Brain and Spinal Cord Tumors in Adults

What are adult brain and spinal cord tumors?

Brain and spinal cord tumors are masses of abnormal cells in the brain or spinal cord that have grown out of control.

Cells in nearly any part of the body can become cancer, and can spread to other areas of the body. To learn more about how cancers start and spread, see What Is Cancer?

In most other parts of the body, it is very important to distinguish between benign (non-cancerous) and malignant (cancerous) tumors. Benign tumors do not grow into nearby tissues or spread to distant areas, so in other parts of the body they are almost never life threatening. One of the main reasons malignant tumors are so dangerous is because they can spread throughout the body.

Although brain tumors rarely spread to other parts of the body, most of them can spread through the brain tissue. Even so-called benign tumors can, as they grow, press on and destroy 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 main concerns with brain and spinal cord tumors are how readily they spread through the rest of the brain or spinal cord and whether they can be removed and not come back.

Brain and spinal cord tumors tend to be 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 brain and spinal cord tumors. Tumors in children are discussed in our document Brain and Spinal Cord Tumors in Children.
The central nervous system

To understand brain and spinal cord tumors, it helps to know about the normal structure and function of the central nervous system (CNS), which 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 the functions of our internal organs.

The brain is 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 liquid, called cerebrospinal fluid (CSF). Cerebrospinal fluid is made by the choroid plexus, which is located in spaces within the brain called ventricles. The ventricles and 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 has 2 hemispheres (halves) and controls reasoning, thought, emotion, and language. It is also responsible for planned (voluntary) muscle movements (throwing a ball, walking, chewing, etc.) and for taking in and interpreting sensory information such as vision, hearing, smell, touch, and pain.

The symptoms caused by a tumor in a cerebral hemisphere depend on where the tumor is. Common symptoms include:

- Seizures
- Trouble speaking
- A change of mood such as depression
- A change in personality
- Weakness or paralysis in part of the body
- Changes in vision, hearing, or other senses

**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 or other involuntary movements.

**Cerebellum:** The cerebellum lies under the cerebrum at the back part of the brain. It helps coordinate movement. Tumors of the cerebellum can cause problems with coordination in walking, trouble with precise movements of hands, arms, feet, and legs, problems swallowing or synchronizing eye movements, and changes in speech rhythm.

Tumors in this critical area of the brain can cause weakness, stiff muscles, or problems with sensation, facial or eye movement, hearing, or swallowing. Double vision is a common early symptom of brain stem tumors, as are problems with coordination in walking. Because the brain stem is a small area that is so essential for life, it might not be possible to surgically remove tumors in this area.

**Spinal cord:** The spinal cord has bundles of very long nerve fibers that carry signals that control muscles, sensation or feeling, and bladder and bowel control.
Spinal cord tumors can cause weakness, paralysis, or numbness. The spinal cord is a narrow structure, so tumors within it usually cause symptoms on both sides of the body (for example, weakness or numbness of both legs). This is different from most brain tumors, which often affect only one side of the body.

The nerves that reach the arms begin in the spinal cord at the level of the neck (cervical spine). Nerves that branch off the spinal cord to the legs, bowel, and bladder arise in the back (thoracic and lumbar spine). Most tumors of the spinal cord start in the neck (cervical spine) and can cause symptoms in the arms and legs, as well as affect bowel and bladder function. Spinal cord tumors below the neck only affect the legs and bowel and bladder function.

Cranial nerves: The cranial nerves extend directly out of the base of the brain (as opposed to coming out of the spinal cord). Tumors starting in cranial nerves can cause
vision problems, trouble swallowing, hearing loss in one or both ears, or facial paralysis, numbness, or pain.

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

The brain and spinal cord have many kinds of tissues and cells, which can develop into different types of tumors.

**Neurons (nerve cells):** These are the most important cells in the brain. They transmit chemical and electric signals that determine thought, memory, emotion, speech, muscle movement, sensation, and just about everything else that the brain and spinal cord do. Neurons send these 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.

Unlike many other types of cells that can grow and divide to repair damage from injury or disease, neurons in the brain and spinal cord largely 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. These tumors are sometimes referred to as 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 a glial cell.

- **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 fatty substance that surrounds and insulates the nerve cell axons of the brain and spinal cord. This helps neurons send electric signals through the 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 CSF flows. Tumors starting in these cells are called *ependymomas.*

- **Microglia** are the immune (infection fighting) cells of the central nervous system.

**Neuroectodermal cells:** These are very early forms of nervous system cells that are probably involved in brain cell development. They are found throughout the brain, although they are not often seen in the adult central nervous system. The most common tumors that come from these cells develop in the cerebellum and are called *medulloblastomas.*
Meninges: These are layers of tissue that line and protect the brain and spinal cord. CSF travels through spaces formed by the meninges. The most common tumors that start in these tissues 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 at the base of the brain. It is connected to a part of the brain called the hypothalamus. Both make hormones that help regulate the activity of several other glands in the body. 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 affect these functions. For example, tumors starting in the pituitary gland sometimes make too much of a certain hormone, which can cause problems. On the other hand, a person may have low levels of one or more hormones after treatment and may need to take hormones to make up for this.

Pineal gland: The pineal gland is not really part of the brain. It is, in fact, a small endocrine gland that sits between the cerebral hemispheres. It makes melatonin, a hormone that regulates sleep, in response to changes in light. The most common tumors of the pineal gland are called pineoblastomas.

Blood-brain barrier: The inner lining of the small blood vessels (capillaries) in the brain and spinal cord creates a very selective barrier between the blood and the tissues of the central nervous system. This barrier normally helps maintain the brain’s metabolic balance and 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 in adults

Tumors that start in the brain (primary brain tumors) are not the same as 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 tumors are not treated the same way. For example, breast or lung cancers that spread to the brain are treated differently from tumors that start in the brain.

This document is only about primary brain and spinal cord tumors, not those that have spread to the brain and spinal cord from elsewhere in the body.
Unlike cancers that start in other parts of the body, tumors that start in the brain or spinal cord rarely spread to distant organs. Even so, tumors of the brain or spinal cord are rarely considered benign (non-cancerous). They can still cause damage by growing and spreading into nearby areas, where they can destroy normal brain tissue. And unless they are completely removed or destroyed, most brain or spinal cord tumors will continue to grow and eventually be life-threatening.

Primary brain tumors can start in almost any type of tissue or cell in the brain or spinal cord. Some tumors have 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 brain tumor. 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 (also known as glioblastoma multiforme), astrocytomas, oligodendrogliomas, and ependymomas. About 3 out of 10 of all brain tumors are gliomas. Most fast-growing brain tumors are gliomas.

Astrocytomas

Astrocytomas are tumors that start in glial cells called astrocytes. About 2 out of 10 brain tumors are astrocytomas.

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

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

- High grade astrocytomas, known as glioblastomas (or glioblastoma multiforme), are the fastest growing. These tumors make up about two-thirds of astrocytomas and are the most common malignant brain tumors in adults.

- Intermediate-grade astrocytomas, or anaplastic astrocytomas, grow at a moderate rate.

- Low-grade (diffuse) astrocytomas tend to be slow growing, but they can become more aggressive and fast growing over time.

- Some low-grade types called non-infiltrating astrocytomas do not usually grow into nearby tissues and tend to have a good prognosis. These include pilocytic astrocytomas and dysembryoplastic neuroepithelial tumors (DNETs). They are more common in children than in adults.
Oligodendrogliomas

These tumors start in brain glial cells called oligodendrocytes. These tumors tend to grow slowly, but like astrocytomas, most of them can grow into (infiltrate) nearby brain tissue and cannot be removed completely by surgery. Oligodendrogliomas sometimes spread along the CSF pathways but rarely spread outside the brain or spinal cord. As with astrocytomas, they can become more aggressive over time. Very aggressive forms of these tumors are known as anaplastic oligodendrogliomas. Only about 2% of brain tumors are oligodendrogliomas.

Ependymomas

These tumors arise from ependymal cells, which line the ventricles. They can range from fairly low-grade (less aggressive) tumors to higher grade ones, which are called anaplastic ependymomas. Only about 2% of brain tumors are ependymomas.

Ependymomas are more likely to spread along the CSF pathways than other gliomas but do not spread outside the brain or spinal cord. Ependymomas may block the exit of CSF from the ventricles, causing the ventricles to become very large – a condition called hydrocephalus.

Unlike astrocytomas and oligodendrogliomas, ependymomas usually do not grow into normal brain tissue. As a result, some (but not all) ependymomas can be removed completely and cured by surgery. But because they can spread along ependymal surfaces and CSF pathways, treating them can sometimes be difficult. Spinal cord ependymomas have the greatest chance of being cured with surgery, but treatment can cause side effects related to nerve damage.

Mixed gliomas

These tumors contain more than one cell type. For example, oligoastrocytomas have some of the same types of cells as both oligodendrogliomas and astrocytomas. Treatment is typically based on the fastest growing component of the tumor.

Meningiomas

Meningiomas begin in 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 tumors in adults (although strictly speaking, they are not actually brain tumors).

The risk of these tumors increases with age. They occur about twice as often in women. Sometimes these tumors run in families, especially in those with neurofibromatosis, a syndrome in which people develop many benign tumors of nerve tissue.
Meningiomas are often assigned a grade, based on how the cells look under the microscope.

- Grade I (benign) tumors have cells that look the most like normal cells. They make up about 80% of meningiomas. Most of these can be cured by surgery, but some grow very close to vital structures in the brain or cranial nerves and cannot be cured by surgery alone.

- Grade II (atypical or invasive) meningiomas usually have cells that look slightly more abnormal. About 15% to 20% of meningiomas are grade II. They can grow directly into nearby brain tissue and bone and are more likely to come back (recur) after surgery.

- Grade III (anaplastic) meningiomas have cells that look the most abnormal. They make up only about 1% to 3% of meningiomas. They tend to grow quickly, can grow into nearby brain tissue and bone, and are the most likely to come back after treatment. Some may even spread to other parts of the body.

