



LEUKEMIA--CHRONIC MYELOID (MYELOGENOUS)

What is cancer?

Cancer develops when cells in a part of the body begin to grow out of control. Although there are many kinds of cancer, they all start because of out-of-control growth of abnormal cells.

Normal body cells grow, divide, and die in an orderly fashion. During the early years of a person's life, normal cells divide more rapidly until the person becomes an adult. After that, cells in most parts of the body divide only to replace worn-out or dying cells and to repair injuries.

Because cancer cells continue to grow and divide, they are different from normal cells. Instead of dying, they outlive normal cells and continue to form new abnormal cells.

Cancer cells develop because of damage to DNA. This substance is in every cell and directs all its activities. Most of the time when DNA becomes damaged the body is able to repair it. In cancer cells, the damaged DNA is not repaired. People can inherit damaged DNA, which accounts for inherited cancers. Many times though, a person's DNA becomes damaged by exposure to something in the environment, like smoking.

Cancer usually forms as a tumor. Some cancers, like leukemia, do not form tumors. Instead, these cancer cells involve the blood and blood-forming organs and circulate through other tissues where they grow.

Often, cancer cells travel to other parts of the body, where they begin to grow and replace normal tissue. This process is called metastasis. Regardless of where a cancer may spread, however, it is always named for the place it began. For instance, breast cancer that spreads to the liver is still called breast cancer, not liver cancer.

Not all tumors are cancerous. Benign (non-cancerous) tumors do not spread (metastasize) to other parts of the body and, with very rare exceptions, are not life threatening.

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 particular kind of cancer.

Cancer is the second leading cause of death in the United States. Nearly half of all men and a little over one third of all women in the United States will develop cancer during their lifetimes. Today, millions of people are living with cancer or have had cancer. The risk of developing most types of cancer can be reduced by changes in a person's lifestyle, for example, by quitting smoking and eating a better diet. The sooner a cancer is found and treatment begins, the better are the chances for living for many years.

What Is Chronic Myeloid Leukemia?

Chronic myeloid leukemia (CML), also known as chronic myelogenous leukemia, is a type of cancer that starts in blood-forming cells of the bone marrow and invades the blood. It usually involves a chromosome abnormality called the Philadelphia chromosome. In CML, leukemia cells tend to build up in the body over time, but in many cases people don't have any symptoms for at least a few years. In time, the cells can also invade other parts of the body, including the spleen. CML can also change into a fast-growing acute leukemia that invades almost any organ in the body.

Although most cases of CML occur in adults, in rare cases it occurs in children. Their treatment is the same as for adults.

Leukemia is different from other types of cancer that start in organs such as the lungs, colon, or breast and then spread to the bone marrow. Cancers that start elsewhere and then spread to the bone marrow are not leukemia.

Normal Bone Marrow, Blood, and Lymphoid Tissue

In order to understand the different types of leukemia, it is helpful to have some basic knowledge about the blood and lymph systems. The information which follows is quite complex. It may prove helpful, but it is not necessary for you to understand all of it in order to learn more about your leukemia.

Bone Marrow

Bone marrow is the soft inner part of some bones such as the skull, shoulder blades, ribs, pelvis, and backbones. The bone marrow is made up of a small number of blood stem cells, more mature blood-forming cells, fat cells, and supporting tissues that help cells grow.

The blood-forming cells come from blood *stem cells*. These stem cells only make new blood-forming cells, not other kinds of cells. (This makes them different from embryonic stem cells, which are formed in a developing fetus and can develop into most other cells in the body.)

Stem cells go through a series of changes. 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 components: red blood cells, white blood cells (other than lymphocytes), or platelets.

Red Blood Cells

Red blood cells carry oxygen from the lungs to all other tissues in the body and take carbon dioxide back to the lungs to be removed. Having too few red blood cells in the body (anemia) typically causes weakness, fatigue, and shortness of breath because the body tissues are not getting enough oxygen.

Platelets

Platelets are actually cell fragments made by a type of bone marrow cell called the megakaryocyte. Platelets are important in plugging up holes in blood vessels caused by cuts or bruises. A shortage of platelets is called thrombocytopenia. A person with thrombocytopenia may bleed and bruise easily.

White Blood Cells

White blood cells are important in defending the body against infections. Lymphocytes are one type of white blood cell. The other types of white blood cells are granulocytes (neutrophils, basophils, and eosinophils) and monocytes.

Lymphocytes are the main cells that make up lymphoid tissue, a major part of the immune system. Lymphoid tissue is found in lymph nodes, the thymus gland, the spleen, the tonsils and adenoids, and it is scattered throughout the digestive and respiratory systems and the bone marrow.

Lymphocytes develop from cells called *lymphoblasts* to become mature, infection-fighting cells. The 2 types of lymphocytes are known as B lymphocytes (B cells) and T lymphocytes (T cells).

- *B lymphocytes* protect the body from invading germs by developing (maturing) into plasma cells, which make antibodies. These antibodies attach to the germs, such as

bacteria, viruses, and fungi. Once the germ has been coated in this way, other white blood cells called granulocytes can recognize and destroy it.

- *T lymphocytes* can recognize cells infected by viruses and directly destroy these cells.

Granulocytes are white blood cells that have granules in them, which are spots that can be seen under the microscope. These granules contain enzymes and other substances that can destroy germs such as bacteria. The 3 types of granulocytes - *neutrophils*, *basophils*, and *eosinophils* - are distinguished by the size and color of their granules. Granulocytes develop from blood-forming cells called *myeloblasts* to become mature, infection-fighting cells.

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

How Leukemia Starts

Any of the blood-forming or lymphoid cells from the bone marrow can turn into a leukemia cell. Once this change takes place, the leukemia cells fail to go through their normal process of maturing. Although leukemia cells may reproduce too quickly, in most cases the problem is that they don't die when they should. They survive and accumulate. Over time, these cells spill into the bloodstream and spread to other organs, where they can prevent other cells in the body from working the way they should.

Types of Leukemia

Not all leukemias are the same. Leukemias are divided into 4 main types. Knowing the specific type of leukemia can help doctors better predict each patient's prognosis (outlook) and select the best treatment.

Acute Leukemia Versus Chronic Leukemia

The first factor to consider in classifying a patient's leukemia is whether most of the abnormal cells are mature (look like normal white blood cells) or immature (look more like stem cells).

Acute leukemia: In acute leukemia, the bone marrow cells cannot mature the way they should. Immature leukemia cells continue to reproduce and build up. Without treatment, most patients with acute leukemia would only live a few months. Some types of acute

leukemia respond well to treatment, and many patients can be cured. Other types of acute leukemia have a less favorable outlook.

Chronic leukemia: In chronic leukemia, the cells can mature partly but not completely. These cells are not really normal. They generally do not fight infection as well as do normal white blood cells. And, of course, they survive longer, build up, and crowd out normal cells. Chronic leukemias tend to develop over a longer period of time, and most patients can live for many years. However, chronic leukemias are generally harder to cure than acute leukemias.

Myeloid Leukemia Versus Lymphocytic Leukemia

The second factor to consider in classifying leukemia is the type of bone marrow cells that are affected.

Leukemias that start in early forms of myeloid cells - white blood cells (other than lymphocytes), red blood cells, or platelet-making cells (megakaryocytes) - are *myeloid* leukemias (also known as *myelocytic*, *myelogenous*, or *non-lymphocytic* leukemias).

If the cancer starts in lymphocytes, it is called *lymphocytic* leukemia (also known as *lymphoblastic* or *lymphoid* leukemia). (Lymphomas are also cancers of lymphocytes. But unlike lymphocytic leukemias, which develop in the bone marrow, lymphomas develop from lymphocytes in lymph nodes or other organs.)

By looking at whether they are acute or chronic and whether they are myeloid or lymphocytic, leukemias can be divided into 4 main types:

- acute myeloid (or myelogenous) leukemia (AML)
- chronic myeloid (or myelogenous) leukemia (CML)
- acute lymphocytic (or lymphoblastic) leukemia (ALL)
- chronic lymphocytic leukemia (CLL)

The rest of this document contains information on chronic myeloid leukemia (CML) only. Separate American Cancer Society documents on other forms of acute and chronic leukemias are available. This document does not contain information on chronic myelomonocytic leukemia (CMML), which is considered to be a myelodysplastic syndrome. CMML is covered in another American Cancer Society document (Myelodysplastic Syndromes).

What Are the Key Statistics About Chronic Myeloid Leukemia?

The American Cancer Society estimates that 4,830 new cases of chronic myeloid leukemia (CML) will be diagnosed in the United States during 2008. About 450 people in the United States will die of CML during 2008.

CML accounts for about 10% to 15% of all leukemias. The average person's lifetime risk of getting CML is less than 1/5 of 1% (less than 1 in 500). The risk is slightly higher in men than in women.

The average age at the time of diagnosis is around 67 years. Chronic myeloid leukemias affect mostly adults, and are only rarely seen in children.

Because of dramatic progress in treatment over the past few years, most people with CML are now surviving *at least* 5 years after diagnosis. But because the highly effective drugs are still fairly new, the average survival of people now being diagnosed with CML is not known.

What Are the Risk Factors for Chronic Myeloid Leukemia?

