Leukemia: Acute Myeloid (Myelogenous) Overview

This overview is based on the more detailed information in our document, *Leukemia-Acute Myeloid*. 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 myeloid 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 lymph tissue, bone marrow, and blood cells

In order to understand the different types of leukemia, it helps to know something about the lymph and blood 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.

Lymph system

The immune system is made up mainly of lymph tissue (also known as lymphatic or lymphoid tissue). The main cell type that forms lymph tissue is the *lymphocyte*, a kind of white blood cell. (White blood cells help the body fight infections.) 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 in order to find and kill germs.

Bone marrow and blood cells

Bone marrow is the soft, spongy, inner part of bones. It is found in some bones such as the skull, shoulder blades, ribs, pelvis, and backbones. All of the blood cells are made in the bone marrow. Bone marrow is made up of blood stem cells, blood-forming cells, fat cells, and tissues that help blood cells grow.

Blood stem cells go through a series of changes to make new blood cells. (They are different from embryonic stem cells which are from a developing fetus and can grow to become other kinds of cells in the body.) During this process, the cells develop into either lymphocytes (a kind of white blood cell) or other blood-forming cells. The blood-forming cells can develop into 1 of the 3 main types of blood cell: red blood cells, white blood cells, or 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 cell waste product. A shortage of red blood cells causes a person to feel tired, weak, and short of breath.

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.

Platelets: Platelets are actually pieces that break off from certain bone marrow cells. Platelets help stop bleeding by plugging up holes in blood vessels caused by cuts or bruises. A shortage of platelets can cause a person to bleed or bruise easily.

Acute myeloid leukemia

Acute myeloid leukemia (AML) goes by many names, including *acute myelocytic leukemia*, *acute myelogenous leukemia*, *acute granulocytic leukemia*, and *acute non-lymphocytic leukemia*. *Acute* means that the leukemia can grow quickly, and if not treated, could be fatal in a few months.

AML is a cancer that starts in the cells that are supposed to mature into different types of blood cells. AML starts in the bone marrow (the soft inner part of the bones, where new blood cells are made), but in most cases it quickly moves into the blood. It can sometimes spread to other parts of the body including the lymph nodes, liver, spleen, central nervous system (brain and spinal cord), and testicles (in men).

In contrast, other types of cancer can start in these organs and then spread to the bone marrow (or other places). Those cancers are *not* leukemia.

AML 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 AML of adults only. To learn more about AML in children, please see our document, *Childhood Leukemia*.

Chronic leukemias of adults and acute lymphocytic leukemia (ALL) of adults are discussed in other American Cancer Society documents.

How many people get acute myeloid leukemia?

The American Cancer Society's estimates for acute myeloid leukemia (AML) cancer in the United States for 2014 are:

- About 18,860 new cases of AML (most will be in adults)
- About 10,460 deaths from AML (almost all will be in adults)

The average age of a patient with AML is about 66. AML is slightly more common among men than among women. The lifetime risk of getting AML for the average man is about 1 in 227. For the average woman the risk is about 1 in 278.

What are the risk factors for acute myeloid leukemia?

A risk factor is something that affects a person's chance of getting a disease. Some risk factors, like smoking, can be controlled. Others, like 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 not have any known risk factors. Even if a person has a risk factor and gets cancer, it is often very hard to know how much that risk factor may have contributed to the cancer.

Risk factors for acute myeloid leukemia (AML)

There are a few known risk factors for AML.

Smoking

Smoking is a proven risk factor for AML. Many people know that smoking is linked to cancers of the lungs, mouth, and throat. But few know that it can also affect cells that do not come into direct contact with smoke. Cancer-causing substances in tobacco smoke get into the bloodstream and spread to many parts of the body.

Chemicals

Exposure to certain chemicals has been linked to acute leukemia. For instance, long-term exposure to high levels of benzene is a risk factor for AML. Benzene is a solvent used in cleaning. It is also used to produce drugs, plastics, dyes, gasoline, and other goods.

Cancer treatment

Patients with other cancers who are treated with certain chemotherapy drugs are more likely to develop AML. Using these drugs along with radiation treatment further increases the risk.

Radiation

Exposure to a high dose of radiation is a risk factor for AML. People who survived the atomic bomb in Japan had a greatly increased risk of getting acute leukemia, most within 6 to 8 years.

There may also be an increased risk of leukemia from lower levels of radiation, such as from radiation treatment, x-rays, or CT scans. It is not clear how much the increase might be, but to be safe, most doctors try to limit a person's exposure to radiation as much as possible.

Certain blood problems

Patients with certain blood problems such as polycythemia vera, essential thrombocythemia, idiopathic myelofibrosis, and myelodysplastic syndrome seem to be at a higher risk for getting AML. Some people with chronic myelogenous leukemia (CML -- another type of leukemia) later develop a form of AML. The risk of getting AML can be higher for some of these blood problems if treatment includes some types of chemotherapy or radiation.

