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 are brain and spinal cord tumors?

Brain tumors are masses of abnormal cells that have grown out of control. In most other parts of the body, it is very important to distinguish between benign (non-cancerous) tumors and malignant (cancerous) ones. Benign tumors in other parts of the body are almost never life threatening. The main reason cancers are so dangerous is because they can spread throughout the body.

Most brain cancers can spread through the brain tissue but rarely spread to other areas of the body. But even so-called "benign" tumors can, as they grow, compress normal brain tissue, causing damage that is often disabling and sometimes fatal. For this reason, doctors usually speak of "brain tumors" rather than "brain cancers." The major concern with brain tumors is how readily they spread through the rest of the central nervous system and whether they can be removed and not come back.

Brain and spinal cord tumors are different in adults and children. They often form in different areas, develop from different cell types, and may have a different outlook and treatment. *This document refers only to adult tumors. Brain and spinal cord tumors in children are discussed in a separate document.*

In order to understand brain and spinal cord tumors, it helps to know about the normal structure and function of the central nervous system.

The central nervous system

The central nervous system (CNS) is the medical name for the brain and spinal cord.

The brain is the center of thought, feeling, memory, speech, vision, hearing, movement, and much more. The spinal cord and special nerves in the head called cranial nerves help carry
messages between the brain and the rest of the body. These messages tell our muscles how to move, transmit information gathered by our senses, and help coordinate our internal organs.

The brain is located within and protected by the skull. Likewise, the spinal cord is protected by the bones (vertebrae) of the spinal column.

The brain and spinal cord are surrounded and cushioned by a special fluid, called cerebrospinal fluid (CSF). Cerebrospinal fluid is made by the choroid plexus, which is located in cavities within the brain called ventricles. The ventricles as well as the spaces around the brain and spinal cord are filled with CSF.

**Parts of the brain and spinal cord**
The main areas of the brain include the cerebrum, cerebellum, and brain stem. Each of these parts has a special function.

**Cerebrum:** The cerebrum is the large, outer part of the brain. It is made up of 2 hemispheres (halves) and controls reasoning, thought, emotion, and language. It is also responsible for planned muscle movements (throwing a ball, walking, chewing, etc.) and for taking in sensory information such as vision, hearing, smell, touch, and pain.

The symptoms caused by a tumor in a cerebral hemisphere depend on the part of the hemisphere in which the tumor arises. Common symptoms include:

- seizures
- trouble speaking
- a change of mood such as depression
- a change in personality
- weakness or paralysis of part of the body
- changes in vision, hearing, or other sensations

**Basal ganglia:** The basal ganglia are structures deeper within the brain that help control our muscle movements. Tumors or other problems in this part of the brain typically cause weakness, but in rare cases can cause tremor, chorea (involuntary jerky movements), or athetosis (involuntary slow movements).

**Cerebellum:** The cerebellum controls coordination of movement. Tumors of the cerebellum can cause problems with coordination in walking, trouble with fine movements of arms and legs, impairment of swallowing or synchronized eye movements, and changes in rhythm of speech.

**Brain stem:** The brain stem contains bundles of very long nerve fibers that carry signals controlling muscles and sensation or feeling between the cerebrum and the rest the body. In addition, most cranial nerves (which carry signals directly between the brain and the face, eyes, tongue, mouth, and some other areas) start in the brain stem. Special centers in the brain stem also control breathing and the beating of the heart.

Tumors in this critical area of the brain may cause weakness, stiff muscles, or problems with sensation, hearing, facial movement, or swallowing. Double vision is a common early symptom of brain stem tumors, as are problems with coordination in walking. Because tumors of the brain stem often intermingle with normal nerve cells and the brain stem is so essential for life, it may not be possible to surgically remove these tumors.

**Spinal cord:** The spinal cord, like the brain stem, contains bundles of very long nerve fibers that carry signals controlling muscles, sensation or feeling, and bladder and bowel control. Spinal cord tumors may cause weakness, paralysis, or numbness. Because the spinal cord is such a narrow structure, tumors arising within it usually cause symptoms involving both sides of the body (for example, weakness or numbness of both legs). This is different than
tumors of the brain, which usually affect only one side of the body. Moreover, most tumors
of the spinal cord arise below the neck after nerves to the arms have branched off the spinal
cord, so that only lower body functions -- bowel, bladder, or leg -- are affected.

**Cranial nerves:** Tumors may also arise from cranial nerves, which are nerves that extend
directly out of the base of the brain (as opposed to coming out of the spinal cord). Tumors
starting in cranial nerves may cause vision problems, trouble swallowing, hearing loss in one
or both ears, facial paralysis, or facial numbness or pain.

**Types of cells and body tissues in the brain and spinal cord**

The brain and spinal cord contain different kinds of tissues and cells, which can result in
different types of tumors. These tumors can have varying outlooks for survival and may be
treated differently.

**Neurons (nerve cells):** These are the most important cells within the brain. They send
signals through their nerve fibers (axons). Axons in the brain tend to be short, while those in
the spinal cord can be as long as several feet. Electric signals carried by neurons determine
thought, memory, emotion, speech, muscle movement, and just about everything else that the
brain and spinal cord do. Unlike many other types of cells that can grow and divide to repair
damage from injury or disease, neurons stop dividing about a year after birth (with a few
exceptions). Neurons do not usually form tumors, but they are often damaged by tumors that
start nearby.

**Glial cells:** Glial cells are the supporting cells of the brain. Most brain and spinal cord
tumors develop from glial cells. They are sometimes referred to as a group called *gliomas*.

There are 3 types of glial cells -- astrocytes, oligodendrocytes, and ependymal cells. A fourth
cell type called microglia is part of the immune system and is not truly glial in origin.

- **Astrocytes** help support and nourish neurons. When the brain is injured, astrocytes
  form scar tissue that helps repair the damage. The main tumors starting in these cells
  are called astrocytomas or glioblastomas.

- **Oligodendrocytes** make *myelin*, a substance that surrounds and insulates axons of the
  brain and spinal cord. This helps neurons transmit electric signals through axons.
  Tumors starting in these cells are called oligodendrogliomas.

- **Ependymal cells** line the ventricles (fluid-filled areas) within the central part of the
  brain and form part of the pathway through which cerebrospinal fluid travels. Tumors
  starting in these cells are called ependymomas.

- **Microglia** are the immune (infection fighting) cells of the central nervous system.
Neuroectodermal cells: These are primitive cells that are probably the remains of embryonic cells. They are found throughout the brain. The most common tumor that comes from these cells is the medulloblastoma, which arises in the cerebellum from forerunners of nerve cells called granule cells.

Meninges: These are tissues that line and protect the brain and spinal cord. The meninges help form the spaces through which CSF travels. The most common tumors that start in these cells are called meningiomas.

Choroid plexus: The choroid plexus is the area of the brain within the ventricles that makes CSF, which nourishes and protects the brain.

Pituitary gland and hypothalamus: The pituitary is a small gland found at the base of the brain. The hypothalamus is the part of the brain to which the pituitary gland is connected. Both help regulate the activity of several other glands. For example, they control the amount of thyroid hormone made by the thyroid gland, the production and release of milk by the breasts, and the amount of male or female hormones made by the testicles or ovaries. They also make growth hormone, which stimulates body growth, and vasopressin, which regulates water balance by the kidneys.

The growth of tumors in or near the pituitary or hypothalamus, as well as surgery and/or radiation therapy in this area, can interfere with these functions. Consequently, a person may have low levels of one or more hormones and may need hormone treatments to correct any hormone deficiency.

Pineal gland: The pineal gland is not strictly part of the brain. It is, in fact, an endocrine gland that sits between the cerebral hemispheres. Its main function is probably to make melatonin, a hormone that regulates sleep, in response to changes in light.

Blood-brain barrier: Unlike the case with most other organs, the small blood vessels (capillaries) in the brain and spinal cord have a very selective barrier between the blood and the tissues of the central nervous system. This normally keeps harmful toxins from getting into the brain. Unfortunately, it also keeps out most chemotherapy drugs that are used to kill cancer cells, which in some cases limits their usefulness.