**Medulloblastomas**

Medulloblastomas develop from neuroectodermal cells (primitive nerve cells) in the cerebellum. They are fast-growing tumors and often spread throughout the CSF pathways, but they can be treated by surgery, radiation therapy, and chemotherapy.

Medulloblastomas occur much more often in children than in adults. They are part of a class of tumors called primitive neuroectodermal tumors (PNETs) that can also start in other parts of the central nervous system. They are discussed in more detail in our document *Brain and Spinal Cord Tumors in Children*.

**Gangliogliomas**

Gangliogliomas contain both neurons and glial cells. These tumors are very uncommon in adults and can usually be cured by surgery alone or surgery combined with radiation therapy.

**Schwannomas (neurilemmomas)**

Schwannomas develop from Schwann cells, which surround and insulate cranial nerves and other nerves. They make up about 8% of all CNS tumors.

Schwannomas are almost always benign tumors. They can arise from any cranial nerve. When they form on the cranial nerve responsible for hearing and balance near the cerebellum they are called *vestibular schwannomas* or *acoustic neuromas*. They can also start on spinal nerves after the point where they have left the spinal cord. When this
happens, they can press on the spinal cord, causing weakness, sensory loss, and bowel and bladder problems.

**Craniopharyngiomas**

These slow-growing tumors start above the pituitary gland but below the brain itself. They may press on the pituitary gland and the hypothalamus, causing hormone problems. Because they start very close to the optic nerves, they can also cause vision problems. Their tendency to stick to these important structures can make them hard to remove completely without damaging vision or hormone balance. Craniopharyngiomas are more common in children, but they are sometimes seen in adults.

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

**Chordomas**

These rare tumors start in the bone at the base of the skull or at the lower end of the spine. Chordomas don’t start in the central nervous system, but they can injure the nearby brain or spinal cord by pressing on it.

These tumors are treated with surgery if possible, often followed by radiation therapy, but they tend to come back in the same area after treatment, causing more damage. They usually do not spread to other organs. For more information on chordomas, see our document *Bone Cancer*.

**Non-Hodgkin lymphomas**

Lymphomas are cancers that start in cells called lymphocytes (one of the main cell types of the immune system). Most lymphomas start in other parts of the body, but some may start in the CNS. These lymphomas are more common in people with immune system problems, such as those infected with HIV, the virus that causes AIDS. Because of new treatments for AIDS, CNS lymphomas have become less common in recent years.

These lymphomas often grow quickly and can be hard to treat. Recent advances in chemotherapy, however, have improved the outlook for people with these cancers. For more information on CNS lymphomas (including treatment), see our document *Non-Hodgkin Lymphoma*.

**Pituitary tumors**

Tumors that start in the pituitary gland are almost always benign (non-cancerous). But they can still cause problems if they grow large enough to press on nearby structures or if
they make too much of any kind of hormone. For more information, see our document *Pituitary Tumors.*

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

The American Cancer Society’s estimates for brain and spinal cord tumors in the United States for 2015 include both adults and children.

- About 23,770 malignant tumors of the brain or spinal cord (13,350 in males and 10,420 in females) will be diagnosed. These numbers would be much higher if benign tumors were also included.
- About 16,050 people (9,440 males and 6,610 females) will die from brain and spinal cord tumors.

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 140 for a man and 1 in 180 for a woman).

Survival rates for brain and spinal cord tumors 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 “Survival rates for selected adult brain and spinal cord tumors.”

Visit the American Cancer Society’s Cancer Statistics Center for more key statistics.

**What are the risk factors for brain and spinal cord tumors?**

A risk factor is anything that affects your chance of getting a disease such as a brain or spinal cord tumor. Different types of cancer have different risk factors. Some risk factors, like smoking, you can change. Others, like your age or family history, can’t be changed.

But having a risk factor, or even several, does not always mean that a person will get the disease, and many people get tumors without having any known risk factors. Even if a person has a risk factor, it is often very hard to know how much it contributed to the tumor.

Most brain tumors are not linked with any known risk factors and have no obvious cause. But there are a few factors that can raise the risk of brain tumors.
Radiation exposure

The best known environmental risk factor for brain tumors is radiation exposure, most often from radiation therapy to treat some other condition. For example, before the risks of radiation were known, children with ringworm of the scalp (a fungal infection) were sometimes treated with low-dose radiation therapy, which was later found to increase their risk of brain tumors as they got older.

Today, most radiation-induced brain tumors are caused by radiation to the head given to treat other cancers. They occur most often in people who received radiation to the brain as children as part of their treatment for leukemia. These brain tumors usually develop around 10 to 15 years after the radiation.

Radiation-induced tumors are still fairly rare, but because of the increased risk (as well as the other side effects), radiation therapy to the head is only given after carefully weighing the possible benefits and risks. For most patients with other cancers involving the brain or head, the benefits of radiation therapy far outweigh the risk of developing a brain tumor years later.

The possible risk from exposure to imaging tests that use radiation, such as x-rays or CT scans, is not known for sure. These tests use much lower levels of radiation than those used in radiation treatments, so if there is any increase in risk, it is likely to be very small. But to be safe, most doctors recommend that people (especially children and pregnant women) not get these tests unless they are clearly needed.

Family history

Most people with brain tumors do not have a family history of the disease, but in rare cases brain and spinal cord cancers run in families. In general, patients with familial cancer syndromes tend to have many tumors that first occur when they are young. Some of these families have well-defined disorders, such as:

Neurofibromatosis type 1 (NF1)

This genetic disorder, also known as von Recklinghausen disease, is the most common syndrome linked to brain or spinal cord tumors. People with this condition have higher risks of schwannomas, meningiomas, and certain types of gliomas, as well as neurofibromas (benign tumors of peripheral nerves). Changes in the \( NF1 \) gene cause this disorder. These changes are inherited from a parent in about half of all cases. In the other half, the \( NF1 \) gene changes occur before birth in people whose parents did not have this condition.
Neurofibromatosis type 2 (NF2)

This condition, which is much less common than NF1, is associated with vestibular schwannomas (acoustic neuromas), which almost always occur on both sides of the head. It is also linked with an increased risk of meningiomas or spinal cord ependymomas. Changes in the NF2 gene are responsible for neurofibromatosis type 2. Like NF1, the gene changes are inherited in about half of cases or may occur before birth in children without a family history.

Tuberous sclerosis

People with this condition may have subependymal giant cell astrocytomas (SEGAs), which are low-grade astrocytomas that develop beneath the ependymal cells of the ventricles. They may also have other benign tumors of the brain, skin, heart, kidneys, and other organs. This condition is caused by changes in either the TSC1 or the TSC2 gene. These gene changes can be inherited from a parent, but most often they develop in people without a family history.

Von Hippel-Lindau disease

People with this condition tend to develop benign or cancerous tumors in different parts of the body, including hemangioblastomas (blood vessel tumors) in the brain, spinal cord, or retina, as well as tumors of the inner ear, kidney, adrenal gland, and pancreas. It is caused by changes in the VHL gene. Most often the gene changes are inherited, but in some cases the changes happen before birth in people whose parents don’t have them.

Li-Fraumeni syndrome

People with this condition are at higher risk for developing gliomas, along with breast cancer, soft tissue sarcomas, leukemia, and adrenal gland cancer, and certain other types of cancer. It is caused by changes in the TP53 gene.

Other syndromes

Other inherited conditions are also linked with increased risks of certain types of brain and spinal cord tumors, including:

- Gorlin syndrome (basal cell nevus syndrome)
- Turcot syndrome
- Cowden syndrome

Some families may have genetic disorders that are not well recognized or that may even be unique to a particular family.
Immune system disorders

People with impaired immune systems have an increased risk of developing lymphomas of the brain or spinal cord (known as primary CNS lymphomas). Lymphomas are cancers of lymphocytes, a type of white blood cell that fights disease. Primary CNS lymphoma is less common than lymphoma that develops outside the brain.

A weakened immune system can be congenital (present at birth), or it can be caused by treatments for other cancers, treatment to prevent rejection of transplanted organs, or diseases such as the acquired immunodeficiency syndrome (AIDS).

Factors with uncertain, controversial, or unproven effects on brain tumor risk

Cell phone use

This has been the subject of a great deal of debate in recent years. Cell phones give off radiofrequency (RF) rays, a form of energy on the electromagnetic spectrum between FM radio waves and those used in microwave ovens, radar, and satellite stations. Cell phones do not give off ionizing radiation, the type that can cause cancer by damaging the DNA inside cells. Still, there have been concerns that the phones, whose antennae are built-in and therefore are placed close to the head when being used, might somehow raise the risk of brain tumors.

Some studies have suggested a possible increased risk of brain tumors or of vestibular schwannomas with cell phone use, but most of the larger studies done so far have not found an increased risk, either overall or among specific types of tumors. Still, there are very few studies of long-term use (10 years or more), and cell phones haven’t been around long enough to determine the possible risks of lifetime use. The same is true of any possible higher risks in children, who are increasingly using cell phones. Cell phone technology also continues to change, and it’s not clear how this might affect any risk.

These risks are being studied, but it will probably be many years before firm conclusions can be made. In the meantime, for people concerned about the possible risks, there are ways to lower your exposure, such as using an earpiece to move the phone itself away from the head. For more information, see our document Cellular Phones.

Other factors

Other environmental factors such as exposure to vinyl chloride (a chemical used to manufacture plastics), petroleum products, and certain other chemicals have been linked with an increased risk of brain tumors in some studies but not in others.

Exposure to aspartame (a sugar substitute), exposure to electromagnetic fields from power lines and transformers, and infection with certain viruses have been suggested as
possible risk factors, but most researchers agree that there is no convincing evidence to link these factors to brain tumors. Research on these and other potential risk factors continues.

**Do we know what causes brain and spinal cord tumors in adults?**

The cause of most brain and spinal cord tumors is not fully understood. But researchers have found some of the 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 strands of DNA in each cell. Brain and spinal cord tumors, like other tumors, are caused by changes in the DNA inside cells. DNA is the chemical that makes up our genes — the instructions for how our cells function. We usually look like our parents because they are the source of our DNA. But DNA affects more than how we look.

