

## BRAIN AND SPINAL CORD CANCERS OF ADULTS: WHAT IS IT?

In this section of the Adult Brain and Spinal Cord Cancer Resource Center, you'll find an [introduction to cancer](#) and related [adult brain and spinal cord cancer statistics](#).

### WHAT ARE BRAIN AND SPINAL CORD CANCERS?

There are many types of cancers that start in the *central nervous system (CNS)* (brain and spinal cord). Because the patient's symptoms, outlook for survival, and treatment depend on the precise location of their tumor within the central nervous system, this section begins with an introduction to the main parts of the brain and spinal cord. Prognosis and treatment also depend on the type of cells the cancer developed from, so the main types of brain and spinal cord cells and the names of cancers they form are discussed.

Central nervous system tumors of adults and children often form in different areas and from different cell types, and may have a different prognosis and treatments. This document refers only to tumors of adults.

The *brain* is the center of thought, memory, emotion, and speech. The *spinal cord* and special nerves in the head called *cranial nerves* carry messages between the brain and the rest of the body. These messages tell our muscles how to move, transmit information gathered by our senses, and help coordinate our internal organs. The brain is located within and protected by a hard bone, the *skull*. Likewise, the spinal cord is protected by the bones of the *vertebral (spinal) column*. The brain and spinal cord are surrounded and cushioned by a special fluid, called *cerebrospinal fluid*. Cerebrospinal fluid is produced in cavities within the brain called *ventricles*. The *ventricles* as well as the spaces around the brain and spinal cord are filled with cerebrospinal fluid.

### Parts of the Brain and Spinal Cord

The main parts of the *central nervous system (CNS)* are the brain and spinal cord. The main areas of the brain include the cerebral hemispheres, basal ganglia, cerebellum, and brain stem. Each of these parts has a special purpose. Tumors of different parts of the CNS disrupt different functions and cause different symptoms. These symptoms are not specific for brain cancer and may be caused by any disease involving that particular location within the brain. Also, tumors in different areas of the CNS may be treated differently and have a different *prognosis* (survival).

The *cerebral hemispheres* control reasoning, thought, emotion, and language. They are also ultimately responsible for muscle movements and for interpreting sensory information such as vision, hearing, touch, and pain sensation. The symptoms caused by a tumor of a cerebral hemisphere depend on the part of the hemisphere in which the tumor arises. Common symptoms include seizures, difficulty with speech or language, a change of mood such as depression, a change in personality, weakness or paralysis of one side of the body (the left side of the brain controls movement and recognition of sensation from the right side of the body), changes in vision, hearing, and sensation.

The *basal ganglia* help control our muscle movements. Tumors or other problems in this part of the brain typically cause *chorea* (abnormal movements) or *athetosis* (abnormal positioning).

The *cerebellum* controls coordination of movement. Tumors of the cerebellum cause lack of coordination in walking, difficulty with fine movements of arms and legs, and changes in rhythm of speech.

The *brain stem* contains bundles of very long axons that carry signals controlling muscles and

sensation or feeling. In addition, most cranial nerves start in the brain stem. Special centers in the brain stem control breathing and the beating of the heart. Tumors in this critical area of the brain may cause weakness, stiff muscles, or problems with sensation, hearing, facial movement, and swallowing. Double vision is a common early symptom of brain stem tumors, as is lack of coordination in walking. Because the brain stem is so essential for life, it is impossible to surgically remove tumors from the brain stem.

The *spinal cord*, like the brain stem, contains bundles of very long axons that carry signals controlling muscles, sensation or feeling and bladder and bowel control. Spinal cord tumors may cause weakness, paralysis, or numbness. Because the spinal cord is such a small structure, tumors arising within it usually cause symptoms involving both sides of the body (e.g., weakness or numbness of both legs). This distinguishes them from tumors of the brain, which usually cause symptoms affecting only one side of the body. Moreover, most tumors of the spinal cord arise below the neck after nerves to the arms have branched off the spinal cord, so that only leg function is affected.

Tumors may also arise from *cranial nerves* or *peripheral nerves*. The most common, the acoustic neuroma, arises from the acoustic or hearing nerve and causes loss of hearing in one ear. Tumors arising from other cranial nerves may cause visual loss (optic nerve), facial paralysis (facial nerve) or facial pain (trigeminal nerve). Tumors arising in the peripheral nervous system generally cause pain in the area subserved by that nerve as well as weakness of muscles controlled by that nerve.

## Types of Cells and Tissues in the Brain and Spinal Cord

The brain consists of different kinds of tissues and cells. This is important to understand, because different types of *benign* (not cancerous) and *malignant* (cancerous) tumors can start in these different cell and tissue types. These different types of tumors vary in *prognosis* (survival) and the ways they are treated.