Types of brain and spinal cord tumors

It's important to know the difference between tumors that start in the brain (primary brain tumors) and tumors that start in other organs, such as the lung or breast, and then spread to the brain (metastatic or secondary brain tumors). In adults, metastatic tumors to the brain are actually more common than primary brain tumors. These cancers are not treated the same way. For example, breast or lung cancers that spread to the brain are treated differently than
cancers that start in the brain. *This document is only about primary brain and spinal cord tumors not those that have spread from elsewhere in the body.*

Unlike other cancers, tumors arising within the brain or spinal cord rarely metastasize to distant organs. They cause damage because they spread locally and destroy normal brain tissue in the place where they arise. Still, tumors of the brain or spinal cord are rarely considered "benign" (non-cancerous). Unless they are completely removed or destroyed, most brain or spinal cord tumors will continue to grow and eventually lead to death.

Primary brain tumors can start in any of the different types of tissues or cells within the brain or spinal cord. Some tumors contain a mixture of cell types. Tumors in different areas of the central nervous system may be treated differently and have a different prognosis (outlook).

**Gliomas**

Gliomas are not a specific type of cancer. Glioma is a general term for a group of tumors that start in glial cells. A number of tumors can be considered gliomas, including glioblastoma multiforme, astrocytomas, oligodendrogliomas, and ependymomas. About 4 out of 10 of all brain tumors are gliomas. Counting only malignant tumors, about 8 out of 10 are gliomas.

**Astrocytomas:** Most tumors that arise within the brain itself start in glial cells called *astrocytes*. These tumors are called astrocytomas. About 3 out of 10 brain tumors are astrocytomas.

Most astrocytomas can spread widely throughout and blend with the normal brain tissue, which can make them very hard to remove by surgery. Sometimes they spread along the cerebrospinal fluid pathways. It is very rare for them to spread outside of the brain or spinal cord.

Astrocytomas are often classified as low grade, intermediate grade, or high grade, based on how the cells look under the microscope.

- Low-grade astrocytomas are the slowest growing.
- Intermediate-grade astrocytomas, or *anaplastic astrocytomas*, grow at a moderate rate.
- The highest-grade astrocytoma, known as *glioblastoma multiforme* (or just glioblastoma), is the fastest growing. These make up about two-thirds of astrocytomas and are the most common malignant brain tumors of adults.

Some special types of astrocytomas tend to have a particularly good prognosis. These are called *non-infiltrating astrocytomas* (for example, juvenile pilocytic astrocytomas). They are more common in children than in adults.
Oligodendrogliomas: These tumors start in brain cells called oligodendrocytes. Like astrocytomas, most of these can grow into (infiltrate) nearby brain tissue and cannot be completely removed by surgery. Oligodendrogliomas sometimes spread along the cerebrospinal fluid pathways but rarely spread outside the brain or spinal cord. Very aggressive forms of these tumors are known as anaplastic oligodendrogliomas. Only about 4% of brain tumors are oligodendrogliomas.

Ependymomas: These tumors arise from the ependymal cells, which line the ventricles. Ependymomas may block the exit of cerebrospinal fluid from the ventricles, causing the ventricles to become very large -- a condition called hydrocephalus. Unlike astrocytomas and oligodendrogliomas, ependymomas usually do not grow into (infiltrate) normal brain tissue. As a result, some (but not all) ependymomas can be completely removed and cured by surgery. Spinal cord ependymomas have the greatest chance of surgical cure. Ependymomas may spread along the cerebrospinal fluid pathways but do not spread outside the brain or spinal cord. Very aggressive forms of these tumors are known as anaplastic ependymomas. Only about 2% of brain tumors are ependymomas.

Meningiomas

Meningiomas arise from the meninges, the layers of tissue that surround the outer part of the brain and spinal cord. Meningiomas account for about 1 out of 3 primary brain and spinal cord tumors. They are the most common brain tumor in adults (although strictly speaking, they are not actually "brain tumors").

The risk of these tumors increases with age. They are about twice as common in women. In some cases these tumors run in families, especially in those with neurofibromatosis, a syndrome in which people develop many benign tumors of nerve tissue.

Meningiomas cause symptoms by pressing on the brain or spinal cord. About 4 out of 5 meningiomas are benign, and most of these can be cured by surgery. Some meningiomas, however, are located dangerously close to vital structures within the brain and cannot be cured by surgery alone. A small number of meningiomas are malignant and may come back many times after surgery or, rarely, even spread to other parts of the body.

Medulloblastomas

Medulloblastomas are tumors that develop from neuroectodermal cells (primitive nerve cells) in the cerebellum. They are fast-growing tumors and often spread throughout the cerebrospinal fluid pathways, but they can be treated by radiation therapy and chemotherapy. Medulloblastomas occur much more often in children than in adults. They are discussed in more detail in our document, *Brain and Spinal Cord Tumors in Children.*
**Gangliogliomas**

A tumor containing both neurons and glial cells is called a ganglioglioma. These are very uncommon in adults and have a high rate of cure by surgery alone or surgery combined with radiation therapy.

**Schwannomas (neurilemmomas)**

Schwannomas arise from Schwann cells, which are the myelin-forming part of cranial nerves and other peripheral nerves. These are usually benign tumors. They can arise from any cranial nerve. When they form from the cranial nerve responsible for balance near the cerebellum they are called *vestibular schwannomas* or *acoustic neuromas*. They may also arise from spinal nerves after they have left the spinal cord. When this is the case, they can compress the spinal cord, causing weakness, sensory loss, and bowel and bladder problems. These make up about 8% of all CNS tumors.

**Other tumors that can start in or near the brain**

**Chordomas**: These tumors start in the bone at the base of the skull or at the lower end of the spine. These tumors are not from the central nervous system, but they can cause injury to the nearby nervous system by compressing it. Typically they come back many times over 10 to 20 years, causing progressive injury. They usually do not spread to other organs.

**Non-Hodgkin lymphomas**: Lymphomas start in lymphocytes (one of the main cell types of the immune system). Some central nervous system (CNS) lymphomas occur in people with immune system problems, such as those infected with HIV, the virus that causes AIDS. Because of new treatments for AIDS, this type of brain lymphoma has become less common in recent years. Lymphomas of the brain are thought of as highly malignant and are often very hard to treat. Recent advances in chemotherapy, however, have improved the prognosis of people with these cancers. For more information on CNS lymphomas (including treatment), see our document, *Non-Hodgkin Lymphoma*.

**What are the key statistics about brain and spinal cord tumors?**

The American Cancer Society estimates that 21,810 malignant tumors of the brain or spinal cord (11,780 in men and 10,030 in women) will be diagnosed during 2008 in the United States.
States. These numbers would likely be much higher if benign tumors were also included. About 13,070 people (7,420 men and 5,650 women) will die from these tumors.

This would account for about 1.5% of all cancers and 2.3% of all expected cancer-related deaths in 2008. Both adults and children are included in these statistics.

Overall, the chance that a person will develop a malignant tumor of the brain or spinal cord in his or her lifetime is less than 1% (about 1 in 150 for a man and 1 in 182 for a woman).

Survival rates can vary widely, depending on the type of tumor. Survival rates for some of the more common types of brain and spinal cord tumors are discussed in the section, "How are brain and spinal cord tumors treated?"

What Are the Risk Factors for Brain and Spinal Cord Tumors?

A risk factor is anything that increases your chance of getting a disease such as cancer. Different cancers have different risk factors. For example, exposing skin to strong sunlight is a risk factor for skin cancer. Smoking is a risk factor for cancers of the lung, mouth, larynx, bladder, kidney, and several other organs. But having a risk factor, or even several, does not mean that you will get the disease.

The majority of brain tumors are not associated with any risk factors. Most brain tumors simply happen for no apparent reason. A few risk factors associated with brain cancer are known.

Environmental Risk Factors

The only established environmental risk factor for brain tumors is radiation. Before the risks of radiation were recognized, children with ringworm of the scalp (a fungal infection) often received low-dose radiation therapy, which substantially increased their risk of brain tumors in later life.