A risk factor is something that affects a person's chance of getting a disease such as cancer. For example, exposing skin to strong sunlight is a risk factor for skin cancer. Smoking is a risk factor for a number of cancers. But risk factors are rarely absolute. 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 had any known risk factors.

There are very few known risk factors for chronic myeloid leukemia (CML).

High-dose Radiation Exposure

Being exposed to high-dose radiation (such as being a survivor of an atomic bomb blast or nuclear reactor accident) is the only known environmental risk factor for chronic myeloid leukemia.

Gender

CML is slightly more common in males than females, although the reasons for this are not known.

There are no other proven risk factors for CML. The risk of getting CML does not seem to be affected by smoking, diet, or exposure to chemicals or infections. Nor does CML run in families.

Do We Know What Causes Chronic Myeloid Leukemia?

Normal human cells grow and function based mainly on the information contained in each cell's chromosomes. Chromosomes are long molecules of DNA in each cell. DNA is the chemical that carries our genes - the instructions for how our cells function. We resemble our parents because they are the source of our DNA. But our genes affect more than the way we look.

Each time a cell prepares to divide into 2 new cells, it must make a new copy of the DNA in its chromosomes. This process is not perfect, and errors can occur that may affect genes within the DNA.

Some genes contain instructions for controlling when our cells grow and divide. Certain genes that promote cell growth and division are called *oncogenes*. Others that slow down cell division or cause cells to die at the right time are called *tumor suppressor genes*. Cancers can be caused by changes in DNA (mutations) that turn on oncogenes or turn off tumor suppressor genes.

During the past few years, scientists have made great progress in understanding how certain changes in DNA can cause normal bone marrow cells to become leukemia cells. In no cancer is this better understood than in chronic myeloid leukemia (CML).

Each human cell contains 23 pairs of chromosomes. Most cases of CML start when a “swapping” (translocation) of chromosomal material (DNA) occurs between chromosomes 9 and 22 during cell division. Part of chromosome 9 goes to 22 and part of 22 goes to 9. This gives rise to the Philadelphia chromosome, which is an extra short chromosome 22. The Philadelphia chromosome is found in the leukemia cells of almost all patients with CML.

The swapping of DNA between the chromosomes leads to the formation of a new gene (an oncogene) called *bcr-abl*. This gene then produces a BCR-ABL protein, which causes CML cells to grow and reproduce out of control.

A small number of CML patients have the *bcr-abl* oncogene but don't seem to have the Philadelphia chromosome. It is thought that the *bcr-abl* gene must be forming in a different way in these people. In a very small percentage of people who seem to have CML, neither the Philadelphia chromosome nor the *bcr-abl* oncogene can be found. They may have other, unknown oncogenes causing their disease.

Sometimes people inherit DNA mutations from a parent that greatly increase their risk of getting certain types of cancer. But inherited mutations do not cause CML. DNA changes

related to CML occur during the person's lifetime, rather than having been inherited before birth.

Can Chronic Myeloid Leukemia Be Prevented?

Although many types of cancer can be prevented by lifestyle changes to avoid certain risk factors, there is no known way to prevent most cases of chronic myeloid leukemia (CML). Most CML patients have no known risk factors.

Can Chronic Myeloid Leukemia Be Found Early?

The American Cancer Society recommends screening tests for certain cancers in people without any symptoms, because they are easier to treat if found early. But at this time, no screening tests are routinely recommended for early detection of chronic myeloid leukemia (CML).

CML can sometimes be found on routine blood tests done for other reasons. For instance, a person's white blood cell count may be very high, even though he or she doesn't have any symptoms.

It is important to report any symptoms that could be caused by CML to the doctor right away. The symptoms of CML are discussed in the next section, "How Is Chronic Myeloid Leukemia Diagnosed?"

How Is Chronic Myeloid Leukemia Diagnosed?

Many people with chronic myeloid leukemia (CML) do not have symptoms when it is diagnosed. The leukemia is often found when their doctor orders blood tests for some unrelated health problem or during a routine checkup. Even when symptoms are present, they are often vague and non-specific.

Signs and Symptoms of Chronic Myeloid Leukemia

Symptoms of CML can include the following:

- weakness
- fatigue
- night sweats
- weight loss
- fever

- bone pain
- an enlarged spleen (felt as a mass under the left side of the ribcage)
- and pain or a sense of "fullness" in the belly (especially after eating even a small meal)

But these symptoms aren't found only in CML. They can occur with other cancers, as well as many non-cancerous conditions.

Many of the signs and symptoms of CML occur because the leukemia cells replace the bone marrow's normal blood-making cells. As a result, people with CML do not make enough red blood cells, properly functioning white blood cells, and blood platelets.

Problems Caused by a Shortage of Blood Cells

- A shortage of red blood cells (*anemia*) can cause weakness, tiredness, and shortness of breath.
- A shortage of normal white blood cells (*leukopenia*) increases the risk of infections. A common term you may hear is *neutropenia*, which refers specifically to low levels of neutrophils (a type of granulocyte). Although patients with leukemia may have very high white blood cell counts, the leukemia cells do not protect against infection the way normal white blood cells do.
- A shortage of blood platelets (*thrombocytopenia*) can lead to excess bruising or bleeding, frequent or severe nosebleeds, and bleeding gums. Some patients with CML have *thrombocytosis* (too many platelets). But those platelets may not function properly, leading to bleeding and bruising problems.

Some patients have bone pain or joint pain caused by leukemia cells spreading from the marrow cavity to the surface of the bone or into the joint. Occasionally, CML may also spread to other organs.

Types of Samples Used to Test for Chronic Myeloid Leukemia

If signs and symptoms suggest you may have leukemia, the doctor will need to check samples (specimens) of blood and bone marrow to be certain of this diagnosis. Other tissue and cell samples may also be taken in order to guide treatment.

Blood Samples

Blood samples for tests for CML are generally taken from a vein in the arm.

Bone Marrow Samples

Bone marrow samples are obtained from a bone marrow aspiration and biopsy - two tests that are usually done at the same time. The samples are usually taken from the back of the pelvic (hip) bone, although in some cases they may be taken from the breastbone (sternum) or other bones.

For a bone marrow *aspiration*, you lie on a table (either on your side or on your belly). After cleaning the area, the skin over the hip and the surface of the bone is numbed with local anesthetic, which may cause a brief stinging or burning sensation. A thin, hollow needle is then inserted into the bone and a syringe is used to suck out a small amount of liquid bone marrow (about 1 teaspoon). Even with the anesthetic, most patients still have some brief pain when the marrow is removed.

A bone marrow *biopsy* is usually done just after the aspiration. A small piece of bone and marrow (about 1/16 inch in diameter and 1/2 inch long) is removed with a slightly larger needle that is twisted as it is pushed down into the bone. The biopsy may also cause some brief pain. Once the biopsy is done, pressure will be applied to the site to help prevent bleeding.

These samples are sent to a lab, where tests are used to look for leukemia. These tests may also be done after treatment to tell if the leukemia is responding to therapy.

Lab Tests

One or more of the following lab tests may be used, either to diagnose CML or to help determine how advanced the disease is.

Blood Cell Counts and Blood Cell Examination

These tests look at the numbers of different blood cell types and how they look under the microscope. Most patients with CML have too many white blood cells and sometimes not enough red blood cells or blood platelets. Even though these findings may suggest leukemia, the disease usually is not diagnosed without testing a sample of bone marrow cells.

Blood Chemistry Tests

These tests measure the amount of certain chemicals in the blood, but they are not used to diagnose leukemia. In patients already known to have CML, these tests help find liver or kidney problems caused by the spread of leukemia cells or due to the side effects of certain

chemotherapy drugs. These tests also help determine if treatment is needed to correct low or high blood levels of certain minerals.

Routine Microscopic Exam

The samples of blood and bone marrow are looked at under a microscope by a pathologist (a doctor specializing in diagnosing diseases with lab tests) and may be looked at by a hematologist/oncologist (a doctor specializing in treating blood diseases and cancer) as well.

The doctors will look at the size and shape of the cells in the samples and whether they contain granules (small spots seen in some types of white blood cells).

An important factor is whether the cells look mature (like normal circulating blood cells) or immature (lacking features of normal circulating blood cells). The most immature cells are called myeloblasts (or "blasts" for short).

An important feature of a bone marrow sample is its *cellularity*. Normal bone marrow contains a certain number of blood-forming cells and fat cells. Marrow with too many blood-forming cells is said to be *hypercellular*. If too few of these cells are found, the marrow is called *hypocellular*.

Cytochemistry

After cells from the sample are placed on microscope slides, they are exposed to chemical stains (dyes) that react only with some types of leukemia cells. These stains cause color changes that can be seen only under a microscope, and these changes can help the doctor determine what types of cells are present.

Cytogenetics: This test involves looking at chromosomes (pieces of DNA) under a microscope to detect any changes. Normal human cells contain 23 pairs of chromosomes, each of which is a certain size. Most patients with CML have a Philadelphia chromosome, which is a shortened chromosome 22, in their leukemia cells. It is caused by a swapping of pieces (translocation) between chromosomes 9 and 22 (see the section "Do We Know What Causes Chronic Myeloid Leukemia?"). This is a useful feature in helping to identify this type of cancer, as it can often be seen under a microscope. Even when the Philadelphia chromosome can't be seen, it can often be found by chemical tests.