**Neurons:** These are the most important cells within the brain. They carry signals through long wire-like extensions called *axons*. Axons may be very short or 2 to 3 feet long. Electric signals carried by neurons determine thought, memory, emotion, speech, muscle movement, and just about everything else which the brain and spinal cord do. Unlike most other types of cells, which can grow and divide to repair damage from injury or disease, neurons do not divide after birth (with very rare exceptions).

**Glial cells:** There are three types of glial cells - *astrocytes*, *oligodendrocytes* and *ependymal* cells. A fourth type called *microglia* are not truly glial in origin. Normal glial cells grow and divide very slowly. Most brain and spinal cord tumors develop from glial cells.

- **Astrocytes:** This type of glial cell helps support and nourish neurons. When the brain is injured, astrocytes form scar tissue that helps repair the damage.
- **Oligodendrocytes:** These cells make *myelin*. Myelin surrounds and insulates axons of the brain and spinal cord. In this way oligodendrocytes help neurons transmit electric signals through axons.
- **Ependymal cells:** These cells line the ventricles within the central part of the brain. Ependymal cells help form part of the pathway through which cerebrospinal fluid travels.
- **Microglia:** The microglia that represent 10% to 20% of the total population of glial cells in the brain are the immune cells of the central nervous system.

**Meninges:** The spaces around the brain are lined by a specialized tissue called the *meninges*. The meninges help form the spaces through which cerebrospinal fluid travels.

**Schwann cells:** These cells make myelin which surrounds and insulates axons that are present in cranial nerves, and other nerves of the body.

**Choroid plexus:** This tissue is located within the ventricles and makes cerebrospinal fluid.

**Lymphocytes:** These are one type of cell of the immune system. They help the body to fight infections. Most lymphocytes are found in the blood, bone marrow, and in collections of immune cells throughout the body called lymph nodes. Under normal circumstances there are few, if any, lymphocytes in the central nervous system. The origin of lymphocytes that become brain lymphomas is not clear.

**Pituitary gland:** The pituitary is a gland at the base of the brain. Pituitary tumors are discussed in a separate document available from the American Cancer Society.

**Pineal gland:** The pineal gland is not strictly part of the brain. It is, in fact, an *endocrine* (hormone producing) gland that sits between the cerebral hemispheres. It was thought by the philosopher Descartes to be the seat of the soul. Its function is probably more mundane, making *melatonin*, a hormone that responds to changes in light.

**Blood-brain barrier:** Unlike other organs, there is a barrier between the blood and the tissues of the *central nervous system* (brain and spinal cord) that prevents the entry of many drugs, including some *chemotherapeutic agents* (anticancer drugs), into the brain. Malignant tumors usually disrupt the blood-brain barrier but the disruption may not be complete, so that the amount of a chemotherapeutic agent, given by mouth or by IV (into a vein; *intravenously*), that reaches a brain tumor may be less than would reach the same tumor in other organs.

## Types of Brain and Spinal Cord Tumors

Any of the different types of tissues or cells within the brain or spinal cord can become cancerous. Some tumors contain a mixture of cell types. Sometimes brain tumors are found at surgery not to have started in the brain but rather to have spread, or *metastasized*, from some other part of the body. Tumors that start in other organs such as the lung or breast and then spread to the brain are called *metastatic brain cancers* and those that start in the brain are called *primary brain cancers*. This is an important point, because metastatic and primary brain cancers are usually treated in different ways. Metastatic tumors to the brain are more common than primary brain tumors. Unlike other cancers, tumors arising within the brain or spinal cord rarely metastasize to distant organs. They cause damage because they spread locally and destroy normal tissue in the place where they arise. This document is only about primary brain and spinal cord cancers, not those that have spread from elsewhere in the body.

With a few exceptions, tumors of the brain or spinal cord are never *benign* (noncancerous). Because it is usually impossible to completely remove brain or spinal cord tumors, they continue to grow and eventually (sometimes after many years) cause death.

**Meningioma:** Strictly speaking, meningiomas are not brain tumors because they arise from the meninges, a layer of tissue that surrounds the outer part of the brain and spinal cord. Meningiomas cause symptoms by pressing on the brain or spinal cord. Meningiomas are quite common, accounting for about 50% of primary brain and spinal cord tumors.

Most meningiomas, (about 85%), are benign and are cured by surgery. Some meningiomas, however, are located dangerously close to vital structures within the brain and cannot be cured by surgery alone. Other meningiomas are cancerous or malignant and may come back many times after surgery or, rarely, even spread to other parts of the body.

**Astrocytoma:** Most tumors that arise within the brain itself start in brain cells called *astrocytes*. These tumors are called *astrocytomas*. Most astrocytomas cannot be cured because they spread widely throughout the surrounding normal brain tissue. Sometimes astrocytomas spread along the cerebrospinal fluid pathways. With only very rare exceptions, astrocytomas, however, do not spread outside of the brain or spinal cord.