Today, most radiation-induced brain tumors are caused by radiation to the head given for the treatment of other cancers. The most common instance of radiation-induced brain tumors are people who received radiation to the brain as children as part of their treatment for leukemia. This development of new brain tumors usually occurs around 10 to 15 years after the radiation. For this reason (as well as other side effects of radiation therapy), this treatment is only given after careful consideration of benefits and risks. For most patients with cancer involving the brain or other areas of the head, the benefits of radiation therapy far outweigh the risk of developing a second tumor years later.

Other environmental factors such as exposure to vinyl chloride (an odorless gas used in the manufacturing of plastics), petroleum products, and certain other chemicals have been associated with increased risk in some studies but not in others. Exposure to aspartame (a sugar substitute) and exposure to electromagnetic fields from cellular telephones or high-
tension wires have been suggested as risk factors, but most researchers agree that there is no convincing evidence to link these factors. In fact, several recent studies have found no connection between the use of cellular phones and brain tumors.

**Immune System Disorders**

People with impaired immune systems have an increased risk of developing lymphomas of the brain or spinal cord. Lymphomas are cancers of lymphocytes, a type of cell of the immune system. Lymphomas usually form in lymph nodes. Primary lymphoma of the central nervous system is less common than lymphoma that arises outside the brain. Deficiencies of the immune system may be congenital (present at birth), may be a side effect of treatment for other cancers, may be a side effect of treatment to prevent rejection of transplanted organs, or may be the result of the acquired immunodeficiency syndrome (AIDS).

**Family History**

Rare cases of brain and spinal cord cancers run in families. In general, patients with familial cancer syndromes have multiple tumors that occur when they are young. Some of these families have well-known disorders such as:

- **Neurofibromatosis type 2** is an inherited condition associated with schwannomas of both acoustic (hearing) nerves and, in some patients, multiple meningiomas or spinal cord ependymomas.

- Patients with **tuberous sclerosis** (another inherited condition) may have non-infiltrating subependymal giant cell astrocytomas (low-grade astrocytomas that develop beneath the ependymal cells of the ventricles), in addition to benign tumors of the skin, heart, or kidneys.

- **Von Hippel-Lindau disease** is associated with an inherited tendency to develop hemangioblastomas (blood vessel tumors) of the cerebellum or retina as well as renal cell (kidney) carcinomas.

Malignant brain tumors are rare in these disorders. Other families may have a genetic disorder that is not well recognized or that may even be unique to a particular family.

**Cellular Phone Use**

This has been the subject of a huge number of studies, most of which find no connection with brain tumors. A few studies, mostly from Sweden, suggested that people who used cellular phones (cell phones, mobile phones) extensively for many years did have a higher risk for brain tumors. Some studies also suggest there may be some increased risk of brain tumors from long term use of analog phones, an older kind of cellular phones that have been replaced by newer digital phones. Most experts feel that more studies are needed before coming to any conclusion.

**Do we know what causes brain and spinal cord tumors in adults?**
The cause of most central nervous system tumors is not fully understood. But researchers are making progress toward understanding some of the chemical changes that occur in normal brain cells that may lead them to form brain tumors.

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. Brain tumors, like other tumors, are caused by abnormal changes (mutations) in a person's DNA. DNA is the chemical in each of our cells that makes up our genes -- the instructions for how our cells function. We usually resemble our parents because they are the source of our DNA. However, DNA affects more than how we look.

Some genes contain instructions for controlling when our cells grow, divide, and die. Certain genes that speed up cell 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 DNA mutations (changes) that "turn on" oncogenes or "turn off" tumor suppressor genes. These gene changes can be inherited from a parent or may happen during a person's lifetime as cells in the body divide to form 2 new cells.

In recent years, researchers have found the gene mutations that cause some rare inherited syndromes (like neurofibromatosis, tuberous sclerosis, Li-Fraumeni, and von Hippel-Lindau) and increase the risk of developing some central nervous system tumors. For example, the Li-Fraumeni syndrome is caused by mutation of the p53 tumor suppressor gene. Normally, this gene prevents cells with damaged DNA from growing. When it is mutated, the risk of developing brain tumors (particularly gliomas), as well as some other cancers, is increased.

Most brain and spinal cord tumors are not the result of known inherited syndromes. A number of gene or chromosome changes have been found in some of these tumors, although it's not clear if these changes have specific causes. Still, research into these changes may lead to new treatments for central nervous system tumors in the future.

In most cases, it is not known why people without inherited syndromes develop changes in cells of their central nervous system. Most risk factors for cancer somehow damage genes. For example, cigarette smoke is a risk factor for lung cancer and several other cancers because it contains chemicals that can damage genes. The brain is relatively protected from cigarette smoke and other cancer-causing chemicals that we all breathe or eat, so these factors are unlikely to play a major role in these cancers.

Most brain cancers develop genetic abnormalities for no apparent reason and are not associated with anything that the person did or didn't do, or with any known exposures in the environment.

Can brain and spinal cord tumors in adults be prevented?
Most central nervous system tumors have not been linked with any known risk factors. As a result, most of these tumors cannot be prevented at this time.

Can brain and spinal cord tumors in adults be found early?

At this time there are no blood tests or other screening exams that can be used routinely to detect brain tumors before they start to cause symptoms. These tumors usually come to light as a result of signs or symptoms the person is having. In most cases, the patient's survival is determined by their age, the type of tumor, and its location, not by how early it is detected. But as with any disease, earlier detection and treatment is likely to be helpful.

How are brain and spinal cord tumors in adults diagnosed?

Brain and spinal cord tumors are usually found as the result of signs or symptoms a person is having.

Symptoms of brain and spinal cord tumors

A brain or spinal cord tumor usually comes to light because of the symptoms it causes. Symptoms can be fairly general, or they may be more specific depending on where the tumor is located. Symptoms may occur gradually and become worse over time, or they can happen suddenly, such as with a seizure.

General symptoms can arise from an increase in pressure inside the skull. Tumors within any part of the brain may cause pressure to rise within the skull, which can lead to headache, nausea, vomiting, blurred vision, balance problems, or even personality changes. In severe cases, lethargy (drowsiness) and even coma can develop. Headache is a common symptom of a brain tumor, occurring in about half of patients. (Of course, most headaches are not caused by tumors.)

Both brain and spinal cord tumors cause specific symptoms if they irritate or damage certain parts of the brain or spinal cord:

- About half of people with brain tumors will have epileptic seizures at some point. Sometimes this is the first sign of a brain tumor, but fewer than 1 in 10 first seizures are caused by brain tumors.
• Tumors in parts of the brain that control movement or sensation may cause weakness or numbness of part of the body.

• Tumors in or near the parts of the brain responsible for language may cause problems with speech or even understanding words.

• Tumors in the front part of the brain can sometimes affect thinking and personality.

• Tumors in an area of the brain called the basal ganglia typically cause abnormal movements and an abnormal positioning of the body.

• If the tumor is in the cerebellum, where coordination is controlled, a person may have trouble with walking or other everyday functions, even eating.

• Tumors in the back part of the brain, or around the pituitary gland, the optic nerve, or certain other cranial nerves may cause vision problems.

• Tumors in other cranial nerves may lead to loss of hearing, balance problems, or weakness of some facial muscles.

• Spinal cord tumors often cause numbness and/or weakness of both legs.

Because the brain controls functions of some other organs, including the production of hormones, many other symptoms can be caused by brain tumors that haven't been listed here.

It's important to note that none of the symptoms mentioned above is specific for brain or spinal cord tumors, and they may all have other causes. Still, if you have symptoms that suggest that a brain or spinal cord tumor may be present, consult a doctor so that the cause can be evaluated and treated, if needed.