Some genes control when our cells grow, divide into new cells, and die. Certain genes that help cells grow, divide, and stay alive are called oncogenes. Others that slow down cell division, or cause cells to die at the right time, are called tumor suppressor genes. Cells sometimes make mistakes in copying their DNA when dividing into 2 cells. Cancers can be caused by DNA changes that turn on oncogenes or turn off tumor suppressor genes. These gene changes can be inherited from a parent, but more often they happen during a person’s lifetime.

In recent years, researchers have found the gene changes that cause some rare inherited syndromes (like neurofibromatosis, tuberous sclerosis, Li-Fraumeni syndrome, and von Hippel-Lindau syndrome) and increase the risk of developing some brain and spinal cord tumors. For example, the Li-Fraumeni syndrome is caused by changes in the TP53 tumor suppressor gene. Normally, this gene prevents cells with damaged DNA from growing. Changes in this gene increase the risk of developing brain tumors (particularly gliomas), as well as some other cancers.

In most cases, it is not known why people without inherited syndromes develop brain or spinal cord tumors. Most risk factors for cancer somehow damage genes. For example, tobacco 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 tobacco smoke and other cancer-causing chemicals that we might breathe in or eat, so these factors are not likely to play a major role in these cancers.

Several different gene changes must usually occur in normal cells before they become cancerous. There are many kinds of brain tumors, each of which may have different sets
of gene changes. A number of gene or chromosome changes have been found in different brain tumor types, but there are probably many others that have not yet been found.

Researchers now understand some of the gene changes that occur in different types of brain tumors, but it’s still not clear what causes most of these changes. Some gene changes might be inherited, but most brain and spinal cord tumors are not the result of known inherited syndromes. Other than radiation, there are no known lifestyle-related or environmental causes of brain tumors. Most gene changes are probably just random events that sometimes happen inside a cell, without having an outside cause.

Can brain and spinal cord tumors in adults be prevented?

The risk of many cancers in adults can be reduced with certain lifestyle changes (such as staying at a healthy weight or quitting smoking). But other than radiation exposure, there are no known lifestyle-related or environmental causes of brain and spinal cord tumors, so at this time there is no known way to protect against most of these tumors.

For most people with other types of cancer in or near the head, radiation therapy may be given if doctors feel the benefits outweigh the small risk of developing a brain tumor years later. Still, when it is needed, doctors try to limit the dose of radiation as much as possible.

Imaging tests such as x-rays or CT scans use much lower levels of radiation than those used for treatment. If there is any increase in risk from these tests, it is likely to be very small, but to be safe, most doctors recommend that people (especially pregnant women and children) not get these tests unless they are absolutely needed.

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

At this time there are no widely recommended tests to screen for brain and spinal cord tumors. (Screening is testing for cancer in people without any symptoms.) Most brain tumors are found when a person sees a doctor because of signs or symptoms they are having (see “Signs and symptoms of adult brain and spinal cord tumors”).

Most often, the outlook for people with brain and spinal cord tumors depends on 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.

For people with certain inherited syndromes that put them at higher risk for brain tumors, such as neurofibromatosis or tuberous sclerosis, doctors often recommend frequent physical exams and other tests starting when they are young. In some cases these tests
can find tumors when they are still small. Not all tumors related to these syndromes may need to be treated right away, but finding them early might help doctors monitor them so that they can be treated quickly if they begin to grow or cause problems.

**Signs and symptoms of adult brain and spinal cord tumors**

Signs and symptoms of brain or spinal cord tumors may occur gradually and become worse over time, or they can happen suddenly, such as with a seizure.

**General symptoms**

Tumors in any part of the brain may cause the pressure inside the skull (known as *intracranial pressure*) to rise. This can be caused by growth of the tumor itself, swelling in the brain, or blockage of the flow of cerebrospinal fluid (CSF). Increased pressure can lead to general symptoms such as:

- Headache
- Nausea
- Vomiting
- Blurred vision
- Balance problems
- Personality or behavior changes
- Seizures
- Drowsiness or even coma

Headaches that tend to get worse over time are a common symptom of brain tumors, occurring in about half of patients. (Of course, most headaches are not caused by tumors.)

As many as half of people with brain tumors will have seizures at some point. The type of seizure may depend on where the tumor is. Sometimes this is the first sign of a brain tumor, but fewer than 1 in 10 first seizures are caused by brain tumors.

**Symptoms of tumors in different parts of the central nervous system**

Brain and spinal cord tumors often cause problems with the specific functions of the region they develop in. But these symptoms can be caused by any disease in that particular location — they do not always mean a person has a brain or spinal cord tumor.
• Tumors in the parts of the cerebrum (the large, outer part of the brain) that control movement or sensation can cause weakness or numbness of part of the body, often on just one side.

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

• Tumors in the front part of the cerebrum can sometimes affect thinking, personality, and language.

• 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, which controls coordination, a person might have trouble with walking or other everyday functions, even eating.

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

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

• Spinal cord tumors can cause numbness, weakness, or lack of coordination in the arms and/or legs (usually on both sides of the body), as well as bladder or bowel problems.

The brain also controls functions of some other organs, including hormone production, so brain tumors can also cause many other symptoms that aren’t listed here.

Having one or more of the symptoms above does not mean that you definitely have a brain or spinal cord tumor. All of these symptoms can have other causes. Still, if you have any of these symptoms, especially if they don’t go away or get worse over time, see your doctor so that the cause can be found and treated, if needed.

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

Brain and spinal cord tumors are usually found because of signs or symptoms a person is having. If a tumor is suspected, tests will be needed to confirm the diagnosis.

**Medical history and physical exam**

If signs or symptoms suggest you might have a brain or spinal cord tumor, your doctor will get a complete medical history, focusing on your symptoms and when they began. The doctor will also do a neurologic exam to check your brain and spinal cord function. It
tests reflexes, muscle strength, vision, eye and mouth movement, coordination, balance, alertness, and other functions.

If the results of the exam are abnormal, your doctor may refer you to a neurologist (a doctor who specializes in medical treatment of nervous system diseases) or a neurosurgeon (a doctor who specializes in surgical treatment of nervous system diseases), who will do a more detailed neurologic exam or other tests.

Imaging tests

Your doctor may order one or more imaging tests. These tests use x-rays, strong magnets, or radioactive substances to create pictures of the brain and spinal cord. The pictures may be looked at by doctors specializing in this field (neurosurgeons, neurologists, and neuroradiologists) as well as by your primary doctor.

Magnetic resonance imaging (MRI) and computed tomography (CT) scans are used most often for brain diseases. These scans will show a brain tumor, if one is present, in almost all cases. Doctors can often also get an idea about what type of tumor it might be, based on how it looks on the scan and where it is in the brain.

Magnetic resonance imaging (MRI) scan

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 help see details better.

MRI scans can take a long time — often up to an hour. You may have to lie on a table that slides inside a narrow tube, which can be confining and might upset people with a fear of enclosed spaces. Newer, open MRI machines can sometimes be used instead, but they might result in less detailed images and can’t be used in all cases. The machine also makes buzzing and clicking noises that you may find disturbing. Some people might need medicine to help them relax for the test.

Magnetic resonance angiography (MRA): This special form of MRI 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.
Magnetic resonance spectroscopy (MRS): This test is like an MRI, except that it measures radio wave interactions with different chemicals in the brain. MRS highlights some features of brain tumors that are not clearly seen by MRI. It creates graph-like results called spectra (although basic images can also be created). This might give clues as to the type of tumor, but in most cases a biopsy of the tumor is still needed to get an accurate diagnosis. MRS can also be used after treatment to help determine if an area that still looks abnormal on another test is remaining tumor or if it is more likely to be scar tissue.

Magnetic resonance perfusion: For this test, also known as perfusion MRI, a contrast dye is injected quickly into a vein. A special type of MR image is then obtained to look at the amount of blood going through different parts of the brain and tumor. Tumors often have a bigger blood supply than normal areas of the brain. A faster growing tumor may need more blood.

Perfusion MRI can give doctors an idea of the best place to take a biopsy. It can also be used after treatment to help determine if an area that still looks abnormal is remaining tumor or if it is more likely to be scar tissue.

Functional MRI (fMRI): This newer type of MRI looks for tiny blood flow changes in an active part of the brain. It can be used to determine what part of the brain handles a function such as speech, thought, sensation, or movement. Doctors can use this to determine which parts of the brain to avoid when planning surgery or radiation therapy.

This test is similar to a standard MRI, except that you will be asked to do specific tasks (such as answering simple questions or moving your fingers) while the scans are being done.

Computed tomography (CT) scan

The CT scan is an x-ray test that produces 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 body. Unlike a regular x-ray, a CT scan creates detailed images of the soft tissues in the body.

CT scans are not used as often as MRI scans when looking at brain or spinal cord tumors, but they can be useful in some cases. They may be used if MRI is not an option (such as in people who are very overweight or people who have a fear of enclosed spaces). CT scans also show greater detail of the bone structures near the tumor.

Before the scan, you may get 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, people have more serious reactions like trouble breathing or low blood
pressure. Be sure to tell the doctor if you have any allergies or if you ever had a reaction to any contrast material used for x-rays.

A CT scanner has been described as a large donut, with a narrow table that slides in and out of the middle opening. You need to lie still on the table while the scan is being done. Some people feel a bit confined by the ring while the pictures are being taken, although it is not as narrow as an MRI tube.

**CT angiography (CTA):** For this test, you are injected with a contrast material through an IV line while you are in the CT scanner. The scan creates detailed images of the blood vessels in the brain, which can help doctors plan surgery. CT angiography can provide better details of the blood vessels in and around a tumor than MR angiography in some cases.

**Positron emission tomography (PET) scan**

For this test, a radioactive substance (usually a type of sugar known as FDG) is injected into the blood. The amount of radioactivity used is very low and passes out of the body within a day or so. Because tumor cells in the body grow quickly, they absorb larger amounts of the sugar than most other cells. After about an hour, you are moved onto a table in the PET scanner. You lie on the table for about 30 minutes while a special camera creates a picture of areas of radioactivity in the body. The picture is not as detailed as 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 tumors or not.