Fluorescent in situ hybridization (FISH): This is a type of cytogenetic test. It uses special fluorescent dyes that only attach to specific parts of chromosomes. FISH can be used to look for specific pieces of the *bcr-abl* gene on chromosomes. It can be used on regular blood or bone marrow samples and is very accurate, which is why this test is now used in many medical centers.

Polymerase chain reaction (PCR): This is a super-sensitive test for looking for the *bcr-abl* oncogene in leukemia cells. It can be done on blood or bone marrow samples and can detect *bcr-abl* in very small amounts, even when doctors can't find the Philadelphia chromosome in bone marrow cells. It can be used to help diagnose CML and is also useful after treatment to see if copies of the *bcr-abl* gene (and hence leukemia cells) are still present.

Imaging Tests

Imaging tests produce pictures of the inside of the body. There are several imaging tests that might be done in people with leukemia. They are not needed to diagnose the leukemia, but they may be done to help find out the extent of the disease.

Computed Tomography (CT) Scan

The CT scan is a type of x-ray test that produces detailed, cross-sectional images of your body. Unlike a regular x-ray, CT scans can show the detail in soft tissues (such as internal organs). This test can help tell if any organs in your body are enlarged. It isn't usually needed to diagnose CML, but it may be done if your doctor suspects the leukemia is growing in an organ, such as your spleen.

Instead of taking one picture like a regular x-ray, a CT scanner takes many pictures as it rotates around you. A computer then combines these pictures into detailed images of the part of your body that is being studied.

Often after the first set of pictures is taken, you will receive an intravenous (IV) injection of a contrast dye, or you may be asked to drink a solution of contrast material to better outline blood vessels and internal organs. A second set of pictures is then taken.

The IV injection of contrast dye can cause a feeling of flushing or warmth in the face or elsewhere. Some people are allergic and get hives or, rarely, more serious reactions like trouble breathing and low blood pressure. Be sure to tell the doctor if you have ever had a reaction to any contrast material used for x-rays.

CT scans take longer than regular x-rays. You need to lie still on a table while they are being done. During the test, the table moves in and out of the scanner, a ring-shaped machine that completely surrounds the table. You might feel a bit confined by the ring you have to lie in when the pictures are being taken.

Magnetic Resonance Imaging (MRI) Scan

MRI scans are very helpful in looking at the brain and spinal cord. MRI scans use radio waves and strong magnets instead of x-rays. The energy from the radio waves is absorbed by

the body and then released in a pattern formed by the type of body tissue and by certain diseases. A computer translates the pattern into a very detailed image of parts of the body. Not only does this create images of cross-sectional slices of the body like a CT scanner, it can also produce images of slices that are parallel with the length of your body. A contrast material might be injected, just as with CT scans, but this is done less often.

MRI scans take longer than CT scans -- often up to an hour. You may have to lie inside a narrow tube, which is confining and can upset people with a fear of enclosed spaces. Newer, "open" MRI machines can help with this if needed. The MRI machine makes loud buzzing noises that you may find disturbing. Some places provide headphones to block this out.

Ultrasound

Ultrasound uses sound waves and their echoes to produce a picture of internal organs or masses. For this test a small, microphone-like instrument called a transducer is placed on the skin (which is first lubricated with oil). It gives off sound waves and picks up the echoes as they bounce off the organs. The echoes are converted by a computer into an image that is displayed on a computer screen.

Abdominal ultrasound can look for enlarged organs inside your abdomen.

This is an easy test to have done, and it uses no radiation. You simply lie on a table, and a technician moves the transducer over the part of your body being looked at.

Chest x-ray

A plain x-ray of your chest can be done in most outpatient settings. In patients with CML, it isn't needed for a diagnosis, but it may be used to see if you have normal lungs or if you have an infection.

How Is Chronic Myeloid Leukemia Staged?

For most cancers, staging is the process of finding out how far the cancer has spread. Most types of cancer are given stages of I, II, III, or IV, based on the size of the tumor and how far from the original site in the body the cancer has spread. Stages are useful because they can help guide your treatment. They also help determine your prognosis (outlook for chances of survival).

Chronic myeloid leukemia (CML), on the other hand, does not usually form a tumor. It generally involves all of the bone marrow in the body and, in many cases, has spread to other organs such as the spleen at the time it is diagnosed. Therefore the outlook for the patient

with CML depends on other information, such as the cellular features as determined by lab tests and the results of any imaging tests.

Phases of Chronic Myeloid Leukemia

CML is divided into 3 groups. For this type of leukemia, doctors call these groups phases instead of stages. The phases are based mainly on the number of immature white blood cells - myeloblasts ("blasts") - that are seen in the blood or bone marrow. Different groups of experts have suggested slightly different cutoffs to define the phases, but a common system (proposed by the World Health Organization) is described below.

Chronic Phase

Patients in this phase typically have fewer than 10% blasts in their blood or bone marrow samples. These patients usually have fairly mild symptoms (if any) and usually respond to standard treatments.

Accelerated Phase

The standard definition of this phase is that bone marrow or blood samples have more than 10% but fewer than 20% blasts. These patients may have fever, poor appetite, and weight loss. Symptoms and blood counts are not as responsive to treatments as they are during the chronic phase. The leukemia cells often have developed new chromosome changes, aside from the Philadelphia chromosome.

Blast Phase (also called acute phase or blast crisis)

Bone marrow and/or blood samples from a patient in this phase have more than 20% blasts. The blast cells often spread to tissues and organs beyond the bone marrow. These patients often have fever, poor appetite, and weight loss. At this point the CML acts more like an aggressive acute leukemia.

Not all doctors may agree with or follow these cutoff points for the different phases. If you have questions about what phase your CML is in, be sure to have your doctor explain it to you.

Prognostic Factors for Chronic Myeloid Leukemia

Along with the phase of CML, there are other factors that may help predict outlook for survival. These factors are sometimes used along with staging information when deciding

among treatment options. Factors that tend to be linked with shorter survival time are called *adverse prognostic factors*.

Adverse prognostic factors:

- accelerated phase or blast phase
- enlarged spleen
- areas of bone damage due to growth of leukemia
- increased number of basophils and eosinophils (types of granulocytes) in blood samples
- very high or very low platelet counts
- age 60 years or older
- multiple chromosome changes

Many of these factors are taken into account in the *Sokal system*, which develops a score used to help predict prognosis. It takes into account the person's age, the percentage of blasts in the blood, the size of the spleen, and the number of platelets. These factors are used to divide patients into low-, intermediate-, or high-risk groups. Another system, called the *Euro score*, includes the above factors, as well as the number of blood basophils and eosinophils. Having more of these cells indicates a poorer outlook.

The Sokal and Euro models have been used in the past, but it's not clear how useful they are at this time in helping to predict a person's outlook. Newer drugs like imatinib (Gleevec) and dasatinib (Sprycel) have changed the treatment of CML dramatically in recent years. These models haven't been tested in people who are being treated with these drugs.

Survival Rates for Chronic Myeloid Leukemia

New, highly effective drugs to treat most cases of CML first became available in 2001. There is no accurate information yet on how long patients treated with these drugs may live. All that is known is that most patients who have been treated with these drugs, starting in 2001 (or even before), are still alive.

One large study of patients with CML treated with imatinib (Gleevec) found that about 90% of patients were still alive 5 years after starting treatment. Most of these patients had no detectable evidence of leukemia at 5 years, although it's not yet clear if they have been cured. Longer follow-up is still needed.

How Is Chronic 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 him or her questions about your treatment options.

This section starts with general comments about types of treatments used for chronic myeloid leukemia (CML). This is followed by a discussion of treatment options based on the phase of CML.

Targeted Therapies

In recent years, new drugs that target specific parts of cancer cells have become the standard treatment option for many people with early stage CML. Because these drugs are less likely to affect normal cells, their side effects are generally not as severe as those seen with standard chemotherapy drugs or with interferon (described below). These drugs seem to work best on CML that is still in the chronic phase, although they may also help people with more advanced disease.

Imatinib (Gleevec)

Imatinib is a drug that specifically targets the BCR-ABL protein, which almost all CML cells have as a result of chromosome changes (see "Do We Know What Causes Chronic Myeloid Leukemia?"). BCR-ABL is a type of protein known as a tyrosine kinase, so imatinib is a tyrosine kinase inhibitor (TKI).

Almost all patients respond to treatment with imatinib, and most of these responses seem to last for many years. But it is not yet clear if this drug can cure CML, and at this time doctors recommend that patients take it indefinitely. Imatinib is taken by mouth as a pill with food, usually once a day.

The possible side effects of imatinib are usually less severe than those seen with standard chemotherapy drugs or with interferon (described below). But side effects can be more serious at higher doses of the drug.

Common side effects can include diarrhea, nausea, muscle pain, and fatigue. These are generally mild. Itchy skin rashes occur in about 30% of people on the drug. Most of these symptoms can be treated effectively, if needed.