Medical history and physical exam

If symptoms suggest a CNS tumor may be present, your doctor will want to take a complete medical history and perform a physical exam to evaluate brain and spinal cord function (neurologic exam). This special type of physical exam may be done by a general doctor. It commonly involves testing reflexes, muscle strength, eye and mouth movement, coordination, alertness, and other functions. If the results are abnormal, your doctor may refer you to a neurologist (a doctor specializing in diagnosis and medical treatment of nervous system diseases) or a neurosurgeon (a surgeon specializing in operations to treat nervous system diseases) to perform a more detailed exam.
Imaging tests

If your doctor thinks a brain problem may be present, he or she will likely order one or more imaging tests. These studies provide different types of pictures of internal organs such as the brain and spinal cord. The studies are viewed and interpreted by radiologists (doctors specializing in x-ray and other diagnostic imaging tests), as well as by your doctor.

Magnetic resonance imaging (MRI) and computed tomography (CT) scans are used most often for diagnosis of brain diseases. MRI or CT scans will show a brain tumor, if one is present, in almost all cases, and can often tell the doctors exactly where within the brain a tumor is located.

Computed tomography (CT) scan: The CT scan is an x-ray test that can produce detailed cross-sectional images of your brain and spinal cord (or other parts of the body). Instead of taking one picture, like a regular x-ray, a CT scanner takes many pictures as it rotates around you while you lie on a table. A computer then combines these pictures into images of slices of the part of the body being studied. Unlike a regular x-ray, a CT scan creates detailed images of the soft tissues in the body.

You may receive an injection of a contrast dye through an IV (intravenous) line. This helps better outline any tumors that are present. The contrast may cause some flushing (a feeling of warmth, especially in the face). Some people are allergic and get hives. Rarely, more serious reactions like trouble breathing or low blood pressure can occur. 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 will 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. Some people feel a bit confined by the ring they have to lie in while the pictures are being taken.

In recent years, spiral CT (also known as helical CT) has become available in many medical centers. This type of CT scan uses a faster machine. The scanner part of the machine rotates around the body continuously, allowing images to be collected much more quickly than with a standard CT. This lowers the chance of "blurred" images occurring as a result of motion. It also lowers the dose of radiation received during the test. The biggest advantage may be that the "slices" it images are thinner, which yields more detailed pictures and allows doctors to look at suspicious areas from different angles.

Magnetic resonance imaging (MRI) scan: MRI scans are particularly helpful in looking at the brain and spinal cord and are considered the best way to look for tumors in these areas. In some cases, a special form of this test, known as magnetic resonance angiogram (MRA), may be done to look at the blood vessels in the brain. This can be very useful before surgery to help the surgeon plan an operation.
MRI scans provide detailed images of soft tissues in the body. The images of the brain and spinal cord obtained with MRI are generally superior to CT scans. But MRI scans use radio waves and strong magnets instead of x-rays. The energy from the radio waves is absorbed 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. A contrast material called gadolinium may be injected into a vein before the scan to better see details.

MRI scans are a little more uncomfortable than CT scans. First, they take longer -- often up to an hour. Second, you have to lie inside a narrow tube, which can be confining. Newer "open" MRI machines may help with this. The machine also makes buzzing and clicking noises that may be disturbing.

**Magnetic resonance spectroscopy (MRS):** This test (also known as MRI spectroscopy) is like an MRI, except that the radio waves interact with different atoms within the tissues, so the images may highlight some features of brain tumors that are not clearly seen by MRI. Certain tumors give off specific signals that may help in narrowing the possible types of tumor present, but this test rarely makes a biopsy unnecessary.

**Positron emission tomography (PET) scan:** PET scans involve injecting glucose (a form of sugar) that contains a radioactive atom into the blood. The amount of radioactivity used is very low. Because cancer cells in the body are growing quickly, they absorb large amounts of the radioactive sugar. A special camera can then create a picture of areas of radioactivity in the body. The picture is not finely detailed like a CT or MRI scan, but it can provide helpful information about whether abnormal areas seen on other tests (such as MRIs) are likely to be cancerous or not.

This test is also useful after treatment, as it can help tell whether the tumor cells have been killed. (Dead cells do not use glucose.) When MRI scans are unclear, PET scans are particularly helpful in telling whether an MRI abnormality found after treatment is scar tissue or a tumor that has grown back.

**Chest x-ray:** This is a plain x-ray of your chest, which can be done in a doctor's office, in an outpatient radiology center, or in a hospital. It may be done once a tumor is found in the brain, because most tumors in the brain have actually started in another organ (most often the lung) and spread to the brain.

**Angiogram:** This is another imaging test sometimes used in evaluating brain and spinal cord tumors. It involves injecting a special dye into blood vessels near the tumor and then viewing the area with x-rays. This helps doctors look at the blood supply of a tumor.

This test has largely been replaced by other tests that can look at blood vessels in recent years, such as computerized tomographic angiography (CTA) or magnetic resonance angiography (MRA).
Biopsy

Imaging studies such as MRI and CT scans may show that a brain tumor is present (or very likely). However, in most cases these scans cannot give a definite diagnosis of brain cancer. This can only be done by removing some of the tumor tissue for examination, called a biopsy. Once the tissue is removed, it is looked at under a microscope by a pathologist (a doctor specializing in diagnosis of diseases by lab tests) or a neuropathologist (a pathologist specializing in nervous system diseases). The pathologist determines if the tumor is benign or malignant (cancerous) and exactly what type of tumor is present.

In a few instances, the appearance of an astrocytoma on an MRI scan is so characteristic that a biopsy is not needed, especially when the tumor is located in a part of the brain that would make it hard to biopsy (such as the brain stem). In rare cases a PET scan or MRI spectroscopy may give enough information so that a biopsy is not needed.

There are 2 main types of biopsies for brain tumors.

**Stereotactic (needle) biopsy:** This type of biopsy may be used in cases where the risks of surgery might be too high (such as with some tumors in vital areas, those deep within the brain, or other tumors that likely can't be treated with surgery) but where a sample is still needed to make a diagnosis.

For this procedure, the patient may be asleep (under general anesthesia) or awake. If the patient is awake during the biopsy, the neurosurgeon injects a local anesthetic into areas of skin above the skull to numb them. A rigid frame may then be fixed onto the head. This helps make sure the surgeon is targeting the tumor precisely. A cut (incision) is made in the scalp and a small hole is drilled in the skull. An MRI or CT scan is often used along with the frame to help the neurosurgeon guide a hollow needle into the tumor and remove a small piece of tissue. Another approach is to attach markers to the scalp, get an MRI or CT, and then use an image-guidance system to direct the needle into the tumor.

Once the tissue is removed, it is looked at under a microscope by a pathologist, who determines what type of tumor is present. This information is very important in helping to figure out the chances of survival and the best course of treatment.

**Surgical (open) biopsy:** If the tumor appears to be treatable with surgery based on the imaging tests, the neurosurgeon may not do a needle biopsy. Instead, he or she may perform an operation called a craniotomy (described in the section "How are brain and spinal cord tumors treated?") to remove all or most of the tumor. (Removing most of the tumor is known as debulking.)

In this case, small samples of the tumor are immediately looked at by the pathologist while the patient is still in the operating room, to obtain a preliminary diagnosis. This can help
guide treatment, including whether further surgery should be done at that time. A final diagnosis is arrived at 3 to 4 days later in most cases.

**Lumbar puncture (spinal tap)**

This procedure is used to look for cancer cells in the cerebrospinal fluid (CSF), which is the liquid that surrounds the brain and spinal cord. For this test, you lay on your side on a bed or exam table with your knees up near your chest. The doctor first numbs an area in the lower part of the back near the spine. A small, hollow needle is then placed between the bones of the spine to withdraw some of the fluid.

This fluid is looked at under a microscope to see if cancer cells are present. Other tests may be done on the fluid as well.

Lumbar punctures are usually very safe, but doctors have to make sure the test does not result in a dramatic change in pressure in the fluid, which could possibly cause serious problems. For this reason, imaging tests such as MRI scans are done beforehand.

Lumbar punctures usually aren't done to diagnose brain tumors, but they may be done after a diagnosis is made for certain types of brain tumors that can commonly spread via the CSF (such as ependymomas). They are particularly important in people with suspected brain lymphomas because often the lymphoma cells spread into the spinal fluid. Extra treatment must be given if there are lymphoma cells in the spinal fluid.