This test is also useful after treatment to help determine if an area that still looks abnormal on an MRI scan is remaining tumor or if it is more likely to be scar tissue. Any remaining tumor will show up on the PET scan, while scar tissue will not.

**Chest x-ray**

A chest x-ray may be done to look for tumors in the lungs if a tumor is found in the brain, because in adults most tumors in the brain have actually started in another organ (most often the lung) and then spread to the brain. This test can be done in a doctor’s office, in an outpatient radiology center, or in a hospital.

**Angiogram**

For this test, a special dye is injected into blood vessels near the tumor, and the area is then viewed with x-rays. This helps doctors look at the blood supply of a tumor.

This test is not done much for brain or spinal cord tumors anymore, as it has largely been replaced by other tests that can look at blood vessels, such as computerized tomographic angiography (CTA) or magnetic resonance angiography (MRA).
Rarely, an angiogram may be used as part of the treatment for certain brain tumors. It is done as a first step of a procedure called *embolization*, in which the radiologist injects tiny particles into the blood vessels feeding the tumor to block them and make it easier to remove the tumor.

### Brain or spinal cord tumor biopsy

Imaging tests such as MRI and CT scans may show an abnormal area that is likely to be a brain or spinal cord tumor. But most often these scans can’t tell exactly what type of tumor it is. This can only be done by removing some of the tumor tissue, which is called a *biopsy*. A biopsy may be done as a procedure on its own, or it may be part of surgery to treat the tumor.

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). Sometimes it might need to be looked at by a neuropathologist, a pathologist who specializes in nervous system diseases. The pathologist determines if the tumor is benign or malignant (cancerous) and exactly what type of tumor it is.

Sometimes, a tumor may look so much like an astrocytoma on an MRI scan that a biopsy is not needed, especially if the tumor is 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 MR 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 if, based on imaging tests, the risks of surgery to remove the tumor might be too high (such as with some tumors in vital areas, those deep within the brain, or other tumors that probably can’t be treated with surgery) but a sample is still needed to make a diagnosis.

The patient may be asleep (under general anesthesia) or awake during the biopsy. If the patient is awake, the neurosurgeon injects a local anesthetic into areas of skin above the skull to numb them. (The skull and brain do not feel pain.)

A rigid frame may then be attached to the head. This helps make sure the surgeon is targeting the tumor precisely. An incision (cut) 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 to remove small pieces of tissue.

Another approach is to get an MRI or CT, use scalp markers or facial and scalp contours to create a map of the inside of the head, and then use an image-guidance system to direct the needle into the tumor. This still requires making an incision and drilling a small hole into the skull.
The removed tissue is sent to a pathologist, who looks at it under a microscope to determine what type of tumor it is. This is very important in determining the prognosis (outlook) and the best course of treatment.

**Surgical or open biopsy (craniotomy)**

If imaging tests show the tumor can be treated with surgery, the neurosurgeon may not do a needle biopsy. Instead, he or she may do an operation called a *craniotomy* (described in the “Surgery for adult brain and spinal cord tumors” section) to remove all or most of the tumor. (Removing most of the tumor is known as *debulking*.)

Small samples of the tumor are looked at right away by the pathologist while the patient is still in the operating room, for a preliminary diagnosis. This can help guide treatment, including whether further surgery should be done at that time. A final diagnosis is made within a few days in most cases.

You can read more about the kinds of tests that are done on biopsy or tissue samples in our document *Testing Biopsy and Cytology Specimens for Cancer*.

**Lumbar puncture (spinal tap)**

This test is used to look for cancer cells in the cerebrospinal fluid (CSF), 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 sent to a lab to be looked at under a microscope for cancer cells. 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 large drop in pressure in the fluid, which could possibly cause serious problems. For this reason, imaging tests such as CT or MRI scans are done first.

Lumbar punctures usually aren’t done to diagnose brain tumors, but they may be done to help determine the extent of a tumor by looking for cancer cells in the CSF. They are often used if a tumor has already been diagnosed as a type that can commonly spread through the CSF, such as an ependymoma. Lumbar punctures are particularly important in people with suspected brain lymphomas because often the lymphoma cells spread into the CSF.

**Blood and urine tests**

These lab tests rarely are part of the actual diagnosis of brain and spinal cord tumors, but they may be done to check how well the liver, kidneys, and some other organs are
working. This is especially important before any planned surgery. If you are getting chemotherapy, blood tests will be done routinely to check blood counts and to see if the treatment is affecting other parts of the body.

How are brain and spinal cord tumors in adults staged?

The stage of a cancer is a measure of how far it has spread. A staging system is a standard way for the cancer care team to describe the extent of this spread. For most types of cancer, the stage is one of the most important factors in selecting treatment options and in determining the outlook (prognosis).

But tumors of the brain and spinal cord differ in some important ways from cancers in other parts of the body. One of the main reasons other cancers are dangerous is that they can spread throughout the body. Tumors starting in the brain or spinal cord can spread to other parts of the central nervous system, but they almost never spread to other organs. These tumors are dangerous because they can interfere with essential functions of the brain.

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

- The person’s age
- The person’s functional level (whether the tumor is affecting normal brain functions and everyday activity)
- 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)
- Whether or not the tumor has spread through the cerebrospinal fluid (CSF) to other parts of the brain or spinal cord
- Whether or not tumor cells have spread beyond the central nervous system
Survival rates for selected adult brain and spinal cord tumors

Survival rates are a way for doctors and patients to get a general idea of the outlook (prognosis) for people with a certain type of tumor. Some people want to know the statistics for people in their situation, while others may not find them helpful, or may even not want to know them. If you do not want to know the survival rates for adult brain and spinal cord tumors, stop reading here and skip to the next section.

The 5-year survival rate refers to the percentage of people who live at least 5 years after being diagnosed. Of course, many of these people live much longer than 5 years. Five-year relative survival rates, such as the numbers below, assume that some people will die of other causes and compare the observed survival with that expected for people without the tumor. This is a more accurate way to describe the prognosis for patients with a particular type of tumor.

To get 5-year survival rates, doctors have to look at people who were treated at least 5 years ago. Although the numbers below are among the most current available, improvements in treatment since then may result in a better outlook for people now being diagnosed with 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 1995 and 2010. As can be seen below, survival rates for brain and spinal cord tumors can vary widely by age, with younger people tending to have having better outlooks than older people. The survival rates for those 65 or older are generally lower than the rates for the ages listed below.

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

<table>
<thead>
<tr>
<th>Type of Tumor</th>
<th>Age 20-44</th>
<th>Age 45-54</th>
<th>Age 55-64</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-grade (diffuse) astrocytoma</td>
<td>65%</td>
<td>43%</td>
<td>21%</td>
</tr>
<tr>
<td>Anaplastic astrocytoma</td>
<td>49%</td>
<td>29%</td>
<td>10%</td>
</tr>
<tr>
<td>Glioblastoma</td>
<td>17%</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>Oligodendroglioma</td>
<td>85%</td>
<td>79%</td>
<td>64%</td>
</tr>
<tr>
<td>Anaplastic oligodendroglioma</td>
<td>67%</td>
<td>55%</td>
<td>38%</td>
</tr>
<tr>
<td>Ependymoma/anaplastic ependymoma</td>
<td>91%</td>
<td>86%</td>
<td>85%</td>
</tr>
</tbody>
</table>
Meningioma 92% 77% 67%

Survival rates are based on previous outcomes of large numbers of people who had the disease, but they can’t predict what will happen in any person’s case. The type of tumor is important in estimating a person’s outlook. But many other factors can also affect outlook, such as the location of the tumor and whether it can be removed with surgery, as well as a person’s age and overall health. Even when taking these other factors into account, survival rates are at best rough estimates. Your doctor is your best source of information on this, as he or she is familiar with your situation.

How are brain and spinal cord tumors in adults treated?

General comments about treatment

Brain and spinal cord tumors can often be hard to treat and may require care from a team of different types of doctors. This team is often led by a neurosurgeon, a doctor who uses surgery to treat brain and nervous system tumors. Other doctors on the team may include:

- Neurologist: a doctor who diagnoses brain and nervous system diseases and treats them with medicines
- Radiation oncologist: a doctor who uses radiation to treat cancer
- Medical oncologist: a doctor who uses chemotherapy and other medicines to treat cancers
- Endocrinologist: a doctor who treats diseases in glands that secrete hormones

Many other specialists may be involved in your care as well, including physician assistants, nurse practitioners, nurses, psychologists, social workers, rehabilitation specialists, and other health professionals.

Several types of treatment can be used to treat brain and spinal cord tumors, including:

- Surgery
- Radiation therapy
- Chemotherapy
- Targeted therapy
- Other types of drugs
Treatment is based on the type of tumor and other factors, and often more than one type of treatment is used. Doctors plan each person’s treatment individually to give them the best chance of treating the cancer while limiting the side effects as much as possible.

It’s important to discuss all of your treatment options as well as their possible side effects with your treatment team to help make the decision that best fits your needs. If there is anything you don’t understand, ask to have it explained. (See the section “What should you ask your doctor about adult brain and spinal cord tumors?” for some questions to ask.)

If time permits, getting a second opinion from a doctor experienced with your type of tumor is often a good idea. It can give you more information and help you feel more confident about the treatment plan you choose.

The next few sections describe the various types of treatments used for brain and spinal cord tumors. This is followed by a description of the most common approaches used based on the type of tumor.

Thinking about taking part in a clinical trial

Clinical trials are carefully controlled research studies that are done to get a closer look at promising new treatments or procedures. Clinical trials are one way to get state-of-the-art cancer treatment. In some cases they may be the only way to get access to newer treatments. They are also the best way for doctors to learn better methods to treat cancer. Still, they are not right for everyone.