Another common side effect is fluid buildup around the eyes, feet, or abdomen. In rare cases the fluid may collect in the lungs or around the heart, which can cause trouble with breathing. Some recent studies have suggested that some of this fluid buildup may be caused by effects of the drug on the heart. It's not yet clear how serious this is or if it might go away if

treatment is stopped. If you are taking this drug, tell your doctor right away if you notice sudden weight gain, trouble breathing, or fluid buildup anywhere in the body.

Another possible side effect is a drop in a person's white blood cell and platelet counts at the beginning of treatment. This happens because the blood-forming cells that are making these are part of the malignant process. Over time, normal blood-forming cells take over and the blood counts rise back to normal. Your doctor may advise stopping the drug for a short period if your blood counts get too low.

Dasatinib (Sprycel)

Dasatinib is another tyrosine kinase inhibitor that targets the BCR-ABL protein. As with imatinib, this drug is taken by mouth as a pill.

This drug appears to be more potent than imatinib, but its place in therapy has not yet been established. Clinical trials are now under way to help figure this out. At this time, dasatinib is used mainly for people who can't take imatinib or whose CML no longer responds to it.

The possible side effects of dasatinib seem to be similar to those for imatinib, including fluid buildup (which may be related to heart function), lowered blood cell counts, nausea, diarrhea, and skin rashes.

Nilotinib (Tasigna)

A third tyrosine kinase inhibitor, known as nilotinib, also targets the BCR-ABL protein. While it also appears to be more potent than imatinib, at this time it is used mainly for people who can't take imatinib or whose CML no longer responds to it.

The main possible side effects of nilotinib seem to be similar to those of the other drugs, including fluid buildup (which may be related to heart function), lowered blood cell counts, nausea, diarrhea, and skin rashes. This drug can also affect the rhythm of the heart, which in rare cases can be serious.

Interferon Therapy

Interferons are a family of substances naturally made by several types of immune system cells. Interferon-alpha is the type most often used in treating CML. This substance reduces the growth and division of leukemia cells. It is often used along with the chemotherapy drug cytarabine (Ara-C). At one time, this was the favored treatment for CML.

Daily injection under the skin is the most common treatment plan. It may also be injected into a muscle or vein.

Interferon can cause significant side effects. These include muscle aches, bone pain, headaches, problems with thinking and concentration, fatigue, nausea, and vomiting. It can also lower blood cell counts. These effects are usually short-term and improve once treatment is done. Still, some patients find it hard to deal with these side effects on a daily basis and may need to stop treatment because of them.

Chemotherapy

Chemotherapy is the use of anti-cancer drugs that are injected into a vein or taken by mouth. These drugs enter the bloodstream and reach all areas of the body, making this type of treatment useful for cancers such as leukemia that spread throughout the body.

Chemotherapy was once the main treatment for patients with CML. Its main role at this time is as part of the treatment during a stem cell transplant. It may also be used by itself later in the course of disease if other treatments have stopped working.

The chemotherapy drug used most often is hydroxyurea (Hydrea), which can be helpful in lowering very high white blood cell counts and in shrinking an enlarged spleen. Other drugs sometimes used include cytarabine (Ara-C), busulfan, cyclophosphamide, and vincristine.

Side Effects of Chemotherapy

Chemotherapy drugs work by attacking 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 also likely to be affected by chemotherapy, which can lead to side effects.

Possible side effects depend on the type and dose of drugs given and the length of time they are taken. They may include the following:

- hair loss
- mouth sores
- loss of appetite
- nausea, and vomiting
- increased risk of infection (due to low white blood cell counts)
- easy bruising or bleeding (due to low blood platelet counts)
- fatigue (due to low red blood cell counts)

These side effects are usually short-term and go away once treatment is finished.

Be sure to talk with your cancer care team about any side effects you have because there are often ways to lessen them. For example, drugs can be given to prevent or reduce nausea and vomiting.

Drugs known as growth factors (G-CSF and GM-CSF, for example) are sometimes given to increase the white blood cell counts and thus reduce the chance of infection. If your white blood counts are very low during treatment, you can reduce your risk of infection by avoiding exposure to germs. During this time, your doctor may advise that you:

- 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 offers some protection in these situations).

Antibiotics may also be given before there are signs of infection or at the earliest sign that an infection may be developing.

If platelet counts are low, you may be given drugs or platelet transfusions to help protect against bleeding. Likewise, shortness of breath and extreme fatigue caused by low red blood cell counts may be treated with drugs or with red blood cell transfusions.

Radiation Therapy

Radiation therapy is treatment with high-energy rays or particles to destroy cancer cells. Radiation therapy is usually not part of the main treatment for patients with CML, but it is used in certain situations.

Patients may have symptoms if swollen internal organs (such as an enlarged spleen) press on other organs. For instance, pressure against the stomach may affect appetite. If these symptoms are not helped by chemotherapy, radiation therapy to shrink the spleen may be an option.

Radiation therapy can also be useful in treating pain from bone damage caused by the growth of leukemia cells within the bone marrow.

Radiation therapy is sometimes given in low doses to the whole body, just before a stem cell transplant (see the section, "Bone Marrow or Peripheral Blood Stem Cell Transplant").

The main short-term side effects of radiation therapy depend on where the radiation is aimed. Sunburn-like skin changes in the treated area are possible. For radiation that includes large parts of the body, the effects may include fatigue and an increased risk of infection.

Surgery

Because leukemia cells spread so widely throughout the bone marrow and to many other organs, surgery cannot cure this type of cancer. Surgery rarely has any role even in the diagnosis of CML, since a bone marrow aspirate and biopsy are usually all that is needed.

Splenectomy (removal of the spleen) is sometimes done, but it is not expected to cure the leukemia.

Spread of leukemia to the spleen can lead to that organ becoming large enough to compress nearby organs and cause symptoms. If chemotherapy or radiation does not help shrink the spleen, splenectomy may be an option.

Splenectomy may also improve blood cell counts and lower the need for blood product transfusions. One of the spleen's normal functions is to remove worn-out blood cells from the bloodstream. If leukemia or other diseases cause the spleen to become too large, it may become too active in removing blood cells, leading to a shortage of red blood cells or platelets. Taking out the spleen may help prevent this.

Most people have no problem living without a spleen. The risk for certain bacterial infections is increased, which is why doctors often recommend certain vaccines for people who have had their spleen removed.

Bone Marrow or Peripheral Blood Stem Cell Transplant

The usual doses of chemotherapy drugs can cause serious side effects to quickly dividing tissues such as the bone marrow. Even though higher doses of these drugs might be more effective, they are not given because the severe damage to bone marrow cells would cause lethal shortages of blood cells and damage to vital organs.

A stem cell transplant (SCT) allows doctors to use higher doses of chemotherapy and, sometimes, radiation therapy. After treatment is finished, the patient receives a transplant of blood-forming stem cells to restore the bone marrow.

Blood-forming stem cells used for a transplant are obtained either from the blood (for a peripheral blood stem cell transplant, or PBSCT) or from the bone marrow (for a bone marrow transplant, or BMT). Bone marrow transplant was more common in the past, but it has largely been replaced by PBSCT.

Types of Transplants

There are 2 main types of stem cell transplants. They differ with regard to the source of the blood-forming stem cells. The two types are:

- allogeneic stem cell transplant
- autologous stem cell transplant

Allogeneic stem cell transplant: In this type of transplant, the stem cells come from someone else - usually a donor whose tissue type is almost identical to the patient's. Tissue type is based on certain substances present on the surface of cells in the body. These substances can cause the immune system to react against the cells. Therefore, the closer a tissue "match" is between the donor and the recipient, the better the chance the transplanted cells will "take" and begin making new blood cells.

The donor may be a brother or sister or, less often, a matched unrelated donor (MUD). The stem cells from an unrelated donor come from volunteers whose tissue type has been stored in a central list (registry) and matched with that of the patient. Sometimes umbilical cord stem cells are used. These stem cells come from blood drained from the umbilical cord and placenta after a baby is born and the umbilical cord is cut.

Allogeneic stem cell transplants are the main type of transplant done for patients with CML. They offer the best chance to cure the disease. They are often used in younger patients if a good tissue type match can be found. Patients over the age of 50-55 usually cannot tolerate them and will have a high chance of dying from the procedure. However, non-myeloablative SCT (see below) can be used in some older patients.

Autologous stem cell transplant: In an autologous stem cell transplant, a patient's own stem cells are removed from his or her bone marrow or peripheral blood. They are stored while the person gets treatment (high-dose chemotherapy and/or radiation) and then are reinfused into the patient's blood.

Autologous SCT is not used often in treating CML because some leukemia cells might be collected along with the stem cells and be given back to the patient after treatment. A process called "purging" can be used to try to remove the leukemia cells. There is another important reason to use stem cells from someone else for transplantation. These cells seem to help in fighting any remaining leukemia cells through an immune reaction. This is called a "graft-versus-leukemia" reaction.

The Transplant Procedure

Blood-forming stem cells from the bone marrow or peripheral blood are collected, frozen, and stored. The patient receives high-dose chemotherapy and sometimes also radiation treatment to the entire body. (Radiation shields are used to protect the lungs, heart, and kidneys from damage during radiation therapy.)