**Blood and urine tests**

These lab tests are rarely involved in the actual diagnosis of brain and spinal cord tumors, but they may be done if you have been sick for some time to check how well the liver, kidneys, and some other organs are working. Routine blood cell counts may also be needed, especially before any planned surgery.

**How are brain and spinal cord tumors in adults staged?**

*Staging* is the process of gathering information from exams and imaging tests to find out how far a cancer has spread. A staging system is a standardized way in which the cancer care team describes the extent to which the cancer may have spread. For most cancers, the stage (extent) of the cancer is one of the most important factors in selecting treatment options and in determining the outlook (prognosis).
But malignant (cancerous) tumors of the central nervous system (CNS) differ in some important ways from tumors in other parts of the body. For most cancers that start in other parts of the body, their most deadly aspect is their ability to spread throughout the body. In contrast, tumors starting in the brain or spinal cord can spread to other parts of the CNS, but they almost never spread to other organs. The dangerous aspect of these tumors is that they can interfere with essential, normal functions of the brain.

Because brain cancers almost never spread to other parts of the body, there is no formal staging system for tumors in the brain or spinal cord. Some of the most important factors that help determine outlook include:

- the type of tumor (such as astrocytoma, ependymoma, etc.)
- the grade of the tumor (how quickly the tumor is likely to grow, based on how the cells look under a microscope)
- the size and location of the tumor
- how much of the tumor can be removed by surgery (if it can be done)
- the person's age
- the person's functional level (whether the tumor has started to interfere with normal brain functions)
- whether or not the tumor has spread through the cerebrospinal fluid (CSF) to other parts of the brain and/or spinal cord
- whether or not tumor cells have spread beyond the central nervous system

How are brain and spinal cord tumors in adults 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.

The first part of this section describes the various types of treatments used for brain and spinal cord tumors. This is followed by a description of the most common approaches used for these tumors based on the type of tumor.

General comments about treatment
Several types of treatment may be used to treat central nervous system (CNS) tumors, including surgery, radiation therapy, chemotherapy, and other types of drugs. Treatment is different for different kinds of tumors, and in many cases a combination of treatments is used. The effectiveness of treatment depends on a number of factors including the type, size, and location of the tumor.

**Surgery**

**Surgery to remove the tumor**

In most cases, the first step in brain tumor treatment is for the neurosurgeon to remove as much of the tumor as is safe without affecting normal brain function.

Surgery alone or combined with radiation therapy may cure many tumors, including some low-grade astrocytomas, ependymomas, craniopharyngiomas, gangliogliomas, and meningiomas.

Tumors that tend to spread diffusely into nearby brain tissue such as anaplastic astrocytomas or glioblastomas are not cured by surgery. But surgery can reduce the amount of tumor that needs to be treated by radiation or chemotherapy, and this may improve the results of these treatments, resulting in prolonged life even if all of the tumor can't be removed.

Surgery may also improve some of the symptoms caused by brain tumors, particularly those caused by a build up of pressure within the skull. These can include headaches, nausea, vomiting, and blurred vision. Surgery may also improve symptoms of epilepsy and make the seizures more controllable with medications.

Surgery may not be a good option in some cases. Sometimes surgery is not a good choice because the tumor is too deep within the brain, or because the patient is unable to tolerate a major operation. Another reason to avoid surgery is that parts of the brain necessary for life would be destroyed. This happens with brain stem tumors.

Surgery, other than to get a biopsy for diagnosis, is not very effective against some types of brain tumors, such as lymphomas.

**Craniotomy:** This is the main type of operation for treatment of brain tumors. A craniotomy is a surgical opening made in the skull. For this operation, the person may either be under general anesthesia (in a deep sleep) or may be awake for at least part of the procedure (with the surgical area numbed) if brain function needs to be assessed during the operation. Part of the head may need to be shaved. The neurosurgeon first makes an incision in the scalp, and the skin is folded back. The surgeon then uses a special type of saw to remove the piece of bone over the tumor.
The craniotomy is typically large enough for the surgeon to insert multiple instruments and view the parts of the brain needed to operate safely. For tumors deep within the brain, a small incision is made into the brain itself to allow the surgeon to reach the tumor. The surgeon may use MRI, CT, or ultrasound images to help locate the tumor and its edges.

The surgeon can remove the tumor in several ways depending on how hard or soft it is, and whether it contains many or just a few blood vessels. One way is to cut it out with a scalpel or scissors. In other cases, a probe attached to an ultrasonic generator may be placed into the tumor to break it up and liquefy it. A small vacuum device is then used to suck it out.

Many devices can help the surgeon see the tumor and surrounding brain tissue. The surgeon can operate while looking at the brain through a microscope. As mentioned above, image guidance with MRI, CT, or ultrasound can be used to "map" the area of the tumor so the surgeon can find tumors buried deep in the brain.

The surgeon operating on the brain faces the dilemma of removing as much tumor as is possible without destroying important brain tissue. He or she wants to avoid leaving the patient disabled in any way. The surgeon can "see" the function of the brain by electrically stimulating parts of the brain in and around the tumor. This will show if these areas control an important function. Using this technique, surgeons can lower the risk of removing vital parts of the brain.

In most cases the removed piece of bone is put back in place and fastened to the skull with metal screws and plates, wires, or special stitches. Healing usually takes several weeks. Recovery time in the hospital is usually 4 to 6 days, although this may vary according to the size and location of the tumor and the patient's general state of health.

**Surgery to place a shunt**

Blockage of the cerebrospinal fluid (CSF) flow by a tumor can cause increased pressure inside the skull. This can cause symptoms such as headaches, nausea, and drowsiness, and may even be life-threatening. To drain excess CSF and lower the pressure, the neurosurgeon may put a silicone tube called a shunt (sometimes referred to as a ventriculoperitoneal or VP shunt) in place. One end of the shunt is placed in the ventricle of the brain (which contains cerebrospinal fluid) and the other end is placed in the abdomen or, less often, the heart or other areas.

Shunt placement is normally a straightforward procedure that takes less than an hour. As with any operation, complications may develop, such as bleeding or infection. Sometimes shunts get "clogged" and need to be replaced.
The hospital stay after shunt procedures is typically 1 to 3 days, depending on the reason it is placed and the overall health of the patient.

Possible risks and side effects of surgery

Surgery on the brain or spinal cord is a serious operation, and surgeons are very careful to try to limit any problems either during or after surgery. Complications during or after surgery such as bleeding, infections, or reactions to anesthesia are rare, but they can happen. One of the biggest concerns when removing brain tumors is possible loss of brain function afterward, which is why doctors are very careful to remove only as much tissue as is safely possible.

A major concern after surgery is swelling in the brain. Drugs called corticosteroids are typically given for several days after surgery to help lessen this risk.

For more extensive information on surgery as a treatment for cancer, see our document, Surgery.

Radiation therapy

Radiation therapy uses high-energy rays or particles to kill cancer cells. Most brain tumors that are not cured by surgery are treated with high-energy radiation to kill remaining cancer cells.

Types of radiation therapy

In most cases, the radiation is focused precisely on the tumor from a source outside the body. This is called external beam radiation therapy (EBRT).

External beam radiation therapy is much like getting an x-ray, but the dose of radiation is much higher. In most cases, the total dose of radiation is divided into daily fractions (usually given Monday through Friday) over several weeks. At each session, you will lie on a special table while a machine delivers the radiation from a precise angle. The treatment is not painful. Each session lasts about 15 to 30 minutes. Much of that time is spent making sure the radiation is aimed correctly. The actual treatment time each day is much shorter.

Because high doses of radiation therapy can damage normal brain tissue, the radiation oncologist (a doctor specializing in treatment of tumors with radiation) attempts to deliver high doses of radiation to the tumor with the lowest possible dose to normal surrounding
brain areas. Several newer techniques have been developed in recent years to try to improve upon standard EBRT:

**Three-dimensional conformal radiation therapy (3D-CRT):** 3D-CRT uses the results of imaging tests such as MRI and special computers to precisely map the location of the tumor. Several radiation beams are then shaped and aimed at the tumor from different directions. Each beam alone is fairly weak, which makes it less likely to damage normal tissues, but the beams converge at the tumor to give a higher dose of radiation there.