Congenital (present at birth) syndromes

For the most part, AML does not appear to be an inherited disease. It is rare for it to run in families, so a person's risk is not usually increased if a family member has the disease. But there are some syndromes with genetic changes that seem to raise the risk of AML. These include:

- Down syndrome
- Trisomy 8
- Fanconi anemia
- Bloom syndrome
- Ataxia-telangiectasia
- Blackfan-Diamond syndrome
- Schwachman syndrome
- Li-Fraumeni syndrome
- Neurofibromatosis I
- Severe congenital neutropenia (also called Kostmann syndrome)

Family history

Although most cases of AML are not thought to have a strong genetic link, having a close relative (such as a parent or sibling) with AML increases your risk of getting the disease.

Someone who has an identical twin who had AML before the age of one year has a very strong risk of also getting AML.

Gender

AML is more common in males than in females. The reasons for this are not clear.

Can acute myeloid leukemia be prevented?

Most people who develop acute myeloid leukemia (AML) do not have any risk factors that can be avoided. Most cases of AML have no clear cause. Since the cause is not known, there is no way to prevent most cases of leukemia.

Smoking is by far the most important risk factor that can be controlled, and quitting offers the greatest chance to reduce a person's risk of acute myeloid leukemia (AML). Of course, non-smokers are also much less likely than smokers to get many other cancers, as well as heart disease, stroke, and other diseases.

Treatment of other cancers with chemotherapy and radiation may cause secondary (after treatment) leukemias. Doctors are trying to figure out ways to treat these cancers without raising their risk of getting leukemia later on. But for now, the real need to treat cancers with chemotherapy and radiation must be balanced against the small chance of getting leukemia years later.

Avoiding known cancer-causing industrial chemicals, such as benzene, can lower the risk of getting AML. But most experts agree that only a small number of leukemia cases are linked to these chemicals.

Signs and symptoms of acute myeloid leukemia

Patients with AML often have symptoms like weight loss, tiredness (fatigue), fever, night sweats, and loss of appetite. Although these symptoms and signs may be caused by AML, they can also be caused by problems other than cancer. Still, if you have any of them, see a doctor right away so the cause can be found and treated, if needed.

Symptoms from low numbers of normal blood cells

Most signs and symptoms of AML come from a shortage of normal blood cells, which happens when the leukemia cells crowd out the normal blood-making cells in the bone marrow. As a result, people do not have enough normal red blood cells, white blood cells, and blood platelets. These shortages show up on blood tests, but they can also cause symptoms.

- **Shortage of red blood cells (anemia)**: can cause a person to feel short of breath, tired (fatigued), cold, and dizzy or lightheaded.
- **Shortage of normal white blood cells:** Not having enough normal white blood cells can increase the risk of infection. People with leukemia may have very high white blood cell counts, but the cells are not normal and don't protect against infection. Fevers and other signs of infection are common symptoms.
- **Shortage of blood platelets:** Not having enough blood platelets can lead to bruising, bleeding, frequent or severe nosebleeds, and bleeding gums.

Symptoms from high numbers of leukemia cells

AML cancer cells are bigger than normal white blood cells and have more trouble going through tiny blood vessels. These cells can clog up blood vessels and make it hard for normal red blood cells (and oxygen) to get to tissues. If that happens, it can interfere with normal blood flow to the brain, leading to symptoms like those seen with a stroke, such as:

- Headache
- Weakness in one side of the body,
- Slurred speech,
- Confusion
- Sleepiness.

The cancer cells can also interfere with normal blood flow to other tissues, leading to problems with shortness of breath, blurry vision or even loss of vision.

These problems are rare, but they need to be treated right away.

Bleeding and clotting problems

Patients with a certain type of AML called *acute promyelocytic leukemia* (APL) may have bleeding and clotting problems. They may have a nose bleed that won’t stop, or a cut that won’t stop oozing. They may also have calf swelling from a blood clot called a *deep venous thrombosis* (DVT) or chest pain and shortness of breath from a blood clot in the lung (called a *pulmonary embolism* or PE).

Bone or joint pain

Some people have pain caused by the build-up of leukemia cells in bones or joints.

Swelling in the belly

Leukemia can also cause swelling of the liver and spleen. This may be noticed as a fullness or swelling of the belly.

Spread to the skin

If leukemia cells spread to the skin, they can cause lumps or spots that may look like common rashes.

Spread to the gums

Certain types of AML can spread to the gums, causing swelling, pain, and bleeding.

Spread to other organs

Sometimes, leukemia cells spread to other organs. If it spreads to the central nervous system (the brain and spinal cord) it can cause:

- Headaches
- Weakness
- Seizures
- Vomiting
- Trouble with balance
- Numbness on the face
- Blurred vision

AML rarely spreads to the eyes, testicles, kidneys, or other organs.

Enlarged lymph nodes

AML rarely spreads to lymph nodes. Nodes in the neck, groin, under arms, or above the collarbone may swell and be felt as lumps under the skin.

How is acute myeloid leukemia found?

At this time, there are no special tests that can find acute myeloid leukemia (AML) early. Report any symptoms to your doctor right away.

People known to have a higher risk of AML because they have certain blood problems or syndromes or because they were treated with certain chemotherapy drugs or radiation should have careful, regular medical checkups. They do not usually get leukemia, but they and their doctors should be aware of the possible symptoms of AML.