The chemotherapy and radiation treatments are meant to destroy any remaining cancer cells. They also kill the normal cells of the bone marrow and the immune system. This prevents the stem cell transplant (graft) from being rejected. After these treatments, the frozen stem cells are thawed and given 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.

In allogeneic SCTs, the person getting the transplant is given drugs such as prednisone and methotrexate or cyclosporine to help prevent graft-versus-host disease (see below). For the next few weeks the patient gets regular blood tests and supportive therapies as needed, which might include antibiotics, red blood cell or platelet transfusions, other medicines, and help with nutrition.

Usually within a couple of weeks after the stem cells have been infused, they begin making new white blood cells. This is followed by new platelet production and, several weeks later, new red blood cell production.

Patients usually stay in the hospital in protective isolation (guarding against exposure to germs) until their white blood cell count rises above 500. They may be able to leave the hospital when their white blood cell count is near 1,000. Because platelet counts take longer to return to a safe level, patients may receive platelet transfusions as an outpatient.

Practical Points

Bone marrow or peripheral blood SCT is a complex treatment. If the doctors think a patient may benefit from a transplant, it should be done at a hospital where the staff has experience with the procedure and with managing the recovery phase. Some bone marrow transplant programs may not have experience in certain types of transplants, especially transplants from unrelated donors.

SCT is very expensive (more than \$100,000) and often requires a lengthy hospital stay. Because some insurance companies may view it as an experimental treatment, they may not pay for the procedure. It is important to find out what your insurer will cover and what you might have to pay before deciding on a transplant,

In recent years, doctors have become less certain about when to use SCT for patients with CML. Imatinib (Gleevec) seems to be very effective against most cases of CML. In the past, this disease was almost always fatal within several years. This led doctors to recommend a transplant for anyone who could tolerate the procedure – usually anyone younger than 50 or 55. But doctors are now often taking a wait-and-see approach, because they aren't sure who will need a transplant or whether imatinib might cure patients. Fewer patients with CML are now being referred for transplants than before.

But so far, an allogeneic SCT offers the only proven chance to cure this disease, and many doctors still recommend a transplant for younger patients, particularly children and those

with readily available donor matches. Results seem to be best when the stem cell donor is a well-matched brother or sister. They are also better when the transplant is done earlier in the course of the disease.

Side Effects

Side effects from SCT are generally divided into early and long-term effects.

Early side effects: The early complications and side effects are basically the same as those caused by any other type of high-dose chemotherapy (see the Chemotherapy section of this document), and are due to damage to the bone marrow and other quickly dividing tissues of the body. They can include low blood cell counts (with increased risk of infection and bleeding), nausea, vomiting, loss of appetite, mouth sores, and hair loss.

One of the most common and serious short-term effects is the increased risk for infection from bacteria, viruses, or fungi. Antibiotics are often given to try to prevent this from happening. Other side effects, like low red blood cell and platelet counts, may require blood product transfusions or other treatments.

Long term side effects: Some complications and side effects can persist for a long time or may not occur until months or years after the transplant. These include:

- *Graft-versus-host disease* (GVHD), which can occur in allogeneic (donor) transplants. This happens when the donor immune system cells attack tissues of the patient's skin, liver, and digestive tract. Symptoms can include weakness, fatigue, dry mouth, rashes, nausea, diarrhea, yellowing of the skin and eyes (jaundice), and muscle aches. In severe cases, GVHD can be fatal. GVHD is often described as either acute or chronic, based on how soon after the transplant it begins. Drugs that weaken the immune system are often given to try to keep GVHD under control.
- Radiation damage to the lungs, causing shortness of breath
- Damage to the ovaries in women, causing infertility and loss of menstrual periods
- Damage to the thyroid gland that causes problems with metabolism
- Cataracts (damage to the lens of the eye that can affect vision)
- Bone damage called *aseptic necrosis* (the bone dies because of poor blood supply); if damage is severe, the patient will need to have part of the bone and the joint replaced.

Non-myeloablative Transplant (Mini-transplant)

Most patients over the age of 55 can't tolerate a standard allogeneic transplant that uses high doses of chemotherapy. Some may be able to have a non-myeloablative transplant (also known as a mini-transplant or reduced-intensity transplant), where they receive lower doses of chemotherapy and radiation that do not completely destroy the cells in their bone marrow. They then receive the allogeneic (donor) stem cells. These cells enter the body and establish

a new immune system, which sees the leukemia cells as foreign and attacks them (a "graft-versus-leukemia" effect).

Doctors have learned that if they use small doses of certain chemotherapy drugs and low doses of total body radiation, an allogeneic transplant can still work with much less toxicity. In fact, a patient can receive a non-myeloablative transplant as an outpatient. The major complication is graft-versus-host disease.

This procedure is still considered experimental, and studies are under way to determine how useful it may be against CML. For more information on stem cell transplants, see the American Cancer Society document, *Bone Marrow & Peripheral Blood Stem Cell Transplants*.

Clinical Trials

You 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 one way to get state-of-the-art cancer care. Still, they are not right for everyone.

Here we will give you a brief review of clinical trials. Talking to your health care team, your family, and your friends can help you make the best treatment choice for you.

What Are Clinical Trials?

Clinical trials are carefully controlled research studies that are done with patients. These studies test whether a new treatment is safe and how well it works in patients, or they may test new ways to diagnose or prevent a disease. Clinical trials have led to many advances in cancer prevention, diagnosis, and treatment.

The Purpose of Clinical Trials

Clinical trials are done to get a closer look at promising new treatments or procedures in patients. A clinical trial is only done when there is good reason to believe that the treatment, test, or procedure being studied may be better than the one used now. Treatments used in clinical trials are often found to have real benefits and may go on to become tomorrow's standard treatment.

Clinical trials can focus on many things, such as:

- new uses of drugs that are already approved by the US Food and Drug Administration (FDA)

- new drugs that have not yet been approved by the FDA
- non-drug treatments (such as radiation therapy)
- medical procedures (such as types of surgery)
- herbs and vitamins
- tools to improve the ways medicines or diagnostic tests are used
- medicines or procedures to relieve symptoms or improve comfort
- combinations of treatments and procedures

Researchers conduct studies of new treatments to try to answer the following questions:

- Is the treatment helpful?
- What's the best way to give it?
- Does it work better than other treatments already available?
- What side effects does the treatment cause?
- Are there more or fewer side effects than the standard treatment used now?
- Do the benefits outweigh the side effects?
- In which patients is the treatment most likely to be helpful?

Phases of Clinical Trials

There are 4 phases of clinical trials, which are numbered I, II, III, and IV. We will use the example of testing a new cancer treatment drug to look at what each phase is like.

Phase I clinical trials: The purpose of a phase I study is to find the best way to give a new treatment safely to patients. The cancer care team closely watches patients for any harmful side effects.

For phase I studies, the drug has already been tested in lab and animal studies, but the side effects in patients are not fully known. Doctors start by giving very low doses of the drug to the first patients and increase the doses for later groups of patients until side effects appear or the desired effect is seen. Doctors are hoping to help patients, but the main purpose of a phase I trial is to test the safety of the drug.

Phase I clinical trials are often done in small groups of people with different cancers that have not responded to standard treatment, or that keep coming back (recurring) after treatment. If a drug is found to be reasonably safe in phase I studies, it can be tested in a phase II clinical trial.

Phase II clinical trials: These studies are designed to see if the drug works. Patients are given the best dose as determined from phase I studies. They are closely watched for an effect on the cancer. The cancer care team also looks for side effects.

Phase II trials are often done in larger groups of patients with a specific cancer type that has not responded to standard treatment. If a drug is found to be effective in phase II studies, it can be tested in a phase III clinical trial.

Phase III clinical trials: Phase III studies involve large numbers of patients -- most often those who have just been diagnosed with a specific type of cancer. Phase III clinical trials may enroll thousands of patients.

Often, these studies are randomized. This means that patients are randomly put in one of two (or more) groups. One group (called the control group) gets the standard, most accepted treatment. Another group (or more than one group) will get the new treatment being studied. All patients in phase III studies are closely watched. The study will be stopped early if the side effects of the new treatment are too severe or if one group has much better results than the others.

Phase III clinical trials are usually needed before the FDA will approve a treatment for use by the general public.

Phase IV clinical trials: Once a drug has been approved by the FDA and is available for all patients, it is still studied in other clinical trials (sometimes referred to as phase IV studies). This way more can be learned about short-term and long-term side effects and safety as the drug is used in larger numbers of patients with many types of diseases. Doctors can also learn more about how well the drug works, and if it might be helpful when used in other ways (such as in combination with other treatments).

What It Will Be Like to Be in a Clinical Trial

If you are in a clinical trial, you will have a team of experts taking care of you and watching your progress very carefully. Depending on the phase of the clinical trial, you may receive more attention (such as having more doctor visits and lab tests) than you would if you were treated outside of a clinical trial. Clinical trials are specially designed to pay close attention to you.

However, there are some risks. No one involved in the study knows in advance whether the treatment will work or exactly what side effects will occur. That is what the study is designed to find out. While most side effects go away in time, some may be long-lasting or even life threatening. Keep in mind, though, that even standard treatments have side effects. Depending on many factors, you may decide to enter (enroll in) a clinical trial.