Astrocytomas are classified, or *graded* as low grade, intermediate grade, or high grade. Their grade is based on examining a *biopsy* specimen (sample of the tumor) under the microscope. The *pathologist* (a doctor specializing in diagnosis of diseases by laboratory tests) examining an astrocytoma will look for how closely cells are packed together within the tumor, how abnormal the cells are, how many of the cells are dividing or *proliferating*, whether blood vessels are growing near the tumor, and whether some of the cancer cells have spontaneously degenerated. Low-grade astrocytomas are the slowest growing. Intermediate-grade astrocytomas, or *anaplastic astrocytomas*, grow at a moderate rate. The highest-grade astrocytomas, *glioblastomas*, are the fastest growing.

In a few instances, the appearance of an astrocytoma on a *magnetic resonance image* (MRI) is so characteristic that a biopsy is unnecessary, especially when the tumor is located in a part of the brain that is difficult to biopsy. In other instances a *positron emission tomography* (PET) scan or MRI spectroscopy may give sufficient information so that a biopsy becomes unnecessary. See "How Are Brain and Spinal Cord Cancer Diagnosed?" for more information on these tests.

There are some special types of astrocytomas that tend to have a particularly good prognosis. These are called *noninfiltrating astrocytomas* (juvenile pilocytic astrocytomas and subependymal giant cell astrocytomas).

**Oligodendrogliomas:** These tumors start in brain cells called oligodendrocytes. They spread or infiltrate in a manner similar to astrocytomas and, in most cases, cannot be completely removed by surgery. A small number of oligodendrogliomas, however, are associated with long-term survivals of 30 or 40 years. Oligodendrogliomas may spread along the cerebrospinal fluid pathways but rarely spread outside the brain or spinal cord.

**Ependymomas:** These tumors arise from the ependymal cells which line the ventricles. Ependymomas may block the exit of cerebrospinal fluid from the ventricles causing the ventricle to become very large - a condition called *hydrocephalus*. Unlike astrocytomas and oligodendrogliomas, ependymomas characteristically do not spread or infiltrate into normal brain tissue. As a result, some but not all ependymomas can be completely removed and cured by surgery. Spinal cord ependymomas have the greatest chance of surgical cure. Ependymomas may spread along the cerebrospinal fluid pathways but do not spread outside the brain or spinal cord.

**Gliomas:** This is not a specific type of cancer. Glioma is a general category that includes astrocytomas, oligodendrogliomas, and ependymomas.

**Tumors of neurons:** Tumors arising from the neurons are rare. *Medulloblastomas* are tumors that develop from neurons of the cerebellum. They are fast-growing tumors but can be treated and are often cured by radiation therapy. Medulloblastomas occur most commonly in children and frequently spread throughout the cerebrospinal fluid pathways. They are discussed in a separate American Cancer Society document on "Brain and Spinal Cord Cancers of Children."

**Ganglioglioma:** A tumor containing both neurons and glial cells is called a *ganglioglioma*. These have a high rate of cure by surgery alone or surgery combined with radiation therapy.

**Schwannoma (neurilemoma):** Schwannomas start in Schwann cells which surround cranial nerves and other nerves. These are usually benign tumors that often form near the cerebellum and in the cranial nerve responsible for hearing and balance.

**Chordoma:** These tumors start in the bone at the back of the skull or at the lower end of the spinal cord. These tumors typically come back many times over 10 to 20 years. They usually do not spread or metastasize to other organs.

**Lymphoma:** Lymphomas start in *lymphocytes* (the main cell type of the immune system). In the past, lymphomas of the brain have been thought of as highly malignant, usually leading to death within approximately one year. Recent advances in chemotherapy, however, have dramatically changed the prognosis of people with these tumors.

**Germ cell tumors:** Germ cell tumors develop from *germ cells* (the cells that are normally found in the ovaries or testicles and develop into egg cells or sperm cells). During embryonic and fetal development, germ cells may not migrate properly and end up in abnormal locations such as the brain. They may then develop into germ cell tumors, similar to those that can form in the ovaries or testicles. The most common germ cell tumor of the nervous system is the *germinoma*. Germ cell tumors of the nervous system are very rare in adults. They account for a small percentage of childhood brain tumors and are discussed further in the document on "Brain and Spinal Cord Cancers of Children."

## WHAT ARE THE KEY STATISTICS ABOUT BRAIN AND SPINAL CORD CANCERS?

The American Cancer Society estimates that 16,500 malignant tumors of the brain or spinal cord (9,500 in men and 7,000 in women) will be diagnosed during 2000 in the United States. Approximately 13,000 people (7,100 men and 5,900 women) will die from these malignant tumors. This type of cancer accounts for approximately 1.4% of all cancers and 2.4% of all cancer-related deaths. Both adults and children are included in these statistics. The rest of the information in this document discusses brain and spinal cord cancers in adults.

Average survival time for patients with low-grade astrocytomas or oligodendrogliomas is approximately 6 to 8 years. Average survival for patients with anaplastic astrocytomas is approximately 3 years. Average survival for patients with glioblastomas is approximately 12 to 18 months.

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