As noted, most of the symptoms seen in leukemia can also 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 want to ask you questions about your health (get a medical history), such as how long you have had symptoms and whether or not you have any risk factors.

The doctor will likely do a physical exam to look for any enlarged lymph nodes, bleeding or bruising, or signs of infection. If there seems to be a problem with blood cell counts, blood tests will be done. If the results suggest leukemia, your doctor may refer you to a cancer doctor (an oncologist) or a blood doctor (a hematologist), who may do one or more of the tests described below.

Types of samples used to test for AML

The doctor will need to check samples of cells from the blood and bone marrow confirm that you have cancer. Other tissue and cell samples may also be taken to help guide treatment.

Blood samples

Blood samples to check for AML are most often taken from a vein in the arm.

Bone marrow samples

Bone marrow samples are taken through procedures called *bone marrow aspiration* and *biopsy*. These are 2 tests, but they are done together. In bone marrow *aspiration*, a thin needle and syringe is used to take out a small amount of liquid bone marrow. During a bone marrow *biopsy*, a small cylinder of bone and marrow (about ½ inch long) is removed with a slightly larger needle.

Both samples are usually taken at the same time from the back of the hipbone (but sometimes other bones are used instead). The patient usually lies on his or her side or belly and the area is cleaned with a special soap. Before the sample is taken, the doctor uses a long, thin needle to put medicine near the back of the hipbone to numb it. Then the doctor makes a small cut in the skin in order to put in the wider needle. The needle is pushed into the bone with a twisting motion. Sometimes the needle going into the bone

hurts, but it only lasts a short time. The sucking out of the marrow often hurts for a moment, too.

These tests are used to tell whether leukemia is present and -- if you are having treatment-- they are used to see how well treatment is working.

Spinal fluid

This fluid is obtained by a test called a *spinal tap* (lumbar puncture). It is done to look for leukemia cells in the fluid around the brain and spinal cord (cerebrospinal fluid or CSF). The doctor first numbs a place in the lower part of the back over the spine. A small needle is placed between the bones of the spine in the lower back to draw out some of the fluid. The fluid is looked at for leukemia cells.

This test is not usually done for people with AML. It may be done if the doctor suspects that the leukemia has spread to the CSF based on certain symptoms, and to treat it if it has already spread there.

Lab tests

One or more of these lab tests may be done on the samples to tell if you have AML and to learn the exact type.

Blood cell counts and exams

Changes in the numbers of different blood cell types and how the cells look under a microscope can suggest leukemia. Most people with AML will have too many white blood cells, not enough red cells, and not enough platelets. Also, 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.

People already known to have leukemia will have tests done to measure the amount of certain chemicals in the blood. These tests can help tell how well their kidneys and liver are working.

A doctor with special training in blood diseases looks at the biopsy samples (bone marrow, blood, and cerebrospinal fluid) under a microscope. The doctor looks at the size and shape of the cells as well as other features to classify the cells into different types. An important goal of this process is to see whether the cells look mature. The most immature cells are called *blasts*. The number of blasts in the bone marrow is important in telling whether a person has leukemia.

Other lab tests

Other special tests which look at blood, bone marrow, and even DNA, help the doctor decide which type of leukemia a person has. You might hear some of the following terms: *cytochemistry*, *cytogenetics*, *PCR*, *FISH*, and *immunocytochemistry*. These are complex medical and chemical tests. Your doctor can tell you which of these might be done need and why.

Imaging tests

Imaging tests are ways of taking pictures of the inside of the body. Several kinds of these tests might be done in people with leukemia. They are done most often to look for infections or other problems rather than for the leukemia itself.

X-rays

Regular x-rays are not often needed in AML, but a chest x-ray might be done if the doctor thinks there could be a lung infection.

CT (computed tomography) scan

A CT scan is a type of x-ray that gives a detailed picture of the inside of your body. This test can help tell whether any lymph nodes or organs in your body are swollen. This test is not often needed in people with AML.

Before the test, you may have a contrast dye put into a vein, or you may be asked to drink a special liquid to better outline blood vessels and organs. The injection can cause you to 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 a reaction to any contrast material used for x-rays.

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.

MRI (magnetic resonance imaging) scan

Like CT scans, MRI scans make detailed pictures of soft tissues in the body. But MRI scans use radio waves and strong magnets instead of x-rays. MRI scans help look at the brain and spinal cord. But they are not often needed in people with AML.

MRI scans take longer than CT scans. Also, you may be placed inside a narrow tube, which can bother some people. Special, "open" MRI machines may be another choice for people with a fear of closed spaces. The MRI machine makes loud buzzing and thumping noises that you may find disturbing. Some places will give you headphones to block this out.

Ultrasound

Ultrasound uses sound waves to make pictures of organs inside your body. It can be used to look at lymph nodes near the surface of the body or to look for enlarged organs inside your belly, such as the kidneys, liver, and spleen.

This is an easy test to have. For most ultrasound scans, the part of your body that is being looked at is smeared with gel, a kind of wand is moved around, and the picture can be seen on a computer screen.

How is acute myeloid leukemia classified?