Deciding to Enter a Clinical Trial

If you would like to take part in a clinical trial, you should begin by asking your doctor if your clinic or hospital conducts clinical trials. There are requirements you must meet to take part in any clinical trial. But whether or not you enter (enroll in) a clinical trial is completely up to you.

Your doctors and nurses will explain the study to you in detail. They will go over the possible risks and benefits and give you a form to read and sign. The form says that you understand the clinical trial and want to take part in it. This process is known as giving your informed consent. Even after reading and signing the form and after the clinical trial begins, you are free to leave the study at any time, for any reason. Taking part in a clinical trial does not keep you from getting any other medical care you may need.

To find out more about clinical trials, talk to your cancer care team. Here are some questions you might ask:

- Is there a clinical trial that I could take part in?
- What is the purpose of the study?
- What kinds of tests and treatments does the study involve?
- What does this treatment do? Has it been used before?
- Will I know which treatment I receive?
- What is likely to happen in my case with, or without, this new treatment?
- What are my other choices and their pros and cons?
- How could the study affect my daily life?
- What side effects can I expect from the study? Can the side effects be controlled?
- Will I have to stay in the hospital? If so, how often and for how long?
- Will the study cost me anything? Will any of the treatment be free?
- If I am harmed as a result of the research, what treatment would I be entitled to?
- What type of long-term follow-up care is part of the study?
- Has the treatment been used to treat other types of cancers?

How Can I Find Out More About Clinical Trials That Might Be Right for Me?

The American Cancer Society offers a clinical trials matching service for patients, their family, and friends. You can reach this service at 1-800-303-5691 or on our Web site at <http://clinicaltrials.cancer.org>.

Based on the information you give about your cancer type, stage, and previous treatments, this service can put together a list of clinical trials that match your medical needs. The service will also ask where you live and whether you are willing to travel so that it can look for a treatment center that you can get to.

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.

For even more information on clinical trials, the American Cancer Society has a document called *Clinical Trials: What You Need to Know*. You can read this on the Web site, www.cancer.org, or have it sent to you by calling 1-800-ACS-2345.

Complementary and Alternative Therapies

When you have cancer you are likely to hear about ways to treat your cancer or relieve symptoms that are different from mainstream (standard) medical treatment. These methods can include vitamins, herbs, and special diets, or methods such as acupuncture or massage—among many others. You may have a lot of questions about these treatments. Here are some you may have thought of already:

- How do I know if a non-standard treatment is safe?
- How do I know if it works?
- Should I try one or more of these treatments?
- What does my doctor know/think about these methods? Should I tell the doctor that I'm thinking about trying them?
- Will these treatments cause a problem with my standard medical treatment?
- What is the difference between "complementary" and "alternative" methods?
- Where can I find out more about these treatments?

The Terms Can Be Confusing

Not everyone uses these terms the same way, so it can be confusing. The American Cancer Society uses *complementary* to refer to medicines or methods that are used *along with* your regular medical care. *Alternative* medicine is a treatment used *instead of* standard medical treatment.

Complementary methods: Complementary treatment methods, for the most part, are not presented as cures for cancer. Most often they are used to help you feel better. Some methods that can be used in a complementary way are meditation to reduce stress, acupuncture to relieve pain or peppermint tea to relieve nausea. There are many others. Some of these methods are known to help, while others have not been tested. Some have been proven not to be helpful. A few have even been found harmful. However, some of these methods may add to your comfort and well-being.

There are many complementary methods that you can safely use right along with your medical treatment to help relieve symptoms or side effects, to ease pain, and to help you enjoy life more. For example, some people find methods such as aromatherapy, massage therapy, meditation, or yoga to be useful.

Alternative treatments: Alternative treatments are those that are used instead of standard medical care. These treatments have not been proven safe and effective in clinical trials. Some of these methods may even be dangerous and some have life-threatening side effects. The biggest danger in most cases is that you may lose the chance to benefit from standard treatment. Delays or interruptions in your standard medical treatment may give the cancer more time to grow.

Deciding What to Do

It is easy to see why people with cancer may consider alternative methods. You want to do all you can to fight the cancer. Sometimes mainstream treatments such as chemotherapy can be hard to take, or they may no longer be working.

Sometimes people suggest that their method can cure your cancer without having serious side effects, and it's normal to want to believe them. But the truth is that most non-standard methods of treatment have not been tested and proven to be effective for treating cancer.

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

- Talk to your doctor or nurse about any method you are thinking about using.
- Check the list of "red flags" below.
- Contact the American Cancer Society at 1-800-ACS-2345 to learn more about complementary and alternative methods in general and to learn more about the specific methods you are thinking about.

Red Flags

You can use the questions below to spot treatments or methods to avoid. A "yes" answer to any one of these questions should raise a "red flag."

- Does the treatment promise a cure for all or most cancers?
- Are you told not to use standard medical treatment?
- Is the treatment or drug a "secret" that only certain people can give?
- Does the treatment require you to travel to another country?
- Do the promoters attack the medical or scientific community?

The Decision Is Yours

Decisions about how to treat or manage your cancer are always yours to make. If you are thinking about using a complementary or alternative method, be sure to learn about the method and talk to your doctor about it. With reliable 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.

Treatment of Chronic Myeloid Leukemia by Phase

Treatment options for people with CML depend on the phase of their disease (chronic, accelerated, or blast phase), their age, other prognostic factors, and the availability of a stem cell donor with matching tissue type.

Chronic Phase

The main options for primary treatment of chronic phase CML are imatinib (Gleevec) or an allogeneic stem cell transplant (SCT).

A stem cell transplant is the only treatment proven to cure CML. But it doesn't work in all cases, and this treatment does have some potential drawbacks. First, it requires that a well-matched tissue donor be available (preferably a brother or sister with the same tissue type). It also involves the use of high-dose chemotherapy and often radiation, which can cause severe side effects and can even be fatal. Because of this, some doctors consider only patients younger than a certain age for SCT, such as under age 60, 55, or even under age 50. For older patients, a non-myeloablative transplant may be an option, although it's not clear how effective this is. Stem cell transplants seem to work best early in the course of the disease.

Most people, including some who might be eligible for a SCT, are now getting imatinib at a starting dose of 400 mg per day as their first-line treatment. The vast majority of people are helped by this drug.

Doctors look for different kinds of responses to imatinib (or other drugs):

Hematologic Response (usually happens within the first 3 months of treatment)

- A *complete* hematologic response occurs when blood cell counts return to normal, there are no immature cells seen in the blood, and the spleen has returned to normal size.
- A *partial* hematologic response is similar to this, but not all of the above conditions are met.

Cytogenetic Response (may take several months or longer)

- A *complete* cytogenetic response occurs when no cells with the Philadelphia chromosome can be found in the blood or bone marrow.
- A *partial* cytogenetic response occurs when less than 35% of cells still have Philadelphia chromosome.
- (The term "*major* cytogenetic response" is sometimes used to denote either a complete or a partial response.)
- A *minor* cytogenetic response occurs when 35% to 90% of cells still have Philadelphia chromosome.

Monitoring the patient's blood and bone marrow for a response is a very important part of treatment. It is usually done every 3 to 6 months for the first 2 years after starting imatinib. Blood counts are watched closely, and the blood and bone marrow are looked at for the presence of the Philadelphia chromosome. If the Philadelphia chromosome isn't found, the polymerase chain reaction (PCR) test, which is very sensitive, may be used to see if small amounts of *bcr-abl* are still present.

About 90% of people have a complete cytogenetic response within 5 years of starting imatinib. But it's still not clear if these people are being cured. For now, doctors recommend that people stay on the drug indefinitely.

Second-line treatment: Not all people with chronic phase CML have complete, long-term responses to imatinib. For people who don't achieve a complete cytogenetic response or whose leukemia recurs while taking imatinib, there are several options.

- Increasing the dose of imatinib helps some people, although it also usually increases the side effects.
- Dasatinib (Sprycel) and nilotinib (Tasigna) are similar drugs that help many people for whom imatinib is not working.
- For those who can't take these drugs or for whom they are not working, interferon or chemotherapy may be an option.
- Stem cell transplant may be an option, especially for younger people who have a donor with a matching tissue type.

Some people who have a stem cell transplant as first-line treatment may not achieve a complete response. If they *do not* have graft-versus-host disease (GVHD), doctors may try to get their new immune system to fight the leukemia. One way to do this is by slowly lowering the doses or stopping the immune suppressing drugs they are on. Patients are watched closely during this time. Another approach that helps some patients is a donor lymphocyte infusion (DLI), where the patient receives an infusion of lymphocytes taken from the person who donated the stem cells for the transplant. Imatinib and interferon are other options that may be helpful.

In patients who *do* have GVHD after a stem cell transplant, imatinib is usually recommended as second-line treatment.

Accelerated Phase

During the accelerated phase, leukemia cells begin to build up in the body more quickly, which causes symptoms. The leukemia cells often acquire new gene mutations, which help them grow and tend to make treatments less effective.