If you would like to learn more about clinical trials that might be right for you, start by asking your doctor if your clinic or hospital conducts clinical trials. You can also call our clinical trials matching service at 1-800-303-5691 for a list of studies that meet your medical needs, or see “Clinical Trials” to learn more.

Considering complementary and alternative methods

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

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

Be sure to talk to your cancer care team about any method you are thinking about using. They can help you learn what is known (or not known) about the method, which can help you make an informed decision. See Complementary and Alternative Medicine to learn more.
Help getting through cancer treatment

Your cancer care team will be your first source of information and support, but there are other resources for help when you need it. Hospital- or clinic-based support services are an important part of your care. These might include nursing or social work services, financial aid, nutritional advice, rehab, or spiritual help.

The American Cancer Society also has programs and services – including rides to treatment, lodging, support groups, and more – to help you get through treatment. Call our National Cancer Information Center at 1-800-227-2345 and speak with one of our trained specialists on call 24 hours a day, every day.

The treatment information given here is not official policy of the American Cancer 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.

Surgery for adult brain and spinal cord tumors

For brain and spinal cord tumors, surgery may be done for different reasons:

- To get a biopsy sample to determine the type of tumor
- To remove as much of the tumor as possible
- To help prevent or treat possible complications from the tumor

Before surgery, be sure you understand the goal of the surgery, as well as its possible benefits and risks.

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 control or cure many tumors, including some low-grade astrocytomas, ependymomas, craniopharyngiomas, gangliogliomas, and meningiomas.

Tumors that tend to spread widely into nearby brain tissue such as anaplastic astrocytomas or glioblastomas cannot be cured by surgery. But surgery can reduce the amount of tumor that needs to be treated by radiation or chemotherapy, which might help these treatments work better. This could help prolong the person’s life even if all of the tumor can’t be removed.
Surgery may also help relieve some of the symptoms caused by brain tumors, particularly those caused by a buildup of pressure within the skull. These can include headaches, nausea, vomiting, and blurred vision. Surgery may also make seizures easier to control with medicines.

Surgery may not be a good option in some cases, such as if the tumor is deep within the brain, if it is in a part of the brain that can’t be removed, such as the brain stem, or if a person can’t have a major operation for other health reasons.

Surgery is not very effective against some types of brain tumors, such as lymphomas, although it may be used to get a biopsy for diagnosis.

**Craniotomy:** A craniotomy is a surgical opening made in the skull. This is the most common approach for surgery to treat brain tumors. 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 might need to be shaved before surgery. The neurosurgeon first makes an incision in the scalp over the skull near the tumor, and the skin is folded back. A special type of drill is used to remove the piece of the skull over the tumor.

The opening is typically large enough for the surgeon to insert several instruments and view the parts of the brain needed to operate safely. The surgeon may need to make an incision into the brain itself to reach the tumor. The surgeon may use MRI or CT scans taken before the surgery (or may use ultrasound once the skull has been opened) 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 has many or just a few blood vessels. One way is to cut it out with a scalpel or special scissors. Some tumors are soft and can be removed with suction devices. In other cases, a probe attached to an ultrasonic generator can 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 often operates while looking at the brain through a special microscope. As mentioned above, MRI or CT scans can be done before surgery (or ultrasound can be used once the skull has been opened) to map the area of tumors deep in the brain. In some cases, the surgeon uses intraoperative imaging, in which MRI (or other) images are taken at different times during the operation to show the location of any remaining tumor. This may allow some brain tumors to be resected more safely and extensively.

As much of the tumor is removed as possible without affecting important brain tissue or leaving the patient disabled in any way. The surgeon can use different techniques to lower the risk of removing vital parts of the brain, such as:
- **Intraoperative cortical stimulation:** In this approach, the surgeon electrically stimulates parts of the brain in and around the tumor during the operation and monitors the response. This can show if these areas control an important function.

- **Functional MRI:** This type of imaging test (described in “How are adult brain and spinal cord tumors diagnosed?”) can be done before surgery to locate a particular function of the brain. This information can be used to identify and preserve that region during the operation.

Once the tumor is removed, the piece of the skull bone is put back in place and fastened with metal screws and plates, wires, or special stitches. (Usually any metal pieces are made from titanium, which allows a person to get follow-up MRIs.) You may have small tube (called a *drain*) coming out of the incision that allows excess cerebrospinal fluid (CSF) to leave the skull. Other drains may be in place to allow blood that builds up after surgery to drain from under the scalp. The drains are usually removed after a few days. An imaging test such as an MRI or CT scan is typically done 1 to 3 days after the operation to confirm how much of the tumor has been removed. Recovery time in the hospital is usually 4 to 6 days, although this depends on the size and location of the tumor, the patient’s general health, and whether other treatments are given. Healing around the surgery site usually takes several weeks.

**Surgery to place a shunt or ventricular access catheter**

If a tumor blocks the flow of the CSF, it can increase pressure inside the skull. This can cause symptoms like headaches, nausea, and drowsiness, and may even be life-threatening.

To drain excess CSF and lower the pressure, the neurosurgeon may put in a silicone tube called a *shunt* (sometimes referred to as a *ventriculoperitoneal* or *VP shunt*). One end of the shunt is placed in a ventricle of the brain (an area filled with CSF) and the other end is placed in the abdomen or, less often, the heart or other areas. The tube runs under the skin of the neck and chest. The flow of CSF is controlled by a valve placed along the tubing.

Shunts may be temporary or permanent. They can be placed before or after the surgery to remove the tumor. Placing a shunt normally takes about 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 patient’s general health.

Surgery may also be used to insert a ventricular access catheter, such as an Ommaya reservoir, to help deliver chemotherapy directly into the CSF. A small incision is made in the scalp, and a small hole is drilled in the skull. A flexible tube is then threaded through the hole until the open end of the tube is in a ventricle, where it reaches the CSF. The other end, which has a dome-shaped reservoir, stays just under the scalp. After the
operation, doctors and nurses can use a thin needle to give chemotherapy drugs through the reservoir or to remove CSF from the ventricle for testing.

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.

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.

One of the biggest concerns when removing brain tumors is the possible loss of brain function afterward, which is why doctors are very careful to remove only as much tissue as is safely possible. If problems do arise, it might be right after surgery, or it might be days or even weeks later, so close monitoring for any changes is very important (see the section “Recovering from the effects of the brain or spinal cord tumor and its treatment”).

For more information on surgery as a treatment for cancer, see our document Understanding Cancer Surgery: A Guide for Patients and Families.

Radiation therapy for adult brain and spinal cord tumors

Radiation therapy uses high-energy rays or small particles to kill cancer cells. This type of treatment is given by a doctor called a radiation oncologist. Radiation therapy may be used in different situations:

- After surgery to try to kill any remaining tumor cells
- As the main treatment if surgery is not a good option and medicines are not effective
- To help prevent or relieve symptoms

Types of radiation therapy

In most cases, the radiation is focused on the tumor from a source outside the body. This is called external beam radiation therapy (EBRT). This type of radiation therapy is much like getting an x-ray, but the dose of radiation is much higher.

Before your treatments start, the radiation team will determine the correct angles for aiming the radiation beams and the proper dose of radiation. 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 lie on a special table while a machine delivers the radiation from precise angles. The treatment is not painful. Each session lasts about 15 to
Much of that time is spent making sure the radiation is aimed correctly. The actual treatment time each day is much shorter.

High doses of radiation therapy can damage normal brain tissue, so doctors try to deliver the radiation to the tumor with the lowest possible dose to normal surrounding brain areas. Several techniques can help doctors focus the radiation more precisely:

**Three-dimensional conformal radiation therapy (3D-CRT):** 3D-CRT uses the results of imaging tests such as MRI and special computers to map the location of the tumor precisely. 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 moves around the patient as it delivers radiation. Along with shaping the beams and aiming them at the tumor from several angles, the intensity (strength) of the beams can be adjusted to limit the dose reaching the most sensitive normal tissues. This may let the doctor deliver a higher dose to the tumor. Many major hospitals and cancer centers now use IMRT.

**Conformal proton beam radiation therapy:** Proton beam therapy is related to 3D-CRT and uses a similar approach. But instead of using x-rays, it focuses proton beams on the tumor. 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. Doctors can use this property to deliver more radiation to the tumor and do less damage to nearby normal tissues.

This approach may be more helpful for brain tumors that have distinct edges (such as chordomas), but it is not clear if it will be useful with tumors that are infiltrative or mixed with normal brain tissue (such as astrocytomas or glioblastomas). There are only a handful of proton beam centers in the United States at this time.

**Stereotactic radiosurgery/stereotactic radiotherapy:** This type of treatment delivers a large, precise radiation dose to the tumor area in a single session (radiosurgery) or in a few sessions (radiotherapy). (There is no actual surgery in this treatment.) It may be used for some tumors in parts of the brain or spinal cord that can’t be treated with surgery or when a patient isn’t healthy enough for surgery.

First, a head frame is usually attached to the skull to help aim the radiation beams. (Sometimes a face mask is used to hold the head in place instead.) Once the exact location of the tumor is known from CT or MRI scans, radiation is focused at the tumor from many different angles. This can be done in 2 ways:

- In one approach, radiation beams are focused at the tumor from hundreds of different angles for a short period of time. Each beam alone is weak, but they all converge at
the tumor to give a higher dose of radiation. An example of such a machine is the Gamma Knife.

- Another 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 the head to deliver radiation to the tumor from many different angles. Several machines with names such as X-Knife, CyberKnife, and Clinac deliver stereotactic radiosurgery in this way.

Stereotactic radiosurgery typically delivers the whole radiation dose in a single session, though it may be repeated if needed. Sometimes doctors give the radiation in several treatments to deliver the same or a slightly higher dose, and frameless techniques are now available to make this more comfortable. This is called fractionated radiosurgery or stereotactic radiotherapy.

**Brachytherapy (internal radiotherapy):** Unlike the external radiation approaches above, brachytherapy involves inserting radioactive material directly into or near the tumor. The radiation it gives 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 like an MRI scan or lumbar puncture find the tumor has spread along the covering of the spinal cord (meninges) or into the surrounding cerebrospinal fluid, then radiation may be given to the whole brain and spinal cord. Some tumors such as ependymomas and medulloblastomas are more likely to spread this way and often require craniospinal radiation.