Most types of cancer are staged using a number based on the size of the tumor and how far it has spread. But leukemia is not staged in this way because it does not usually form a tumor. It already involves all the bone marrow and, in many cases, it has also spread to other organs. So the outlook for the patient with acute myeloid leukemia (AML) depends on other things, such as the exact type of AML, the age of the patient, and lab test results.

Classification systems

Two systems have been used to classify AML into subtypes -- the French-American-British (FAB) system and the newer World Health Organization (WHO) system.

The French-American-British (FAB) classification of AML

In the 1970s, a group of French, American, and British leukemia experts divided acute myeloid leukemias into subtypes, M0 through M7, based on the type of cell from which the leukemia started and how mature the cells are. This system is based largely on how the leukemia cells looked under the microscope and the symptoms the person has. But now doctors use many advanced gene tests to classify AML.

Prognostic factors

Leukemia treatment has improved, so research has focused on why some patients have a better chance to be cured than others. Differences among patients that affect how they respond to treatment are called *prognostic factors.* These factors include:

- The patient's age
- White blood cell count
- Certain gene test results
- Whether or not the person has had chemotherapy or radiation treatment in the past for another cancer

In recent years, doctors have been using lab tests to learn more about the genetic changes (defects) in AML cells and how they can be used to predict a patient's outlook. These genetic defects might also form the basis for treating the leukemias.

If you would like more details about these prognostic factors, please see the detailed American Cancer Society document, *Leukemia: Acute Myeloid (Myelogenous)* available through our toll-free number or on our website.

World Health Organization (WHO) Classification of AML

The FAB system described above is useful and is still the one most often used to group AML into subtypes. But it doesn't take into account many of the prognostic factors. The World Health Organization (WHO) has proposed a newer system that includes some of these factors to try to help better classify cases of AML based on a patient's outlook. Not all doctors use this new system.

Status of acute myeloid leukemia after treatment

How well leukemia responds to treatment has an effect on the long-term outlook for the patient. A remission can be *complete* (no signs of disease after treatment), or *molecular complete* (meaning that even very sensitive tests find no leukemia cells in the bone marrow).

Minimal residual disease is a term used after treatment when leukemia cells can't be found in the bone marrow using standard tests (such as looking at cells under a microscope), but more sensitive tests can still find leukemia cells in the bone marrow.

Active disease means that either the leukemia is still present during treatment or the disease has come back (relapsed) after treatment. For a patient to be in relapse, they must have more than 5% blast cells present in the bone marrow.

How is acute myeloid 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 questions about your treatment options.

About treatment

As noted before, acute myeloid leukemia (AML) is not just one disease. It is really a group of diseases, and people with different subtypes vary in how they respond to treatment. Treatment options are based on the subtype as well as on the prognostic features. Several different types of treatment may be used in people with AML. The major treatment is chemotherapy, sometimes followed by a stem cell transplant. Surgery and radiation treatment may be used in special cases.

In most cases AML can grow quickly, so it is important to start treatment as soon as possible.

Chemotherapy for acute myeloid leukemia

Chemotherapy (chemo) is the use of drugs to kill or control cancer cells. Usually the drugs are given into a vein or by mouth. These drugs enter the bloodstream and go throughout the body. If leukemia cells are found in the fluid around the brain and spine (CSF), the drugs may be given directly into the CSF. This isn’t common in the treatment of AML.

Chemo for acute myeloid leukemia (AML) usually involves 2 or 3 anti-cancer drugs given for 5 to 7 days.

Treatment of AML is divided into 2 phases:

- Induction (or remission induction)
- Consolidation (post-remission)

For some types of AML, there is a third phase: maintenance.

Induction

The goal of this first phase is to clear the blood of leukemia cells (blasts) and to reduce the number of blasts (very immature cells) in the bone marrow to normal. It usually involves treatment with 2 or 3 chemo drugs that are given while the patient is in the hospital. It takes about a week to give the chemo, and then often the patient stays in the hospital for a few weeks longer. In rare cases where the leukemia has spread to the brain or spinal cord, chemo may be given into the CSF as well.

During this time and in the weeks right after, the patient's blood cell counts will be very low. The doctor will take measures to protect against problems. If one week of chemo does not kill most of the cancer cells (bring about a remission), more chemo may be needed. The success rate for induction varies widely and depends on each person's own case.

Induction usually does not kill all of the leukemia cells. Without more treatment, called consolidation, the leukemia is likely to return in a few months.

Consolidation (post-remission) therapy

While the first phase of treatment usually kills nearly all of the cancer cells, there may still be a small number of "hidden" leukemia cells. The purpose of the second phase is to kill these cells and keep the cancer from coming back (relapsing). The options for consolidation treatment are either more chemo or a stem cell transplant (described later). What treatment is given depends on a number of factors, including the type of leukemia and the patient’s prognostic factors (these were discussed in the section “How is acute myeloid leukemia classified?”).

Stem cell transplants (SCT) have been found to reduce the risk of leukemia coming back more than standard chemo, but they are also more likely to cause serious problems which can even include death. That’s why doctors may give SCTs only to patients whose AML is more likely to come back.

