cancer treatment gives you a chance to focus on the most important things in your life. Now is the time to do some things you've always wanted to do and to stop doing the things you no longer want to do. Though the cancer may be beyond your control, there are still choices you can make.

What's new in acute lymphocytic leukemia research?

Researchers at many medical centers, hospitals, and other institutions are looking at the causes, diagnosis, and treatment of acute lymphocytic leukemia (ALL).

Genetics of leukemia

Scientists are making great progress in learning how changes in a person's DNA can cause normal bone marrow cells to change into leukemia. Doctors are learning how to use these changes to help predict a person's outlook and whether they should get more or less intense treatment. As this information unfolds, it may be used to come up with approaches that use newer targeted treatments against ALL.

A new lab technique is being studied to help find and classify different cancers. Instead of looking at single genes, this test uses a special method to look at the patterns of many different genes in the cancer cells at the same time. Someday this information may allow the doctors to tailor treatment to different people by predicting which chemo drugs are likely to be most effective for each patient. These studies may also shed light on changes inside ALL cells that we didn't know about before. This may help guide the development of new drugs.

Finding "hidden" disease (minimal residual disease)

Progress has also been made in finding leukemia cells after treatment when there may be so few leukemia cells that they cannot be found by routine bone marrow tests. A test called polymerase chain reaction (PCR) can find one cancer cell among many thousands of normal cells. This is helpful in seeing how well the chemo has destroyed the leukemia cells and if a relapse is likely. Doctors are now trying to figure out whether patients with minimal residual disease will be helped by further or more intense treatment.

Better chemotherapy

Studies are going on to find the best combinations of chemotherapy (chemo) drugs (those that work the best and cause the fewest side effects) and to figure out which patients will be helped the most from different types of treatment. Sometimes chemo does not work very well because the leukemia cells become resistant to it. Researchers are now looking at ways to prevent or reverse this resistance by using other drugs along with chemo. New chemo drugs are also being developed and tested.

Stem cell transplants

Studies are also being done to improve the stem cell transplant process and to predict which patients are most likely to be helped by this treatment.

In people who have already had an allogeneic transplant and who relapse, doctors are studying donor leukocyte infusion. In this treatment, the patient gets an infusion of white blood cells (leukocytes) from the same donor who gave stem cells for the transplant. The hope is that the cells will boost the new immune system and add to the graft-versus-leukemia effect. Early study results have shown promise, but more research is needed.

Monoclonal antibodies

These are man-made immune system proteins that attach to certain molecules on the surface of the leukemia cells. Some of them are already used to treat certain lymphomas. Researchers are now looking at whether they might be helpful against ALL. Early results have been good, but it is still too early to know for sure.

More information about acute lymphocytic leukemia

From your American Cancer Society

Here is more information you might find helpful. You also can order free copies of our documents from our toll-free number, 1-800-227-2345, or read them on our website, www.cancer.org.

Leukemia-Acute Lymphocytic (Adults) Detailed Guide (also in Spanish)

Dealing with diagnosis and treatment

Health Professionals Associated With Cancer Care

Talking With Your Doctor (also in Spanish)

After Diagnosis: A Guide for Patients and Families (also in Spanish)

Nutrition for the Person With Cancer During Treatment: A Guide for Patients and Families (also in Spanish)

A Message of Hope: Coping With Cancer in Everyday Life (also in Spanish)

Family and caregiver concerns

Talking With Friends and Relatives About Your Cancer (also in Spanish)

Helping Children When A Family Member Has Cancer: Dealing With Diagnosis (also in Spanish)

What It Takes to Be a Caregiver

Insurance and financial issues

In Treatment: Financial Guidance for Cancer Survivors and Their Families (also in Spanish)

Health Insurance and Financial Assistance for the Cancer Patient (also in Spanish)

More on cancer treatments

Understanding Cancer Surgery: A Guide for Patients and Families (also in Spanish)

Understanding Chemotherapy: A Guide for Patients and Families (also in Spanish)

Understanding Radiation Therapy: A Guide for Patients and Families (also in Spanish)

Targeted Therapy

Clinical Trials: What You Need to Know

Stem Cell Transplant (Peripheral Blood, Bone Marrow, and Cord Blood Transplants)

Cancer treatment side effects

Caring for the Patient With Cancer at Home: A Guide for Patients and Families (also in Spanish)

Distress in People With Cancer

Anxiety, Fear, and Depression

Nausea and Vomiting

Guide to Controlling Cancer Pain (also in Spanish)

Pain Diary

Anemia in People With Cancer

Fatigue in People With Cancer

Your American Cancer Society also has books that you might find helpful. Call us at 1-800-227-2345 or visit our bookstore online at cancer.org/bookstore to find out about costs or to place an order.

National organizations and Web sites*

Along with the American Cancer Society, other sources of information and support include:

Acute lymphocytic leukemia

Leukemia & Lymphoma Society
Toll-free number: 1-800-955-4572
Website: www.lls.org

National Cancer Institute
Toll-free number: 1-800-4-CANCER (1-800-422-6237)
Website: www.cancer.gov

National Coalition for Cancer Survivorship
Toll-free number: 1-888-650-9127
1-877-NCCS-YES (622-7937) for some publications and Cancer Survivor Toolbox® orders
Website: www.canceradvocacy.org

Bone marrow and peripheral blood stem cell transplants

National Bone Marrow Transplant Link (nbmtLINK)
Toll-free number: 1-800-LINK-BMT (1-800-546-5268)
Website: www.nbmtlink.org

Be the Match (formerly National Marrow Donor Program)
Toll-free number: 1-800-MARROW-2 (1-800-627-7692)
Website: www.bethematch.org

**Inclusion on this list does not imply endorsement by the American Cancer Society.*

No matter who you are, we can help. Contact us anytime, day or night, for information and support. Call us at **1-800-227-2345** or visit www.cancer.org.

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For additional assistance please contact your American Cancer Society
1-800-227-2345 or www.cancer.org