**Possible side effects of radiation therapy**

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

Some people become irritable and tired during the course of radiation therapy. Nausea, vomiting, and headaches are also possible but are uncommon. Spinal radiation can cause nausea and vomiting more often than brain radiation. Sometimes dexamethasone (Decadron), a corticosteroid drug, can help relieve these symptoms.

A person may lose some brain function if large areas of the brain get 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 after radiation therapy, a large mass of dead (necrotic) tissue forms at the site of the tumor in the months or years after radiation treatment. This is called radiation necrosis. It can often be controlled with corticosteroid drugs, but surgery may be needed to remove the necrotic tissue in some instances.

Radiation can damage genes inside normal cells. As a result, there is a small risk of developing a second cancer in an area that got radiation — for example, a meningioma of the coverings of the brain, another brain tumor, or less likely a bone cancer in the skull. If this does occur, it is usually many years after the radiation is given. This small risk should not prevent those who need radiation from getting treatment.

To learn more about radiation therapy, see the “Radiation Therapy” section of our website, or our document Understanding Radiation Therapy: A Guide for Patients and Families.

Chemotherapy for adult brain and spinal cord tumors

Chemotherapy (chemo) uses anti-cancer drugs that are usually given into a vein (IV) or taken by mouth. These drugs enter the bloodstream and reach almost all areas of the body. However, many chemo drugs are not able to enter the brain and reach tumor cells.

For some brain tumors, the drugs can be given directly into the cerebrospinal fluid (CSF), either in the brain or into the spinal canal below the spinal cord. To help with this, a thin tube known as a ventricular access catheter may be inserted through a small hole in the skull and into a ventricle of the brain during a minor operation (see the “Surgery for adult brain and spinal cord tumors” section).

In general, chemotherapy is used for faster growing tumors. Some types of brain tumors, such as medulloblastoma and lymphoma, tend to respond better to chemotherapy.

Chemotherapy is most often used along with other types of treatment such as surgery and/or radiation therapy. Chemo may also be used by itself, especially for more advanced tumors or for tumors that have come back after other types of treatment.

Some of the chemo drugs used to treat brain tumors include:

- Carboplatin
- Carmustine (BCNU)
- Cisplatin
- Cyclophosphamide
- Etoposide
- Irinotecan
• Lomustine (CCNU)
• Methotrexate
• Procarbazine
• Temozolomide
• Vincristine

These drugs can be used alone or in various combinations, depending on the type of brain tumor. Doctors give chemo in cycles, with each period of treatment followed by a rest period to give the body time to recover. Each cycle typically lasts for a few weeks.

**Carmustine (Gliadel®) wafers**

These dissolvable wafers contain the chemotherapy drug carmustine (BCNU). After the surgeon removes as much of the brain tumor as is safe during a craniotomy, the wafers can be placed directly on or next to the parts of the tumor that can’t be removed. Unlike IV or oral chemotherapy that reaches all areas of the body, this type of therapy concentrates the drug at the tumor site, producing few side effects in other parts of the body.

**Possible side effects of chemotherapy**

Chemo drugs attack cells that are dividing quickly, which is why they often work against cancer cells. But other cells, such as those in the bone marrow (where new blood cells are made), 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 chemo 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
• Diarrhea
• Increased chance of infections (from having too few white blood cells)
• Easy bruising or bleeding (from having too few blood platelets)
• Fatigue (from having too few red blood cells, changes in metabolism, or other factors)
Some of the most effective drugs against brain tumors tend to have fewer of these side effects than other common chemo drugs. Most side effects tend to be short-term and go away after treatment is finished. There are often ways to lessen these side effects. For example, drugs can be given to help prevent or reduce nausea and vomiting.

Along with the risks above, some chemo drugs can cause other, less common side effects. For example, cisplatin and carboplatin can also cause kidney damage and hearing loss. Your doctor will check your kidney function and hearing if you are given these drugs. Some of these side effects might last after treatment is stopped.

Be sure to report any side effects while getting chemotherapy to your medical team so that you can be treated promptly. In some cases, the doses of the drugs may need to be reduced or treatment may need to be delayed or stopped to prevent the effects from getting worse.

To learn more about chemotherapy, see the “Chemotherapy” section on our website, or our document *A Guide to Chemotherapy*.

**Targeted therapy for adult brain and spinal cord tumors**

As researchers have learned more about the inner workings of cells that cause cancer or help cancer cells grow, they have developed newer drugs that specifically target these changes. These targeted drugs work differently from standard chemotherapy drugs. They sometimes work when chemo drugs don’t, and they often have different (and less severe) side effects. These drugs do not yet play a large role in treating brain or spinal cord tumors, but some of them may be helpful for certain types of tumors.

**Bevacizumab (Avastin)**

Bevacizumab is a man-made 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*). Tumors need new blood vessels to grow.

Studies have shown that when added to chemotherapy, this drug can help extend the time until certain brain tumors (especially glioblastomas) start growing again after surgery, but it does not seem to help people live longer. It can also help lower the dose of the steroid drug dexamethasone needed to help reduce swelling in the brain, which is especially important for patients sensitive to steroid side effects.

Bevacizumab is given by intravenous (IV) infusion, usually once every 2 weeks.

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, holes (perforations) in the intestines, and slow wound healing.
**Everolimus (Afinitor)**

Everolimus works by blocking a cell protein known as *mTOR*, which normally helps cells grow and divide into new cells. For subependymal giant cell astrocytomas (SEGAs) that can’t be removed completely by surgery, it may shrink the tumor or slow its growth for some time, although it’s not clear if it can help people with these tumors live longer.

Everolimus is taken as a pill once a day. Common side effects include mouth sores, increased risk of infections, nausea, loss of appetite, diarrhea, skin rash, feeling tired or weak, fluid buildup (usually in the legs), and increases in blood sugar and cholesterol levels. A less common but serious side effect is damage to the lungs, which can cause shortness of breath or other problems.

Other targeted therapies are now being developed and studied in clinical trials.

**Other drug treatments for adult brain and spinal cord tumors**

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

**Corticosteroids**

Corticosteroid drugs such as dexamethasone (Decadron) are often given to reduce swelling around brain tumors. This may help relieve headaches and other symptoms.

**Anti-seizure drugs (anti-epileptics)**

Drugs may also be given to lower the chance of seizures in people with brain tumors. Different anti-seizure drugs can be used. Because many of these drugs can affect how other drugs such as chemotherapy work in the body, they are not usually given unless the tumor has caused seizures.

**Hormones**

The pituitary gland helps control the levels of many different hormones in the body. If the pituitary gland is damaged by the tumor itself or by tumor treatments (such as surgery or radiation therapy), you may need to take pituitary hormones or other hormones to replace those missing.

**Treating specific types of adult brain and spinal cord tumors**

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

These tumors include pilocytic astrocytomas, which most often occur in the cerebellum in young people, and subependymal giant cell astrocytomas (SEGAs), which are almost always seen in people with tuberous sclerosis. Many doctors consider these benign tumors because they tend to grow very slowly and rarely grow into (infiltrate) nearby tissues.

These astrocytomas can often be cured by surgery alone, but older patients are less likely to be cured. Radiation therapy may be given after surgery, particularly if the tumor is not removed completely, although many doctors will wait until there are signs the tumor has grown back before considering it. Even then, repeating surgery may be the first option.

The outlook is not as good if the tumor occurs in a place where it can’t be removed by surgery, such as in the hypothalamus or brain stem. In these cases, radiation therapy is usually the best option.

For SEGAs that can’t be removed completely with surgery, treatment with the drug everolimus (Afinitor) may shrink the tumor or slow its growth for some time, although it’s not clear if it can help people live longer.

Low-grade astrocytomas
(Infiltrating or diffuse astrocytomas)

The initial treatment is surgery to remove the tumor if it can be done, or biopsy to confirm the diagnosis if surgery is not feasible. 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 can remove it all, the patient may be cured.

Radiation therapy may be given after surgery, especially if a lot of tumor remains. Younger adults whose tumors were small and not causing many symptoms may not be given radiation unless the tumor shows signs of growing again. (In some cases, a second surgery may be tried before giving radiation.) In people who are older or whose tumors are at higher risk of coming back for other reasons, radiation is more likely to be given after surgery. Chemotherapy may also be given after surgery in some cases. Some doctors use genetic tests of the tumor to help determine if radiation or chemotherapy should be given.

Radiation or chemotherapy may be used as the main treatment if surgery is not a good option for some reason.
Intermediate- and high-grade gliomas
(Glioblastomas, anaplastic astrocytomas, anaplastic oligodendrogliomas, anaplastic oligoastrocytomas)

Surgery is often the first treatment when it can be done, but these tumors are almost never cured with surgery. As much of the tumor is removed as is safely possible. Radiation therapy is then given in most cases. This may be given with or followed by chemotherapy if the person’s health allows. For some people who are in poor health or whose tumor cells have certain gene changes, chemo may be used instead of radiation therapy.

For tumors that can’t be treated with surgery, radiation therapy — with or without chemo — is usually the best option.

Temozolomide is the chemotherapy drug used first by most doctors because it crosses the blood-brain barrier and it’s convenient because it can be taken as a pill. It is sometimes given along with radiation therapy and then continued after the radiation is completed.

Cisplatin, carmustine (BCNU), and lomustine (CCNU) are other commonly used drugs. Combinations of drugs may also be used, such as the PCV regimen (procarbazine, CCNU, and vincristine). All of these treatments may shrink or slow tumor growth for some time, but they are very unlikely to cure the tumor.

If standard chemotherapy drugs are no longer effective, the targeted drug bevacizumab (Avastin) may be helpful for some people, either alone or with chemo.