Treating frail, older adults

Treatment of AML in people under 60 is fairly standard. It involves cycles of intense chemo (discussed above). Many patients older than 60 are healthy enough to be treated in the same way, although sometimes the chemo may be less intense. People who are much older or are in poor health may not be able to take this intense treatment. In fact, intense chemo could actually shorten their lives.

In some cases, doctors may recommend less intense treatment. In some cases, this may induce remission. In others, it may control the leukemia for a time. Treatment of these patients is often not divided into induction and consolidation, but may be given every so often as long as it seems helpful.

Sometimes, these patients may be treated with a drug more often used to treat another disease called myelodysplastic syndrome, like azacitidine (Vidaza®) or decitabine (Dacogen®). These drugs are not approved to treat AML, but still may be helpful.

Some patients decide against chemo and other drugs and instead choose supportive care. This focuses on treating any symptoms or problems that arise and keeping the person as comfortable as possible.

Maintenance

Maintenance involves giving a low dose of a chemo drug for months or years after consolidation is finished. This is often used for one type of AML (AML M3), but it is rarely used for other types.

Side effects of chemo

Chemo drugs work by killing cells that are dividing quickly, which is why they work against cancer cells. But other cells in the body, such as those in the bone marrow, the lining of the mouth and intestines, and the hair follicles, also divide quickly. These cells are likely to be affected by chemo, which can lead to side effects.

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

- Hair loss
- Mouth sores
- Loss of appetite
- Nausea and vomiting
- Greater chance of infection (due to a shortage of normal white blood cells)
- Easy bruising or bleeding (due to a shortage of blood platelets)
- Tiredness (due to a shortage of red blood cells)

Most of these side effects go away after treatment ends. And there are often ways to manage these side effects during treatment. For example, there are drugs than can be taken along with the chemo to prevent or reduce nausea and vomiting. Drugs known as growth factors are sometimes given to keep blood counts higher and reduce the chance of infection.

If your white blood cell counts are very low during treatment, it increases the risk of serious infection. Your doctor may tell you to take special steps to avoid germs. Antibiotics are often given before there are signs of infection or as soon as it looks like one may be starting.

If your platelet counts are low, you might get platelet transfusions to prevent bleeding. Low red blood cell counts, causing shortness of breath and tiredness, can be treated with drugs or with transfusions.

Tumor lysis syndrome is a side effect caused by the rapid breakdown of leukemia cells during treatment. It is most common during the first treatment (induction), when the patient has the highest numbers of leukemia cells. When these cells die, they break open

and release their contents into the bloodstream. These "waste" chemicals can affect the kidneys, heart, and nervous system. Extra fluids or certain drugs that help rid the body of these substances can help prevent this problem.

Organs that could be damaged by chemo include the kidneys, liver, testes, ovaries, brain, heart, and lungs. By watching the patient carefully, the doctor may be able to prevent many of these side effects. If serious side effects happen, though, the drugs may have to be given at lower doses or even stopped. Be sure to tell your doctor about any problems you have.

For more details about the treatment of AML, see our document, *Leukemia–Acute Myeloid (Myelogenous).*

Our document, *Understanding Chemotherapy: A Guide for Patients and Families* has more information about chemo and its side effects.

Other drugs for acute myeloid leukemia

Acute promyelocytic leukemia (APL or AML M3) is different from other types of acute myeloid leukemia (AML) in some important ways. First, the leukemia cells (or blasts) contain proteins that when released into the bloodstream cause the blood to clot in an out-of-control way. This can lead to problems not only with blood clots, but also with severe bleeding. This was a big problem in the past, since treating APL with regular chemotherapy (chemo) drugs caused those cells to die and release these proteins into the bloodstream. Patients sometimes died from complications from out-of-control clotting.

Then experts found that there were drugs that could fight the leukemia without leading to the clotting problems: all-trans-retinoic acid (ATRA, tretinoin, or Vesanoid®) and arsenic trioxide (ATO, Trisenox®). These drugs are only used for this one type of AML known as APL -- they are not helpful for any other type. One or both of these drugs may be used as a part of the treatment of APL. Often, ATRA combined with chemo is the first treatment given. ATRA is also given as maintenance and may be part of consolidation (these terms were discussed in the section about chemotherapy).

Side effects

The most important side effect of either of these drugs is a syndrome known as *retinoic acid syndrom*e or *differentiation syndrome*. It is most often only seen during the first treatment cycle. Symptoms include breathing problems from fluid buildup in the lungs and around the heart, low blood pressure, kidney damage, and severe fluid buildup elsewhere in the body. It can often be treated by stopping the drugs for a while and giving a steroid.

ATRA can also have side effects like those seen if you take too much vitamin A. Symptoms include:

- Headache,
- Fever,
- Dry skin and mouth,
- Skin rash,
- Swollen feet,
- Sores in the mouth or throat,
- Itching and irritated eyes.
- Higher blood lipid levels (like those of cholesterol and triglycerides)

These side effects often go away when the drug is stopped.

Most side effects of arsenic trioxide are mild and can include:

- Tiredness,
- Nausea and vomiting,
- Diarrhea,
- Stomach pain, and
- Nerve damage leading to numbness and tingling in the hands and feet
- Problems with heart rhythm. This is why your doctor may check your EKG often (even daily) while you are getting this drug.