**Intensity modulated radiation therapy (IMRT):** IMRT is an advanced form of 3D therapy. It uses a computer-driven machine that actually moves around the patient as it delivers radiation. In addition to shaping the beams and aiming them at the tumor from several angles, the intensity (strength) of the beams can be adjusted to minimize the dose reaching the most sensitive normal tissues. This may allow the doctor to deliver a higher dose to the tumor.

**Conformal proton beam radiation therapy:** Proton beam therapy is related to 3D-CRT and uses a similar approach. But instead of using x-rays, this technique focuses proton beams on the cancer. Protons are positive parts of atoms. Unlike x-rays, which release energy both before and after they hit their target, protons cause little damage to tissues they pass through and then release their energy after traveling a certain distance. This means that proton beam radiation may be able to deliver more radiation to the tumor and do less damage to nearby normal tissues. The machines needed to make protons are expensive, and there are only a handful of them in use in the United States at this time.

**Stereotactic radiosurgery/stereotactic radiotherapy:** This is a type of radiation treatment that delivers a large, precise radiation dose to the tumor area in a single session. (There is no actual "surgery" involved in this treatment.) This treatment may be useful for some brain and spinal cord tumors that are in locations where surgery would damage important tissues or when a patient's condition does not permit surgery.

First, a head frame is attached to the skull to help precisely aim the radiation beams. Once the exact location of the tumor is known from the CT or MRI scans, radiation may be delivered in one of two ways.

In one approach, radiation beams are focused at the tumor from hundreds of different angles for a short period of time. The machine used to deliver this type of radiation is known as a Gamma Knife.

A similar approach uses a movable linear accelerator (a machine that creates radiation) that is controlled by a computer. Instead of delivering many beams at once, this machine moves around to deliver radiation to the tumor from different angles. Several machines do stereotactic radiosurgery in this way, with names such as X-Knife, CyberKnife, and Clinac.

*Stereotactic radiosurgery* typically uses a single session to deliver the whole radiation dose, though it may be repeated if needed. Sometimes doctors give the radiation in several
treatments to deliver the same or slightly higher dose. This is called fractionated radiosurgery or stereotactic radiotherapy.

**Brachytherapy (interstitial radiotherapy):** Unlike the external radiation approaches above, brachytherapy inserts radioactive material directly into or near the tumor. The radiation given off travels a very short distance, so it affects only the tumor. This technique is most often used along with external radiation. It provides a high dose of radiation at the tumor site, while the external radiation treats nearby areas with a lower dose.

**Whole brain and spinal cord radiation therapy (craniospinal radiation):** If tests such as an MRI scan or lumbar puncture find the tumor has spread along the spinal cord covering, the meninges, and surrounding fluid, then radiation may be given to the whole brain and spinal cord. Some tumors such as ependymomas spread more commonly in this manner and because of this, more often require craniospinal radiation.

### Possible side effects of radiation therapy

Radiation is more harmful to tumor cells than it is to normal cells. Still, normal brain tissue is also damaged by radiation.

Some people may become irritable and fatigued during the course of radiation therapy. Nausea, vomiting, and headaches are also possible but are uncommon. Sometimes dexamethasone (Decadron), a cortisone-like drug, can help relieve the symptoms.

A person may lose some brain function if large areas of the brain receive radiation. Problems can include memory loss, personality changes, and trouble concentrating. There may also be other symptoms depending on the area of brain treated and how much radiation was given. These risks must be balanced against the risks of not using radiation and having less control of the tumor.

Rarely, a large mass of dead (necrotic) tissue forms at the site of an irradiated tumor. This occurs months to years after radiation is given and is called radiation necrosis. Occasionally, surgery may be needed to remove the necrotic tissue.

Radiation can damage genes. As a result, radiation therapy is associated with a very small risk of developing a second cancer in the radiation field -- for example, a meningioma of the coverings of the brain, or less likely a bone cancer in the skull -- usually many years after the radiation is given. This small risk should not prevent those who need radiation from getting treatment.

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

Chemotherapy (also known as "chemo") uses anti-cancer drugs that are usually given into a vein intravenously (IV) or taken by mouth. These drugs enter the bloodstream and reach almost all areas of the body. However, many chemotherapy drugs are not able to enter the brain and reach tumor cells. For some brain tumors, the drugs may be given directly into the cerebrospinal fluid (CSF) in the brain or into the spinal canal below the spinal cord.

Chemotherapy is most often used along with other types of treatment such as surgery and/or radiation therapy. In general, chemotherapy is used for higher grade tumors. Some types of brain tumors, such as medulloblastoma and lymphoma, tend to respond well to chemotherapy.

Some of the chemotherapy drugs that may be used to treat brain tumors include:

- carboplatin
- carmustine (BCNU)
- cisplatin
- etoposide
- irinotecan
- lomustine (CCNU)
- methotrexate
- procarbazine
- temozolomide
- vincristine

These drugs may be used alone or in various combinations, depending on the type of brain tumor.

Carmustine (Gliadel®) wafers: These dissolvable wafers contain the chemotherapy drug carmustine (BCNU). During a craniotomy, they can be placed directly on or next to parts of brain tumors that can't be removed. Unlike IV or oral chemotherapy that reaches all areas of the body, this type of therapy increases the drug concentration at the tumor site with minimal side effects in other parts of the body.

Possible side effects of chemotherapy

Chemotherapy drugs work by attacking cells that are dividing quickly, which is why they often 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.

The side effects of chemotherapy depend on the type of drugs, the amount taken, and the length of treatment. Possible side effects can include:

- hair loss
- mouth sores
- loss of appetite
- nausea and vomiting
- increased chance of infections (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, changes in metabolism, or other factors)

Along with the risks above, some chemotherapy drugs have specific side effects (although these are relatively uncommon). For example, cisplatin and carboplatin can also cause kidney damage and hearing loss. Your doctor will check your kidney function and hearing periodically if you are given these drugs. Some of these side effects may persist after treatment is stopped.

Your doctor and treating team will watch closely for any side effects that develop. Most side effects can be treated effectively or even prevented altogether. For example, drugs can be given to help prevent or reduce nausea and vomiting. Do not hesitate to discuss any questions about side effects with the cancer care team.

For more information on chemotherapy, see our document, *Understanding Chemotherapy: A Guide for Patients and Families*.

### Targeted therapies

As researchers have learned more about the gene changes in cells that cause cancer, they have been able develop newer drugs that specifically target these changes. These targeted drugs work differently than standard chemotherapy drugs. They often have different (and less severe) side effects. While none have yet been FDA approved specifically for use against brain tumors, some have shown promise in early clinical studies.

**Bevacizumab (Avastin):** Bevacizumab is a manmade version of an immune system protein called a monoclonal antibody. This antibody targets vascular endothelial growth factor (VEGF), a protein that helps tumors form new blood vessels to get nutrients (a process known as angiogenesis). Bevacizumab is most often used along with chemotherapy drugs.

Bevacizumab is given by intravenous (IV) infusion, usually once every 2 or 3 weeks. Some early studies have shown it may help improve survival when added to chemotherapy for
aggressive brain tumors, but it can also add to the side effects. More common side effects include high blood pressure, tiredness, bleeding, low white blood cell counts, headaches, mouth sores, loss of appetite, and diarrhea. Rare but possibly serious side effects include blood clots, internal bleeding, heart problems, and slow wound healing.

Other drug treatments

Some drugs commonly used in people with brain tumors do not treat the tumors directly, but they may help to lessen symptoms from the tumor or its treatment.

Corticosteroids: Cortisone-like drugs such as dexamethasone (Decadron) are often given to reduce the swelling that may occur around brain tumors. This may help relieve headaches and other symptoms.