In general, these tumors are very hard to control for long 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

If possible, surgery is the first option for oligodendrogliomas. Surgery usually doesn’t cure these tumors, but it can relieve symptoms and prolong survival. Many oligodendrogliomas grow slowly, especially in younger people, and may not need further treatment right away. Surgery may be repeated if the tumor grows back in the same spot. Radiation therapy and/or chemo (most often with temozolomide or the PCV regimen) may also be options after surgery.

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

Radiation therapy or chemotherapy may be helpful for tumors that can’t be treated with surgery.
Ependymomas and anaplastic ependymomas

These tumors usually do not grow into nearby normal brain tissue. Sometimes, patients may be cured by surgery alone if the entire tumor can be removed, but often this is not possible. If only part of the tumor is removed with surgery (or if it is an anaplastic ependymoma), radiation therapy is given after surgery. If surgery cannot be done, radiation therapy is the main treatment.

Sometimes the tumor cells can spread into the cerebrospinal fluid (CSF). Patients typically get an MRI of the brain and spine (and possibly a lumbar puncture) a few weeks after surgery if it is done. If either of these tests shows that the cancer has spread through the CSF, radiation therapy is given to the entire brain and spinal cord.

Chemotherapy is usually not helpful for these tumors, so it is usually not given unless the tumor can no longer be treated with surgery or radiation.

Meningiomas

Most meningiomas tend to grow slowly, so small tumors that aren’t causing symptoms can often be watched rather than treated, particularly in the elderly.

If treatment is needed, these tumors can usually be cured if they are removed completely with surgery. Radiation therapy may be used along with, or instead of, surgery for tumors that can’t be removed completely. For meningiomas that are atypical or invasive (grade II) or anaplastic (grade III), which tend to recur after treatment, radiation therapy is typically given after surgery even if all of the tumor has been removed.

For meningiomas that recur after initial treatment, further surgery (if possible) or radiation therapy may be used. If surgery and radiation aren’t options, drug treatments (chemotherapy, immunotherapy, or hormone-like drugs) may be used, but it’s not clear how much benefit they offer.

Schwannomas (including acoustic neuromas)

These slow-growing tumors are usually benign and are cured by surgery. In some centers, small acoustic neuromas are treated by stereotactic radiosurgery (see the section “Radiation therapy for adult brain and spinal cord tumors”). For large schwannomas where complete removal is likely to cause problems, tumors may be operated on first to decrease their size and then the remainder is treated with radiosurgery.

Spinal cord tumors

If a spinal cord tumor is small and not causing symptoms, it might not need to be treated right away. Other spinal cord tumors are treated like those in the brain. Astrocytomas of the spinal cord usually cannot be removed completely. They may be treated with surgery
to obtain a diagnosis and remove as much tumor as possible, and then by radiation
therapy, or with radiation therapy alone. Meningiomas of the spinal canal are often cured
by surgery, as are some ependymomas. If surgery doesn’t remove an ependymoma
completely, radiation therapy is often given.

**Lymphomas**

Treatment of central nervous system lymphomas generally consists of chemotherapy
and/or radiation therapy. Treatment is discussed in more detail in our document *Non-
Hodgkin Lymphoma.*

**Brain tumors that occur more often in children**

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

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

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

- What kind of tumor do I have?
- Is the tumor benign or malignant? What does this mean?
- Where in the brain or spinal cord is the tumor and how far has it spread?
- Do I need other tests before we can decide on treatment?
- How much experience do you have treating this type of tumor?
- Should I get a second opinion? Can you recommend a doctor or cancer center?
- What are my treatment choices? What do you recommend? Why?
- What’s the goal of treatment (cure, prolonging life, relieving symptoms, etc.)?
- Will treatment relieve any of the symptoms I now have?
What are the possible risks or side effects of treatment? What disabilities might I develop?

What should I do to be ready for treatment?

How long will treatment take? What will it be like? Where will it be given?

What is my expected prognosis (outlook)?

What would we do if the treatment doesn’t work or if the tumor comes back?

What type of follow-up will I need after treatment?

Where can I find more information and support?

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 or activity schedule. Or you might want to ask about clinical trials that might be right for you.

What happens after treatment for adult brain and spinal cord tumors?

For some people with brain or spinal cord tumors, treatment can remove or destroy the tumor. Completing treatment can be both stressful and exciting. You may be relieved to finish treatment, but find it hard not to worry about the tumor coming back. (When a tumor comes back after treatment, it is called recurrence.) This is a very common concern in people who have had a brain or spinal cord tumor.

It may take a while before your fears lessen. But it may help to know that many cancer survivors have learned to live with this uncertainty and are leading full lives. Our document Living With Uncertainty: The Fear of Cancer Recurrence, gives more detailed information on this.

For other people, the tumor may never go away completely. Some people may continue to be treated with radiation therapy, chemotherapy, or other treatments to try to keep the tumor in check. Learning to live with a tumor that does not go away can be difficult and very stressful. It has its own type of uncertainty. Our document When Cancer Doesn’t Go Away talks more about this.

Follow-up care

If you have completed treatment, your doctors will still want to watch you closely. It’s very important to keep all follow-up appointments. During these visits, your doctors will ask about symptoms, examine you, and may order lab tests or imaging tests such as MRI
scans to look for a recurrence of the tumor. In some cases, some of the tumor may still be left behind after treatment. Even tumors that have been treated successfully can sometimes come back.

Whether the tumor was removed completely or not, your health 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 the cause can be found and treated, if needed. Your doctor can give you an idea of what to look for. If you need further treatment at some point, the doctor will go over your options with you.

Should your tumor come back, our document *When Your Cancer Comes Back: Cancer Recurrence* can give you information on how to manage and cope with this phase of your treatment.

**Recovering from the effects of the brain or spinal cord tumor and its treatment**

The tumor and its treatment can have physical and mental effects, which can range from very mild to fairly severe.

Once you have recovered from treatment, your doctors will try to determine if damage was done to the brain or other areas. Careful physical exams and imaging tests (CT or MRI scans) might be done to determine the extent and location of any long-term changes in the brain.

Several types of doctors and other health professionals might help look for these changes and help you recover.

- A neurologist (a doctor who specializes in medical treatment of the nervous system) may assess your physical coordination, muscle strength, and other aspects of nervous system function.

- If you have 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 your speech is affected, a speech therapist will help you improve communication skills.

- If needed, an ophthalmologist (a doctor who specializes in eye problems) will check your vision, and an audiologist may check your hearing.
- After surgery, you may also see a psychiatrist or psychologist to determine the extent of any changes caused by the tumor or surgery. If you get radiation therapy and/or chemotherapy, this process may be repeated again after treatment is finished.

- If you were treated with surgery or radiation therapy for a tumor near the base of the brain, pituitary hormone production may be affected. You might be seen by an endocrinologist (a doctor who specializes in hormone disorders). If hormone levels are affected, you might need hormone treatments to restore normal levels for the rest of your life.

Keeping copies of your medical records and health insurance

At some point after your diagnosis and treatment, you may see a new doctor who does not know your medical history. It is important that you be able to give your new doctor the details of your diagnosis and treatment. Gathering these details soon after treatment may be easier than trying to get them at some point in the future. Make sure you have this information handy, and always keep copies for yourself:

- A copy of the pathology report(s) from any biopsies or surgeries

- Copies of imaging tests (CT or MRI scans, etc.), which can usually be stored digitally (on a DVD, etc.)

- If you had surgery, a copy of the operative report(s)

- If you stayed in the hospital, copies of the discharge summaries that doctors prepare when patients are sent home

- If you had chemotherapy or other drug treatments, a list of the drugs, doses, and when they were given

- If you had radiation therapy, a summary of the type and dose of radiation and when and where it was given

It’s also very important to keep your health insurance. Tests and doctor visits cost a lot, and even though no one wants to think of a tumor coming back, this could happen.

Lifestyle changes during and after an adult brain or spinal cord tumor

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

Making healthier choices

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

You can start by working on the things that worry you most. Get help with those that are harder for you. For instance, if you are thinking about quitting smoking and need help, call the American Cancer Society at 1-800-227-2345. A tobacco cessation and coaching service can help increase your chances of quitting for good.

Eating better

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

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

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

You can get more information in our document *Nutrition and Physical Activity During and After Cancer Treatment: Answers to Common Questions*.

Rest, fatigue, and exercise

Extreme tiredness, called *fatigue*, is very common during and after treatment. This is not a normal tiredness, but a bone-weary exhaustion that often doesn’t get better with rest. For some people, fatigue lasts a long time after treatment, and can make it hard for them
to be active and do other things they want to do. But exercise can help reduce fatigue. Studies have shown that patients who follow an exercise program tailored to their personal needs feel better physically and emotionally and can cope better, too.

If you were sick and not very active during treatment, it’s normal for your fitness, endurance, and muscle strength to decline. Any plan for 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 twice a week. If you haven’t exercised in a few years, you will have to start slowly – maybe just by taking short walks.

Talk with your health care team before starting anything. Get their opinion about your exercise plans. Then, try to find an exercise buddy so you’re not doing it alone. Having family or friends involved when starting a new exercise program can give you that extra boost of support to keep you going when the push just isn’t there.

If you are very tired, you will need to balance activity with rest. It’s OK to rest when you need to. Sometimes it’s really hard for people to allow themselves to rest when they are used to working all day or taking care of a household, but this is not the time to push yourself too hard. Listen to your body and rest when you need to. For more information on dealing with fatigue and other treatment side effects, please see the “Physical Side Effects” section of our website or “Additional resources for brain and spinal cord tumors in adults” to get a list of available information.

Keep in mind exercise can improve your physical and emotional health.

- It improves your cardiovascular (heart and circulation) fitness.
- Along with a good diet, it will help you get to and stay at a healthy weight.
- It makes your muscles stronger.
- It reduces fatigue and helps you have more energy.
- It can help lower anxiety and depression.
- It can make you feel happier.
- It helps you feel better about yourself.

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

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

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

At this time, not enough is known about brain and spinal cord tumors to say for sure if there are things you can do that will be helpful. Adopting healthy behaviors such as eating well, staying active, and maintaining a healthy weight may help, but no one knows for sure. However, we do know that these types of changes can have positive effects on your health that can extend beyond your risk of cancer.