The treatment options for accelerated phase CML depend on whether or not a patient was treated before, and if so, what treatment(s) they had. In general, the options are similar to

those for patients with chronic phase CML, but patients with accelerated phase CML are less likely to have a long-term response with any treatment.

Imatinib (often at higher doses than used for chronic phase CML) is an option for most people. Although treatment with imatinib can lead to responses in most patients in this phase, the responses do not seem to last as long as they do in the chronic phase. Still, about half these patients are still alive after 4 years. The newer targeted drugs like dasatinib and nilotinib seem to work better than imatinib in this phase, although this is still being studied. Interferon is another option, but it is also much less effective in this phase than in the chronic phase. About 20% of patients have some response to chemotherapy, but these responses are usually shorter than 6 months.

An allogeneic stem cell transplant may be the best option for most patients who are young enough to be eligible. About 20% to 40% of patients with accelerated phase CML are alive several years after a stem cell transplant. Most doctors prefer that the leukemia be controlled, preferably in remission, before beginning the transplant procedure. To achieve this, chemotherapy will often be used.

In some cases, an autologous SCT may be an option to try to get the CML back into the chronic phase, although it is very unlikely to result in a cure.

Blast Phase

In the blast phase of CML, the leukemia cells become more abnormal. The disease acts more like an acute leukemia, with blood counts getting higher and symptoms appearing or becoming more severe.

For people with blast phase CML who haven't had prior treatment, high-dose imatinib may be helpful, although it works in a smaller number of people and for shorter lengths of time than when used earlier in the course of the disease. The newer targeted agents dasatinib and nilotinib may prove to be better, but this is still under study. Patients who respond to these drugs may want to consider a stem cell transplant, if possible.

Most often, the leukemia cells act like cells of acute myeloid leukemia (AML), but they are often resistant to the chemotherapy drugs used to treat AML. Standard chemotherapy for AML (see our document *Acute Myeloid Leukemia*) will bring about a remission in about 1 out of 5 patients, but this is usually short-lived. If this does occur, it may be a chance to consider some sort of stem cell transplant.

A smaller number of patients have blast cells that act like cells of acute lymphoblastic leukemia (ALL). These cells are more sensitive to chemotherapy drugs. Remissions can be induced in about half of these patients with drugs such as vincristine, prednisone, and doxorubicin, along with imatinib, if that hasn't been given yet. These patients are at risk for spread to the central nervous system, so they often get chemotherapy (cytarabine (Ara-C) or

methotrexate) infused into the spinal fluid. Radiation therapy to the brain is another option but is used less often.

Allogeneic SCT is less successful for blast phase CML than for earlier phases, and the long-term survival rate is less than 10%. Still, it is the only known option that may cure the disease. It is more likely to be effective if the CML can be brought back to the chronic phase before the transplant.

Because most patients with blast phase CML can't be cured, palliative treatment (intended to relieve symptoms rather than cure the disease) is important. Radiation therapy can help shrink an enlarged spleen or reduce pain from areas of bone damaged by leukemia. Chemotherapy (usually with drugs such as hydroxyurea) may relieve some symptoms for a time.

Clinical trials of new combinations of chemotherapy, targeted agents, and biologic therapies are important options.

More Treatment Information

For more details on treatment options -- including some that may not be addressed in this document -- the National Comprehensive Cancer Network (NCCN) and the National Cancer Institute (NCI) are good sources of information.

The NCCN, made up of experts from many of the nation's leading cancer centers, develops cancer treatment guidelines for doctors to use when treating patients. Those are available on the NCCN Web site (www.nccn.org).

The NCI provides treatment guidelines via its telephone information center (1-800-4-CANCER) and its Web site (www.cancer.gov). Detailed guidelines intended for use by cancer care professionals are also available on www.cancer.gov.

What Should You Ask Your Doctor About Chronic Myeloid Leukemia?

As you cope with cancer and cancer treatment, you need to have honest, open discussions with your doctor. You should 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. Nurses, social workers, and other members of the treatment team may also be able to answer many of your questions.

- What phase is my chronic myelogenous leukemia in?
- What treatment choices do I have?

- Should I consider a stem cell transplant at this time?
- Which treatment do you recommend, and why?
- What side effects are there to the treatments that you recommend?
- What can I do to be ready for treatment?
- What are the chances that my leukemia will come back once I am in remission?

Be sure to write down any questions that occur to you that are not on this list. For instance, you might want information about recovery times so that you can plan your work schedule. Or you may want to ask about second opinions or about clinical trials for which you may qualify.

Taking another person and/or a tape recorder to the appointment may be helpful. Getting copies of your medical records, including pathology and radiology reports, may be useful in case you wish to seek a second opinion at a later time.

What Happens After Treatment for Chronic Myeloid Leukemia?

Completing treatment can be both stressful and exciting. You will be relieved to finish treatment, yet it is hard not to worry about cancer coming back. (When cancer returns, it is called recurrence.) This is a very common concern among those who have had cancer.

It may take a while before your confidence in your own 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 possibility of cancer coming back in the American Cancer Society document, *Living with Uncertainty: The Fear of Cancer Recurrence*, available at 1-800-ACS-2345.

Most people being treated for chronic myeloid leukemia (CML) will likely be treated indefinitely, as it's not yet clear whether the newer targeted drugs like imatinib (Gleevec) can cure this disease. Still, people getting long-term treatment may have questions or concerns, even if there are no signs of the cancer still being present.

Follow-up Care

You will likely need frequent follow-up exams for many years after treatment, even if there are no signs of the disease. These follow-up visits are very important. Your doctors will continue to watch for signs of recurrent disease, as well as for short-term and long-term side effects of treatment. It is important that you report any new symptoms to the doctor right away so that relapse or side effects can be treated.

Checkups will likely include careful physical exams, blood tests, and bone marrow aspirations and biopsies when needed. A benefit of follow-up care is that it gives you a chance to discuss questions and concerns that can arise during and after your recovery.

It is also important to keep medical insurance. Even though no one wants to think of their cancer coming back, it is always a possibility. If it happens, the last thing you want is to have to worry about paying for treatment. Should your cancer come back the American Cancer Society document, *When Your Cancer Comes Back: Cancer Recurrence* gives you information on how to manage and cope with this phase of your treatment. You can get this document by calling 1-800-ACS-2345.

Seeing a New Doctor

At some point after your cancer diagnosis and treatment, you may find yourself in the office of a new doctor. Your original doctor may have moved or retired, or you may have moved or changed doctors for some reason. It is important that you be able to give your new doctor the exact details of your diagnosis and treatment. Make sure you have the following information handy:

- a copy of your pathology report from any biopsy or surgery
- if you had surgery, a copy of your operative report
- if you were hospitalized, a copy of the discharge summary that every doctor must prepare when patients are sent home from the hospital
- finally, since some drugs can have long-term side effects, a list of your drugs, drug doses, and when you took them

Lifestyle Changes to Consider During and After Treatment

Having cancer and dealing with treatment can be time-consuming and emotionally draining, 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. Some people even begin this process during cancer treatment.

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, or ate more than you needed, or smoked, or didn't exercise very often. Emotionally, maybe you kept your feelings bottled up, or maybe you let stressful situations go on too long.

Now is not the time to feel guilty or to blame yourself. However, 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. What better time than now to take advantage of the motivation you have as a result of going through a life-changing experience like having cancer?

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

Diet and Nutrition

Eating right can be a challenge for anyone, but it can get even tougher during and after cancer treatment. For instance, treatment often may change your sense of taste. Nausea can be a problem. You may lose your appetite for a while and lose weight when you don't want to. On the other hand, some people gain weight even without eating more. This can be frustrating, too.

If you are losing weight or have taste problems during treatment, do the best you can with eating and remember that these problems usually improve over time. You may want to ask your cancer team for a referral to a dietitian, an expert in nutrition who can give you ideas on how to fight some of the side effects of your treatment. You may also find it helps to eat small portions every 2 to 3 hours until you feel better and can go back to a more normal schedule.

One of the best things you can do after treatment is to put healthy eating habits into place. You will be surprised at the long-term benefits of some simple changes, like increasing the variety of healthy foods you eat. Try to eat 5 or more servings of vegetables and fruits each day. Choose whole grain foods instead of white flour and sugars. Try to limit meats that are high in fat. Cut back on processed meats like hot dogs, bologna, and bacon. Get rid of them altogether if you can. If you drink alcohol, limit yourself to 1 or 2 drinks a day at the most. And don't forget to get some type of regular exercise. The combination of a good diet and regular exercise will help you maintain a healthy weight and keep you feeling more energetic.

Rest, Fatigue, Work, and Exercise

Fatigue is a very common symptom in people being treated for cancer. This is often not an ordinary type of tiredness but a "bone-weary" exhaustion that doesn't get better with rest. For some, this fatigue lasts a long time after treatment, and can discourage them from physical activity.

However, exercise can actually help you reduce fatigue. Studies have shown that patients who follow an exercise program tailored to their personal needs feel physically and emotionally improved and can cope better.

If you are ill and need to be on bed rest during treatment, it is normal to expect your fitness, endurance, and muscle strength to decline some. Physical therapy can help you maintain

strength and range of motion in your muscles, which can help fight fatigue and the sense of depression that sometimes comes with feeling so tired.