More detailed information about these drugs and the treatment of APL can be found in our detailed document, *Leukemia–Acute Myeloid (Myelogenous)*.

Surgery for acute myeloid leukemia

Surgery plays a very small part in the treatment of leukemia, because leukemia is a disease of blood and bone marrow and it is not possible to cure it with surgery. But surgery may be used to help deliver treatment. A plastic tube called a *venous access device* can be put into a large vein. The tube allows chemo drugs or other medicines to be given and blood samples to be taken. This lessens the number of needle sticks needed during treatment. The patient must learn how to take care of the device to keep it from getting infected.

Radiation therapy for acute myeloid leukemia

Radiation treatment is the use of high-energy x-rays to kill cancer cells. It is not often part of the main treatment for people with acute myeloid leukemia (AML). There are a few times in which radiation may be used to help treat leukemia:

- It 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 stem cell transplant.
- It is used (rarely) to help shrink a tumor if it is pressing on the windpipe and causing breathing problems. But chemo is often used instead since it may work more quickly.
- Radiation can also be used to reduce pain in a bone that has leukemia in it, if chemo hasn't helped.

The possible side effects of radiation depend on where the radiation is aimed. Sunburn-like skin changes in the treated area can happen. Radiation to the belly (abdomen) can sometimes cause nausea, vomiting, or diarrhea. If large areas of the body get radiation, the effects may include tiredness and an increased risk of infection.

For more information about radiation therapy, see our document *Understanding Radiation Therapy: A Guide for Patients and Families*.

Bone marrow or peripheral blood stem cell transplant for acute myeloid leukemia

Very high doses of chemo drugs might work better to kill cancer cells, but the damage to the bone marrow could be fatal. A stem cell transplant (SCT) offers a way for doctors to use high doses of chemo. The drugs destroy the patient's bone marrow, but the transplanted stem cells restore it.

Stem cells for a transplant come from either from the blood or from the bone marrow. Bone marrow transplants were more common in the past, but today peripheral blood stem cell transplant (PBSCT) is much more common.

There are 2 main types of stem cell transplants: *allogeneic* and *autologous*. The difference is the source of the blood-forming stem cells.

- An allogeneic transplant is the most common form of SCT used to treat acute leukemia. For this, the stem cells come from someone else -- a donor whose tissue matches the patient's -- often a close relative, like a brother or sister. Sometimes umbilical cord stem cells are used.

- In an autologous transplant, a patient's own stem cells are removed from bone marrow or blood. They are frozen and stored while the person gets strong chemo and perhaps radiation. The stem cells are then given back to the patient after treatment.

There is a good reason to use stem cells from someone else for the transplant. These cells seem to help fight any remaining leukemia cells through an immune reaction. This is called a *graft-versus-leukemia* reaction and is explained below. Also, the patient’s own stem cells may contain some leukemia cells, even if they are collected when the leukemia is in remission.

The transplant process

The treatment works like this: stem cells are collected from the bloodstream in a process called *apheresis*. The cells are frozen and stored. Patients are then given very high doses of chemo to kill the cancer cells. They also may get total body radiation to kill any remaining cancer cells. 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 as needed to prevent infections. Usually, stem cells start making new white blood cells within a couple of weeks after they are given. 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 stay in the hospital until the white cell count reaches a certain number, usually around 1,000. After they go home, they will be seen in the outpatient clinic almost every day for several weeks.

Mini-transplant

Most older patients can't have a regular transplant that uses high doses of chemo. Some may be able to have what is called a *mini-transplant* (also called a *non-myeloablative transplant* or *reduced-intensity transplant*), where they get lower doses of chemo and radiation that do not destroy the all 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 sees the leukemia cells as foreign and attacks them (a graft-versus-leukemia effect). This is not the standard type of transplant used for AML, and some doctors still think of this approach as experimental in this disease.

Some things to keep in mind

Stem cell transplantation (SCT) is a complex treatment. 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.

SCT can cost more than $100,000 and might mean a long hospital stay. Because certain types of SCT may be seen as “experimental” by insurance companies, they might not pay for it. You should find out what your insurance will cover and what you might have to pay before deciding on a transplant.

Side effects of stem cell transplant

Common side effects are much the same as those caused by any other type of chemo and can be severe. These include nausea and vomiting, mouth sores, and severe low blood counts. One of the most common and serious short-term effects is the greater risk of infection caused by low white blood cell counts. Antibiotics are often given to try to prevent this. Other side effects, like low red blood cell and platelet counts, often mean the patient will need transfusions.

Graft-versus-host disease (GVHD) is the main problem of a donor stem cell (allogeneic) transplant. It happens when the immune system of the patient is taken over by that of the donor. The donor immune system then starts to attack the patient's other tissues and organs. In severe cases, GVHD can be life-threatening.

Symptoms can include bad skin rashes with itching and severe diarrhea. The liver and lungs may also be damaged. The patient may also be very tired and have aching muscles. If bad enough, GVHD can be fatal. Drugs that weaken the immune system may be given to try to control it. The plus side of graft-versus-host disease is that the donor bone marrow usually kills any remaining leukemia cells. This is called the graft-versus-leukemia effect.