How might having an adult brain or spinal cord tumor affect your emotional health?

During and after treatment, you may find yourself overcome with many different emotions. This happens to a lot of people.

You may find yourself thinking about death and dying. Or maybe you’re more aware of the effect the tumor has on your family, friends, and career. You may take a new look at your relationships with those around you. Unexpected issues may also cause concern. For instance, you might be stressed by financial concerns resulting from your treatment. You might also see your health care team less often after treatment and have more time on your hands. These changes can make some people anxious.

Almost everyone who is going through or has been through tumor treatment can benefit from getting some type of 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 one-on-one counselors. 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 journey can feel very lonely. It’s not necessary or good for you to try to deal with everything on your own. And your friends and family may feel shut out if you do 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 1-800-227-2345 and we can put you in touch with a group or resource that may work for you. You can also read our document Distress in People with Cancer or see the “Emotional Side Effects” section of our website for more information.
If treatment for an adult brain or spinal cord tumor stops working

If a tumor keeps growing or comes back after one kind of treatment, it’s often possible to try another approach to treating the tumor. Clinical trials also might offer chances to try newer treatments that could be helpful. But when a person has tried many different treatments and the tumor is still growing, even newer treatments might no longer be helpful. If this happens, it’s important to weigh the possible limited benefits of trying a new treatment against the possible downsides, including treatment side effects. Everyone has their own way of looking at this.

This is likely to be the hardest part of your battle with a tumor — when you have been through many treatments and nothing’s working anymore. Your doctor may offer you new options, but at some point you might need to consider that treatment is not likely to improve your health or change your outcome or survival.

If you want to continue to get treatment for as long as you can, you need to think about the odds of treatment having any benefit and how this compares to the possible risks and side effects. Your doctor can estimate how likely it is the tumor will respond to treatment you’re considering. For instance, the doctor may say that more treatment might have about a 1 in 100 chance of working. Some people are still tempted to try this. But it’s important have realistic expectations if you do choose this plan.

You can learn more about the changes that occur when treatment stops working, and about planning ahead for yourself and your family, in our documents *Advanced Cancer* and *Nearing the End of Life*.

**Palliative care**

No matter what you decide to do, it’s important that you feel as good as you can. Make sure you are asking for and getting treatment for any symptoms you might have, such as nausea or pain. This type of treatment is called *palliative care*.

Palliative care helps relieve symptoms, but is not expected to cure the disease. It can be given along with tumor treatment, or can even be treatment. The difference is its purpose — the main goal of palliative care is to improve the quality of your life, or help you feel as good as you can for as long as you can. Sometimes this means using drugs to help with symptoms like pain or nausea. Sometimes, though, the treatments used to control your symptoms are the same as those used to treat the tumor. But this is not the same as treatment to try to cure the tumor.

**Hospice care**

At some point, you may benefit from hospice care. This is special care that treats the person rather than the disease; it focuses on quality rather than length of life. Most of the
time, it’s given at home. Your tumor may be causing problems that need to be managed, and hospice focuses on your comfort. You should know that while getting hospice care often means the end of treatments such as chemo and radiation, it doesn’t mean you can’t have treatment for the problems caused by the tumor or other health conditions. In hospice the focus of your care is on living life as fully as possible and feeling as well as you can at this difficult time. You can learn more about hospice in our document Hospice Care.

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

What’s new in adult brain and spinal cord tumor research and treatment?

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

Genetics

Researchers are looking for changes inside brain tumor cells to see if they can be used to help guide treatment. For example, doctors have found that patients with oligodendrogliomas whose cells are missing parts of certain chromosomes (known as a \textit{1p19q co-deletion}) are much more likely to be helped by chemotherapy than patients whose tumors do not.

Imaging and surgery techniques

Recent advances have made surgery for brain tumors much safer and more successful. Some of these newer techniques include:

- **Functional magnetic resonance imaging** (fMRI, described in “How are brain and spinal cord tumors in adults diagnosed?”). This technique can help identify important functional areas of the brain and how close they are to the tumor.

- **Magnetic resonance spectroscopic imaging** (MRSI, described in “How are brain and spinal cord tumors in adults diagnosed?”). In this approach, specially processed MRS information is used to make a map of important chemicals involved in tumor metabolism. This is being developed to help surgeons direct their biopsies to the most
abnormal areas in the tumor and to help doctors direct radiation and evaluate the
effects of chemotherapy or targeted therapy.

- **Fluorescence-guided surgery.** For this approach, the patient drinks a special
  fluorescent dye a few hours before surgery. The dye is taken up mainly by the tumor,
  which then glows when the surgeon looks at it under special lighting from the
  operating microscope. This lets the surgeon better separate tumor from normal brain
tissue.

- **Newer surgical approaches** for some types of tumors. For example, a newer
  approach to treat some tumors near the pituitary gland is to use an endoscope, a thin
  tube with a tiny video camera lens at the tip. The surgeon passes the endoscope
  through a small hole made in the back of the nose to operate through the nasal
  passages, limiting the potential damage to the brain. A similar technique can be used
  for some tumors in the ventricles, where a small opening in the skull near the hairline
  serves as the point of endoscope insertion. The use of this technique is limited by the
  tumor’s size, shape, and position.

**Radiation therapy**

Some newer types of external radiation therapy let doctors deliver radiation more
precisely to the tumor, which helps spare normal brain tissue. Techniques such as 3-
dimensional conformal radiation therapy (3D-CRT), intensity modulated radiation
therapy (IMRT), and proton beam therapy are described in the section “Radiation therapy
for adult brain and spinal cord tumors.”

Newer methods of treatment planning are also being studied. For example, image-guided
radiation therapy (IGRT) uses a CT scan done just before each treatment to better guide
the radiation to its target.

**Chemotherapy**

Along with developing and testing new chemotherapy drugs, many researchers are testing
new ways to get chemotherapy to the brain tumor.

Many chemotherapy drugs are limited in their effectiveness because the tightly controlled
openings in the brain capillaries, sometimes referred to as the *blood-brain barrier*,
prevents them from getting from the bloodstream to the brain. Researchers are now trying
to modify some of these drugs by putting them in tiny droplets of fat (liposomes) or
attaching them to molecules that normally cross the blood-brain barrier, to help them
work better. This is an area of active research and clinical trials.

For another newer method called *convection-enhanced delivery*, a small tube is placed
into the tumor in the brain through a small hole in the skull during surgery. The tube
extends through the scalp and is connected to an infusion pump, through which drugs can
be given. This can be done for hours or days and may be repeated more than once, depending on the drug used. This method is still being studied in clinical trials.

Other new treatment strategies

Researchers are also testing some newer approaches to treatment that may help doctors target tumors more precisely. This could lead to treatments that work better and cause fewer side effects. Several of these treatments are still being studied.

**Tumor vaccines**

Several vaccines are being tested against brain tumor cells. Unlike vaccines against infections, 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 attack the brain tumor.

Early study results of vaccines to help treat glioblastoma have shown promise, but more research is needed to determine how well they work. At this time, brain tumor 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. One of these drugs, bevacizumab (Avastin), has been approved by the FDA to treat recurrent glioblastomas because it has been shown to slow the growth of some tumors.

Other drugs that impair blood vessel growth, such as sorafenib (Nexavar) and trebananib, are being studied and are available through clinical trials.

**Growth factor inhibitors**

Tumor cells are often very sensitive to proteins called *growth factors*, which help them grow and divide. Newer drugs target some of these growth factors, which may slow the growth of tumor cells or even cause them to die. Several of these targeted drugs are already used for other types of cancer, and some are being studied to see if they will work for brain tumors as well.

**Hypoxic cell sensitizers**

Some drugs increase the oxygen content in tumors, which might make tumor cells more likely to be killed by radiation therapy if they are given before treatment. These types of drugs are now being studied to see if they can improve treatment outcomes.
Electric treatment fields

The Optune device (formerly called the NovoTTF-100A system) is approved by the FDA to help treat glioblastomas. To use this device, the head is shaved and 4 sets of electrodes are placed on the scalp. The electrodes are attached to a battery pack and are worn for most of the day. They generate mild electric currents that are thought to affect tumor cells in the brain more than normal cells.

In a clinical trial, people with newly diagnosed glioblastoma first had standard treatments such as surgery, radiation therapy, and chemotherapy. They were then assigned to either use the device along with chemotherapy or to just get chemotherapy. Those who used the device lived an average of several months longer than those who just got chemotherapy.

Side effects of the device tend to be minor, and can include skin irritation at the electrode sites and a slightly increased risk of headaches and seizures.

Additional resources for brain and spinal cord tumors

More information from your American Cancer Society

We have a lot more information that you might find helpful. Explore www.cancer.org or call our National Cancer Information Center toll-free number, 1-800-227-2345. We’re here to help you any time, day or night.

National organizations and websites*

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

**National Brain Tumor Society**  
Toll-free number: 1-800-934-2873 (1-800-934-CURE)  
Website: www.braintumor.org

Call or choose “information” on the website home page to get lists of treatment centers, learn about living with brain tumor, manage common problems, and find resources for caregivers and family members. Also has information in Spanish.

**American Brain Tumor Association**  
Toll-free number: 1-800-886-2282 (1-800-886-ABTA)  
Website: www.abta.org

Has information for patients and caregivers about brain tumors in adults, teens, and children, online and by phone. Also has lists of support groups across the US.
National Cancer Institute
Toll-free number: 1-800-422-6237 (1-800-4-CANCER)
Website: www.cancer.gov

Offers a wide variety of free, accurate, up-to-date information about many types of cancer to patients, their families, and the general public; has information about coping and family; and can also help people find clinical trials in their area.

National Coalition for Cancer Survivorship
Toll-free number: 1-877-622-7937 (1-877-NCCS-YES)
Website: www.canceradvocacy.org

Has publications on many cancer-related topics; also offers the Cancer Survival Toolbox – a free program that teaches skills that can help people with cancer meet the challenges of their illness.

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

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

References


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