Any program of physical activity should fit your own situation. An older person who has never exercised will not be able to take on the same amount of exercise as a 20-year-old who plays tennis 3 times a week. If you haven't exercised in a few years but can still get around, you may want to think about taking short walks.

Talk with your health care team before starting, and get their opinion about your exercise plans. Then, try to get an exercise buddy so that 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 okay to rest when you need to. It is really hard for some people to allow themselves to do that when they are used to working all day or taking care of a household. (For more information about fatigue, please see the publication, "Cancer Related Fatigue and Anemia Treatment Guidelines for Patients.")

Exercise can improve your physical and emotional health.

- It improves your cardiovascular (heart and circulation) fitness.
- It strengthens your muscles.
- It reduces fatigue.
- It lowers anxiety and depression.
- It makes you feel generally happier.
- It helps you feel better about yourself.

And long term, we know that exercise plays a role in preventing some cancers. The American Cancer Society, in its guidelines on physical activity for cancer prevention, recommends that adults take part in at least 1 physical activity for 30 minutes or more on 5 days or more of the week. Children and teens are encouraged to try for at least 60 minutes a day of energetic physical activity on at least 5 days a week.

How About Your Emotional Health?

Once your treatment ends, you may find yourself overwhelmed by emotions. This happens to a lot of people. You may have been going through so much during treatment that you could only focus on getting through your treatment.

Now you may find that you think about the potential of your own death, or the effect of your cancer on your family, friends, and career. You may also begin to re-evaluate your relationship with your spouse or partner. Unexpected issues may also cause concern -- for

instance, as you become healthier and have fewer doctor visits, you will see your health care team less often. That can be a source of anxiety for some.

This is an ideal time to seek out emotional and social support. You need people you can turn to for strength and comfort. Support can come in many forms: family, friends, cancer support groups, church or spiritual groups, online support communities, or individual counselors.

Almost everyone who has been through cancer can benefit from getting some type of support. What's best for you depends on your situation and personality. Some people feel safe in peer-support groups or education groups. Others would rather talk in an informal setting, such as church. Others may feel more at ease talking one-on-one with a trusted friend or counselor. Whatever your source of strength or comfort, make sure you have a place to go with your concerns.

The cancer journey can feel very lonely. It is not necessary or realistic to go it all by yourself. And 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-ACS-2345 and we can put you in touch with an appropriate group or resource.

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 feeling as well as possible, physically and emotionally.

What Happens if Treatment Is No Longer Working?

If cancer continues to grow after one kind of treatment, or if it returns, it is often possible to try another treatment plan that might still cure the cancer, or at least control it enough to help you live longer and feel better. On the other hand, when a person has received several different medical treatments and the cancer has not been cured, over time the cancer tends to become resistant to all treatment. At this time it's important to weigh the possible limited benefit of a new treatment against the possible downsides, including continued doctor visits and treatment side effects.

Everyone has his or her own way of looking at this. Some people may want to try anything possible, while others focus on remaining comfortable during their limited time left.

This is likely to be the most difficult time in your battle with cancer -- when you have tried everything medically within reason and it's just not working anymore. Although your doctor may offer you new treatment, you need to consider that at some point, continuing treatment is not likely to improve your health or change your prognosis or survival.

If you want to continue treatment to fight your cancer as long as you can, you still need to consider the odds of more treatment having any benefit. In many cases, your doctor can

estimate the response rate for the treatment you are considering. Some people are tempted to try more chemotherapy or radiation, for example, even when their doctors say that the odds of benefit are less than 1%. In this situation, you need to think about and understand your reasons for choosing this plan.

No matter what you decide to do, it is important that you be as comfortable as possible. Make sure you are asking for and getting treatment for any symptoms you might have, such as pain. This type of treatment is called "palliative" treatment.

Palliative treatment helps relieve these symptoms, but is not expected to cure the disease; its main purpose is to improve your quality of life. Sometimes, the treatments you get to control your symptoms are similar to the treatments used to treat cancer. For example, radiation therapy might be given to help relieve bone pain from bone metastasis. Or chemotherapy might be given to help shrink a tumor and keep it from causing a bowel obstruction. But this is not the same as receiving treatment to try to cure the cancer.

At some point, you may benefit from hospice care. Most of the time, this can be given at home. Your cancer may be causing symptoms or problems that need attention, and hospice focuses on your comfort. You should know that receiving hospice care doesn't mean you can't have treatment for the problems caused by your cancer or other health conditions. It just means that the focus of your care is on living life as fully as possible and feeling as well as you can at this difficult stage of your cancer.

Remember also that maintaining hope is important. Your hope for a cure may not be as bright, but there is still hope for good times with family and friends -- times that can bring happiness and meaning. In a way, pausing at this time in your cancer treatment is an opportunity to refocus on the most important things in your life. This 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.

What's New in Chronic Myeloid Leukemia Research and Treatment?

There are many studies of chronic myeloid leukemia (CML) being done in labs and in clinical trials around the world.

Genetics of Chronic Myeloid Leukemia

Scientists are making great progress in understanding how changes in a person's DNA can cause normal bone marrow cells to develop into leukemia cells. Learning about changes in the genes (regions of the DNA) involved in CML is providing insight into why these cells grow too quickly, live too long, and fail to develop into normal blood cells. The explosion of knowledge in recent years is being used to develop many new drugs, as described below.

Sorting Out the Targeted Drugs

Imatinib has now been in use for several years and has been shown to be very effective, but other drugs (dasatinib and nilotinib) that target the BCR-ABL protein are more potent when tested in the lab. Studies are now under way to see if these drugs might be better as first-line treatment for CML, as opposed to using them only in cases where imatinib is no longer working.

Combining Imatinib (Gleevec) or Dasatinib (Sprycel) with Other Treatments

Imatinib and other drugs that target the BCR-ABL protein have proven to be very effective, but by themselves these drugs don't help everyone. Studies are now in progress to see if combining these drugs with other treatments, such as chemotherapy, interferon, or cancer vaccines (see below) might be better than either one alone. Studies are also looking at the role of these drugs with regard to stem cell transplants.

New Drugs for CML

Because the main cause of CML (the *bcr-abl* gene and its protein) is now known, researchers have been able to develop many new drugs that might work against it.

In some cases, CML cells develop a change in the *bcr-abl* oncogene known as a T315I mutation, which makes them resistant to current targeted therapies (imatinib, dasatinib, and nilotinib). Newer drugs that work against T315I mutant cells are now being tested. For instance, MK-0457 (VX-680) is an experimental drug known as an *aurora kinase inhibitor*. It has been shown to work against cells with this mutation in the lab and is now being studied in clinical trials. Another drug, adaphostin, has also shown promise in the lab against this and other mutations, but it has yet to enter clinical trials.

Other drugs called farnesyl transferase inhibitors, such as lonafarnib and tipifarnib, seem to have some activity against CML and may increase response rates when combined with imatinib. Further studies of these drugs are under way.

Cancer Vaccines

Because cancer cells are different from normal cells, it is sometimes possible to get the body to form an immune reaction against them. One way to do this is to use a cancer vaccine - a substance injected into the body that boosts the immune system and causes it to attack certain cells. Several vaccines are now being studied for use against CML. For instance, in one small

study, a vaccine called CMLVAX100 was given along with imatinib and seemed to increase its effectiveness. Further research into this and other vaccines is ongoing.

Additional Resources

More Information From Your American Cancer Society

The following information may also be helpful to you. These materials may be ordered from our toll-free number, 1-800-ACS-2345.

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

Bone Marrow & Peripheral Blood Stem Cell Transplants

Caring for the Patient With Cancer at Home (also available in Spanish)

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

The following books are available from the American Cancer Society. Call us at 1-800-ACS-2345 to ask about costs or to place your order.

American Cancer Society's Guide to Pain Control

Cancer in the Family: Helping Children Cope With a Parent's Illness

Caregiving: A Step-By-Step Resource for Caring for the Person With Cancer at Home

Coming to Terms With Cancer: A Glossary of Cancer-Related Terms

Consumers Guide to Cancer Drugs

Informed Decisions, Second Edition: The Complete Book of Cancer Diagnosis, Treatment, and Recovery

When the Focus Is on Care: Palliative Care and Cancer

National Organizations and Web Sites*

In addition to the American Cancer Society, other sources of patient information and support include:

Caitlin Raymond International Registry (for unrelated bone marrow transplants)
Telephone: 1-800-726-2824
Internet Address: www.crir.org

Leukemia & Lymphoma Society
Telephone: 1-800-955-4572
Internet Address: www.lls.org

Leukemia Links
Internet Address: www.acor.org/leukemia

National Bone Marrow Transplant Link (nbmtLINK)
Telephone: 1-800-LINK-BMT (1-800-546-5268)
Internet Address: www.nbmtlink.org

National Cancer Institute
Telephone 1-800-4-CANCER (1-800-422-6237)
Internet Address: www.cancer.gov

National Marrow Donor Program
Telephone: 1-800-MARROW2 (1-800-627-7692)
Internet Address: www.marrow.org

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

The American Cancer Society is happy to address almost any cancer-related topic. If you have any more questions, please call us at 1-800-ACS-2345 any day, 24 hours a day.

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