Anti-seizure drugs (anti-epileptics): Drugs may also be prescribed to prevent seizures, which happen often in people with brain tumors. Many anti-seizure drugs are available and may be used depending on a given patient's circumstances. Because these drugs can interfere with other drugs, such as chemotherapy, they are not usually given unless the tumor has caused seizures.

Clinical trials

You may have had to make a lot of decisions since you've been told you have cancer. One of the most important decisions you will make is deciding which treatment is best for you. You may have heard about clinical trials being done for your type of cancer. Or maybe someone on your health care team has mentioned a clinical trial to you. Clinical trials are 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 1 of 2 (or
more) groups. One group (called the control group) gets the standard, most accepted
treatment. The other group(s) gets the new one(s) 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 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 specific types of brain and spinal cord tumors

The treatment options for brain and spinal cord tumors depend on several factors, including the type of tumor and how far it has grown or spread.

Non-infiltrating astrocytomas

These tumors include juvenile pilocytic astrocytomas, which most commonly occur in the cerebellum in young people, and the subependymal giant cell astrocytomas, which are almost always associated with tuberous sclerosis. Many doctors consider these to be benign tumors.

In most cases, these astrocytomas are cured by surgery alone. Older patients, though, are less likely to be cured. Radiation therapy may be given, particularly if the tumor is not completely removed, although many doctors will wait until there are signs the tumor has grown back before considering it. Even then, repeat surgery may be the first option. The outlook is not as good if the astrocytoma occurs in a place that does not allow it to be removed surgically, such as the hypothalamus or brain stem.
Low-grade astrocytomas (infiltrating or diffuse astrocytomas)

The main treatment for these tumors is surgery when possible. These tumors are hard to cure by surgery because they often grow into (infiltrate) nearby normal brain tissue. Usually the surgeon will try to remove as much of the tumor as safely possible. If the surgeon is able to remove it all this may be curative.

Radiation therapy may be given after surgery, especially if large amounts of tumor remain. In younger patients, this may be postponed until the tumor shows signs of regrowth. (In some cases, a second surgery may be tried before giving radiation.) Some doctors may also consider giving chemotherapy after surgery.

Radiation or chemotherapy may also be used as the main treatment if surgery is not a good option because of tumor location.

Intermediate- and high-grade astrocytomas (Anaplastic astrocytomas, glioblastoma multiforme)

Although surgery is often the first treatment when it can be done, these tumors are not curable by surgery. As much of the tumor as is safely possible is removed. Chemotherapy wafers may be placed in or near any remaining tumor at this time. Radiation therapy is then given, usually along with or followed by chemotherapy.

Temozolomide is the drug most commonly used to treat these tumors. It is often given along with radiation therapy, as it appears to make it more effective. It is then continued after the radiation is completed. Temozolomide is the drug used first by most doctors because it's a pill, is convenient to give, and has shown success in prolonging lives.

Cisplatin, carmustine (BCNU), and lomustine (CCNU) are other drugs commonly used. Combinations of drugs may also be used, such as the PCV regimen (procarbazine, CCNU, and vincristine). All of these treatments have had some success, but none is curative.

For tumors that cannot be treated with surgery, radiation therapy -- with or without chemotherapy -- is usually the best option.

In general, these tumors are very hard to treat effectively for extended periods of time. Because these tumors are so hard to cure with current treatments, clinical trials of promising new treatments may be a good option.

Oligodendrogliomas and anaplastic oligodendrogliomas
If possible, surgery is the first option for oligodendrogliomas. While they are usually not curable by surgery, it can relieve symptoms and prolong survival. Many oligodendrogliomas grow slowly, especially in younger people, and may not require further immediate treatment. Surgery may be repeated in many cases if it grows back in the same spot. Radiation therapy and/or chemotherapy (most often with temozolomide or the PCV regimen) may also be options after surgery, particularly in cases of anaplastic oligodendroglioma.

These tumors may respond to chemotherapy better than other brain tumors if certain chromosome changes are present in the tumor cells. You can ask your doctor about testing for these changes.

For tumors in which surgery is not an option, chemotherapy, with or without radiation therapy, may be helpful.

Anaplastic oligodendrogliomas tend to be more aggressive. They are treated the same way as anaplastic astrocytomas (see above).

**Ependymomas and anaplastic ependymomas**

These tumors usually do not infiltrate normal brain tissue. They may be cured in some cases by surgery alone if the entire tumor can be removed. But often this is not possible. In cases where these tumors can't be cured with surgery, radiation therapy is given after surgery. If imaging tests or a lumbar puncture show that the cancer may have reached the spinal cord, the radiation may be extended to include the spinal cord.

The use of chemotherapy after surgery is still being tested in clinical trials. It may be recommended, although its benefit is still uncertain. It may be more helpful if the tumor is an anaplastic ependymoma.

**Meningiomas**

These tumors can usually be cured if completely removed surgically. Some tumors, particularly those at the base of the brain, cannot be completely removed, and a few are malignant and recur despite apparent complete removal. Radiation therapy may be used along with, or instead of, surgery for tumors that can't be completely removed. It may also be used to try to control regrowth of meningiomas that recur after surgery. Chemotherapy or hormonal drugs may be tried if surgery and radiation aren't effective, but it's not clear if they offer any benefit.

Because of their slow growth, small or asymptomatic meningiomas can often be watched rather than treated, particularly in the elderly.
Schwannomas (including acoustic neuromas)

These slow growing tumors are usually benign and are cured by surgical removal. In some centers, small acoustic neuromas are treated by stereotactic radiosurgery (see the section on Radiotherapy above). In cases of large schwannomas where complete removal is likely to cause problems, tumors may be operated on first to decrease their size and then have the remainder treated with radiosurgery. For the rare malignant schwannomas, radiation therapy is often given after surgery.

Spinal cord tumors

These tumors are treated in a manner similar to those in the brain. Astrocytomas of the spinal cord usually cannot be completely removed. They may be treated with surgery to remove as much tumor as possible, followed by radiation therapy, or with radiation therapy alone. Meningiomas of the spinal canal are often cured by surgical removal, as are some ependymomas. If surgery doesn't completely remove an ependymoma, radiation therapy is often given.

Lymphomas

Treatment of CNS lymphomas is discussed in our document, Non-Hodgkin Lymphoma.

Brain tumors that occur more often in children

Some brain tumors occur more commonly in children but do occur occasionally in adults. These include brain stem gliomas, germ cell tumors, craniopharyngiomas, choroid plexus tumors, medulloblastomas, primitive neuroectodermal tumors, and some others. Treatment of these cancers is described in our document, Brain and Spinal Cord Tumors in Children.

Survival rates for selected brain and spinal cord tumors

The numbers below come from the Central Brain Tumor Registry of the United States (CBTRUS) and are based on people who were treated between 1973 and 2002. There are some important points to note about these numbers:
• The 5-year survival rate refers to the percentage of patients who live at least 5 years after being diagnosed. Many of these patients live much longer than 5 years after diagnosis. Five-year relative survival rates (such as the numbers below) don't include patients who die from other causes. They are considered to be a more accurate way to describe the outlook for patients with a particular type of cancer.

• Survival rates for brain and spinal cord tumors vary widely by age, with younger people generally having better outlooks than older people (as can be seen in the numbers below). The survival rates for those 65 or older are generally lower than the rates for the ages listed below.

• While these numbers are among the most current we have available, they represent people who were first diagnosed and treated many years ago. Improvements in treatment since then mean that the survival rates for those now being diagnosed with these cancers may be higher.

• These numbers are for some of the more common types of malignant brain and spinal cord tumors. Numbers are not readily available for all types of tumors, often because they are rare or are hard to classify.

• Survival statistics can sometimes be useful as a general guide, but they may not accurately represent any one person's prognosis. A number of other factors, including the size and location of the tumor and the amount that can be removed by surgery, can also affect outlook. Your doctor is likely to be a good source as to how well these numbers may apply to you, as he or she is familiar with the aspects of your particular situation.