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

Clinical trials for acute myeloid leukemia

You may have had to make a lot of decisions since you've been told you have cancer. 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.

There are requirements you must meet to take part in any clinical trial. If you do qualify for a clinical trial, it is up to you whether or not to enter (enroll in) it.

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 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 website or call our toll-free number and have it sent to you.

Complementary and alternative therapies for acute myeloid leukemia

When you have cancer 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 could 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. You can also check them out on the *Complementary and Alternative Medicine* page of our website.

The choice is yours

Decisions about how to treat or manage your cancer are always yours to make. 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 if the acute myeloid leukemia doesn't respond or comes back after treatment?

For most types of acute myeloid leukemia

If acute myeloid leukemia (AML) doesn't go away with the first treatment, newer or stronger doses of chemotherapy (chemo) drugs may be tried. A stem cell transplant may be tried in younger patients if a matched stem cell donor can be found. Clinical trials of new treatment approaches may also be an option.

If the disease comes back after treatment it will most often be in the bone marrow and blood. Rarely the brain or spinal fluid will be the first place it is seen. This would be treated with chemo given right into the spinal fluid. If the leukemia went away and has come back, another remission might be possible, but most doctors think it would be only short-term. They might suggest a stem cell transplant in this case. If the leukemia keeps

coming back or doesn't go away, chemo will not be very helpful. If a stem cell transplant is not an option, taking part in a clinical trial might be a good idea.

For acute promyelocytic leukemia

Most patients with acute promyelocytic leukemia (APL) are treated with ATRA plus chemo and do well. If the leukemia doesn’t respond to the first treatment with ATRA or it comes back (relapses), a drug called arsenic trioxide (Trisenox) often works well in bringing about a second remission. A stem cell transplant may be another option if a donor can be found.

Palliative treatment

If a clinical trial is not an option, then it may be time to focus on relieving symptoms rather than curing the cancer. This is known as *palliative treatment*. The doctor may suggest milder chemo to slow the growth of the leukemia and reduce symptoms.

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

What are some questions I should ask my doctor about acute myeloid leukemia?

As you cope with cancer and cancer treatment, we encourage you to have honest, open talks with your doctor. Feel free to ask any question that's on your mind, 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?
- Are there any specific factors that might affect my outlook?
- Do other tests need to be done before we can decide on treatment?
- How much experience do you and this medical center have treating this type of cancer?
- Should I get a second opinion?
- What treatment choices do I have?
- Which treatment do you recommend, and why?

- What are the risks and side effects of the treatments you recommend?
- What can I do to be ready for treatment?
- How long will treatment last? What will it involve? Where will it be done?
- How will treatment affect my daily activities?
- What can I do to help reduce the side effects I may have from the chemo?
- Should we think about a stem cell transplant? If so, when?
- What are the chances that my leukemia will come back once I am in remission?
- What is the outlook for my survival?
- 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 myeloid leukemia

It can feel good to be done with treatment, but it can also be stressful. You might find that you now worry about the cancer coming back. This is a very common concern among those who have had cancer. (When cancer comes back, it is called a *recurrence*.)

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*.

Follow-up care

Treatment for acute myeloid leukemia (AML) can continue for months or years. Even after treatment ends, you will need frequent follow-up exams -- probably every few months for several years. It is very important to go to all follow-up appointments. During these visits, your doctors will ask about symptoms, do physical exams, and order blood

tests or bone marrow tests. Follow-up is needed to see if the leukemia has come back, as well as possible side effects of certain treatments.

If the cancer comes back, it usually does so while the patient is being treated or shortly after chemo is finished. If this happens, treatment would be as described in the section, "What if the leukemia doesn't respond or comes back after treatment?" But it is unusual for AML to return if there are no signs of the disease a few years after 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.

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.

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.

Seeing a new doctor

At some point after your cancer 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 were in the hospital, a copy of the discharge summary that the doctor wrote when you were sent home from the hospital
- If you had radiation treatment, a copy of the treatment summary
- If you had chemotherapy or other 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 myeloid leukemia

Having cancer and dealing with treatment can take a lot of time and energy, but it can also 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.

Make healthier choices

Think about your life before you learned you had cancer. Were there things you did that might have made you less healthy? Maybe you drank too much alcohol, ate more than you needed, used tobacco, or didn't exercise very often.

Now is not the time to feel guilty or blame yourself. You can start making changes today that can have positive effects for the rest of your life. Not only will you feel better but 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 is hard for many people, but it can be even harder to do 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.

For more information about nutrition, see our document *Nutrition for the Person With Cancer During Treatment: A Guide for Patients and Families*. The section called “Additional resources for acute myeloid leukemia” has a list of some other documents that you may find helpful.

Fatigue and exercise

Feeling 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 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 detailed document, *Fatigue in People With Cancer* and *Anemia in People With Cancer.* A list of some other documents about treatment side effects can be found in the “Additional resources for acute myeloid leukemia” section.

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. Get their input on your exercise plans. Then try to get an exercise buddy so that you're not doing it alone.

Exercise can improve your physical and emotional health.

- It improves your cardiovascular (heart and circulation) fitness.
- It makes your muscles stronger.
- It reduces fatigue.
- It lowers anxiety and depression.
- It can make you feel generally happier.
- It helps 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.

How about your emotional health after acute myeloid leukemia?

Once your treatment ends, 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. Money may be a concern as the medical bills pile up. Or you may begin to think about the changes that cancer has brought to your relationship with your spouse or partner. 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.

You can't change the fact that you have had cancer. What you can change is how you live the rest of your life -- making healthy choices and helping your body and mind feel well.

If treatment for acute myeloid 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 and clinic visits.

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 it 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 having hospice care 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 documents, *Hospice Care* and *Nearing the End of Life*. They can be read online, or call us to have free copies mailed to you.

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 joy 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 myeloid leukemia research?

Research into the causes, diagnosis, and treatment of leukemia is going on at many medical centers, hospitals, and other places.

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 cells. Doctors are now learning how to use these changes to help them predict a person's outlook and figure out whether they need more or less intense treatment. In the future, this information may be used to come up with an approach that uses newer targeted treatments against acute myeloid leukemia (AML).

A new lab technique is being studied to help find and classify different cancers, too. 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. This may add to the information that comes from the lab tests now in use.

Finding "hidden" disease (minimal residual disease)

Progress has also been made in finding leukemia cells after treatment, when there are so few leukemia cells that they cannot be found by routine bone marrow tests. A test called *PCR* (polymerase chain reaction) can find one cancer cell among a million normal cells. This is helpful in seeing how well the chemo has destroyed the leukemia cells and whether it is likely that the cancer will come back (relapse). Doctors are also trying to figure out what effect hidden disease has on a patient's outlook, and how this might affect the need for more treatment.

Better chemo

Studies are going on to find the best combination of chemo drugs, with fewer side effects, and to figure out which patients will benefit the most from different types of treatment. Studies of newer chemo drugs now used to treat other cancers are being done to see if they will work for AML.

Sometimes chemo may 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.

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. Many studies are also trying to help figure exactly which type of transplants might be best.

Targeted therapies

New targeted drugs that attack some of the genetic changes seen in AML are now being developed.

Immunotherapy

Monoclonal antibodies are man-made versions of immune system proteins (antibodies) that are designed to attach to certain targets, such as substances on the surface of leukemia cells. Some of these antibodies have radioactive chemicals or cell poisons attached to them so that when they are injected into the patient, they lock onto the cancer cells and kill them. One such antibody (gemtuzumab ozogamicin or Mylotarg®) was at one time was approved by the FDA to treat AML in older patients. Although it was taken off the market because it didn't seem very helpful, it is showing promise in certain patients in clinical trials.

Vaccine therapy: A study of an experimental vaccine had promising results. For this vaccine, white blood cells (cells of the immune system) are removed from the patient's blood and exposed to a protein found on many AML cells. These cells are then given back to the patient into a vein (IV). In the body, the cells cause other immune system cells to attack the patient's leukemia.

More information about acute myeloid 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.

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)

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 websites*

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

Acute myeloid leukemia

Leukemia & Lymphoma Society
Toll-free number: 1-800-955-4572
Website: www.lls.org
Has a variety of service programs and resources available throughout the US and Canada including: the Information Resource Center, staffed by health care professionals, available via the toll-free number; free publications on all forms of leukemia and related topics; First Connection, a telephone-based peer support network for patients and survivors; family support groups; education teleconferences and Web-casts – a schedule is on the website.

National Cancer Institute
Toll-free number: 1-800-4-CANCER (1-800-422-6237)
Website: www.cancer.gov
Their "Cancer Information Service" offers a wide variety of free, accurate, up-to-date information about cancer to patients, their families, and the general public; also can help people find clinical trials in their area.

National Coalition for Cancer Survivorship (NCCS)
Toll-free number: 1-888-650-9127
Website: www.canceradvocacy.org
Has publications on many cancer-related topics; also offers the Cancer Survival Toolbox – a free program that teaches skills that can help people with cancer meet the challenges of their illness.

Bone marrow and peripheral blood stem cell transplants

National Bone Marrow Transplant Link (nbmtLink)
Toll-free number: 1-800-546-5268 (1-800-LINK-BMT)

Website: www.nbmtlink.org
Programs and services include: information and referrals to meet a wide range of needs; support via one-on-one conversations with trained peer support volunteers who are transplant survivors, caregivers, and donors; telephone support groups, facilitated by a clinical social worker, that link patients and families together to offer mutual support and coping strategies; and the nbmtLINK Online Resource Library – a comprehensive, searchable library giving access to the latest transplant information.

Be the Match (formerly the **National Marrow Donor Program)**
Toll-free number: 1-800-627-7692 (1-800-MARROW-2)
Website: www.bethematch.org
Provides a registry of volunteer bone marrow donors and cord blood units (the largest listing in the world), as well as a searchable listing of transplant centers that can be accessed directly at www.marrow.org/access. This listing contains information to help a patient choose a transplant center. Also supports patients and their doctors throughout the transplant process, from diagnosis through survivorship; matches patients with the best donor or cord blood unit using innovative science and technology; has free educational materials; and offers financial assistance to eligible underinsured patients through the Patient Assistance Program.

**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