<table>
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<tr>
<th>Type of Tumor</th>
<th>5-Year Relative Survival Rate</th>
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<td>Age 20-44</td>
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<tr>
<td>Low-grade (diffuse) astrocytoma</td>
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<td>Anaplastic astrocytoma</td>
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<td>Glioblastoma multiforme</td>
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<td>56%</td>
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<tr>
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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 information via telephone (1-800-4-CANCER) and its Web site (www.cancer.gov). Information for patients as well as more detailed information intended for use by cancer care professionals is also available on www.cancer.gov.

What should you ask your doctor about brain and spinal cord tumors?

It is important for you to have honest, open discussions with your cancer care team. They want to answer all of your questions, no matter how trivial you might think they are. Here are some questions to consider:

- What kind of tumor do I have? Is it benign or malignant?
- Where in the brain or spinal cord is the cancer located and how far has it spread?
- What tests need to be done before we can decide on treatment?
- Which treatments might be appropriate for me? What do you recommend? Why?
- What is the goal of treatment (cure, prolonging life, relieving symptoms, etc.)?
- Will treatment relieve any of the symptoms I currently have?
- What are the possible risks or side effects of treatment? What disabilities might I develop?
- How long will treatment take? What will it involve? Where will it be given?
- What are the chances my cancer will recur (come back) with the treatment we have discussed? What would we do if that happens?
- What should I do to be ready for treatment?
- What is my expected prognosis, based on my cancer as you view it?
- What type of follow-up will I need after treatment?

Along with these sample questions, be sure to write down any others you want to ask. For instance, you might want information about recovery times so that you can plan your work and activity schedule. Or you may want to ask about second opinions concerning the diagnosis and treatment, as well as clinical trials for which you may qualify.

What happens after treatment for brain and spinal cord tumors?
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 our document, *Living with Uncertainty: The Fear of Cancer Recurrence*, available at 1-800-ACS-2345 (1-800-227-2345).

**Follow-up care**

After your treatment is over, it is very important to keep all follow-up appointments. During these visits, your doctors will ask about symptoms, do physical exams, and may order lab tests or imaging studies such as MRI scans to watch for a recurrence of the cancer.

In some cases, even with slow growing tumors, some of the tumor may still be present after treatment. Even with tumors that are treated successfully, it is important to remember that some may come back even many years later.

Whether there is evidence of tumor still present or not, your cancer care team will want to follow up closely with you, especially in the first few months and years after treatment to make sure there is no progression or recurrence. Depending on the type and location of the tumor and the extent of the treatment, the team will decide which tests should be done and how often.

During this time, it is important to report any new symptoms to your doctor right away, so that the cause can be determined and treated, if needed. Your doctor can give you an idea of what to look for. Should further treatment be needed at some point, the doctor will go over potential treatment options with you.

**Recovering from the effects of the tumor and its treatment**

The possible effects of the tumor and its treatment on physical and mental function can range from very mild to fairly severe.

Once you have recovered from treatment, doctors will try to determine the extent of any damage to the brain or other areas. Physical exams and imaging tests (CT or MRI scans) may be done after treatment to determine the extent and location of any changes that have occurred in the brain.
Several types of doctors and other health professionals may be involved in assessing any damage and helping you to recover.

A neurologist (a doctor who specializes in treating the nervous system) may assess your function in areas such as physical coordination and muscle strength. If there is muscle weakness or paralysis, you will be seen by physical and/or occupational therapists and perhaps a physiatrist (a doctor who specializes in rehabilitation) while in the hospital and/or as an outpatient for physical therapy.

If the speech center of the brain is damaged, a speech therapist will help you to improve communication skills.

Keeping medical insurance and copies of your medical records

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 the pathology report from any biopsies or surgeries
- if there was surgery, a copy of the operative report
- if there were hospitalizations, copies of the discharge summaries that doctors prepare when patients are sent home
- if there was chemotherapy treatment for the cancer, a list of the drugs, drug doses, and when they were given
- if there was radiation, a summary of the type and dose of radiation and when and where it was given

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 (1-800-227-2345).

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 the American Cancer Society's Quitline® tobacco cessation program at 1-800-ACS-2345 (1-800-227-2345).

**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.

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 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 (1-800-227-2345) 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 shrink the tumors 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 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 are filled with 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 brain and spinal cord tumor research and treatment?

There is always research going on in the area of brain tumors. Scientists are looking for causes and ways to prevent brain cancer, and doctors are working to improve treatments.

Imaging and surgery techniques

Recent advances have made surgery for brain tumors much safer and more successful. Such techniques include:

- functional magnetic resonance imaging (fMRI), which can identify the site of important areas of the brain and how close they are to the tumor
- cortical mapping, which helps identify important areas of the brain during the course of surgery
- image-guided surgery, which allows for safer and more extensive resection

Radiotherapy

Several newer types of radiation therapy now allow doctors to deliver radiation more precisely to the tumor, which helps spare normal brain tissue from getting too much radiation. Newer techniques such as stereotactic radiosurgery, 3-dimensional conformal radiation therapy (3D-CRT), intensity modulated radiation therapy (IMRT), and proton beam therapy are described in the section "How are brain and spinal cord tumors in adults treated?"

Chemotherapy

Newer approaches may help make chemotherapy more effective.

In addition to developing and testing new chemotherapy drugs, many researchers are testing new ways to target chemotherapy to the brain tumor. For example, a method of getting drugs
to the tumor, called *convection enhanced delivery*, requires direct placement of tiny tubes into the tumor. This allows treatment delivery right to the tumor, which may avoid problems with the blood brain barrier and side effects in the rest of the body.

**Other new treatment strategies**

Researchers are also testing some newer approaches to treatment that may help doctors target tumors more precisely. In theory this should allow for more effective treatments that cause fewer side effects. Several of these treatments are under study at this time.

**Tumor vaccines:** Several vaccines have been developed against brain tumor cells. Unlike vaccines against infectious diseases, these vaccines are meant to help treat the disease instead of prevent it. The goal of the vaccines is to stimulate the body's immune system to more effectively fight the brain tumor.

Among the most promising is a vaccine called CDX-110, which targets a specific protein on cancer cells called EGFRvIII. A small clinical trial found that patients with glioblastomas who received the vaccine along with standard treatment seemed to live about twice as long as would have been expected otherwise. A larger study is now under way to try to confirm these results.

Several other vaccines that target brain tumors cells in other ways are also being studied. At this time, all of these vaccines are available only through clinical trials.

**Angiogenesis inhibitors:** Tumors need to create new blood vessels (a process called angiogenesis) to keep their cells nourished. New drugs that attack these blood vessels are used to help treat some cancers. Some of these are now being tested in clinical trials against brain tumors. Researchers have reported promising results using the drug bevacizumab (Avastin) along with chemotherapy in glioblastomas. While it is not specifically FDA approved to treat brain tumors, it is already in use against some other types of cancer, and some doctors are now using it to treat glioblastomas.

**Growth factor inhibitors:** Tumor cells are often very sensitive to proteins called growth factors, which cause them to grow and divide. Newer drugs target these growth factors, which may slow the growth of tumor cells or even cause them to die. Several of these 'targeted drugs' are already in use for other types of cancer, and studies are ongoing to see if they will work for brain tumors as well.

**Hypoxic cell sensitizers:** Some drugs have been found to make tumor cells more likely to be killed by radiation therapy if they are given before treatment. Studies are under way to see if this affects the outcome of treatment.
Additional resources

More information from your American Cancer Society

The following related information may also be helpful to you. These materials may be ordered from our toll-free number, 1-800-ACS-2345 (1-800-227-2345).

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

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

Pain Control: A Guide for People With Cancer and Their Families (also available in Spanish)

Surgery (also available in Spanish)

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

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

The following books are available from the American Cancer Society. Call us at (1-800-227-2345) to ask about costs or to place your order.

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


National organizations and Web sites*

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

American Brain Tumor Association
Toll-free number: 1-800-886-2282
Web site: www.abta.org

Brain Tumor Society
Toll-free number: 1-800-770-8287 (1-800-770-TBTS)
Web site: www.tbts.org
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 (-1800-227-2345) at any time, 24 hours a day.

References


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