Brain and spinal cord tumors can often be hard to treat and require care from a team of different types of doctors and other health professionals. This team is often led by a **neurosurgeon**, a doctor who operates on brain and nervous system tumors. Other doctors on the team might 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 cancer
- **Endocrinologist:** a doctor who treats diseases in glands that secrete hormones

You might have many other health professionals on your treatment team as well, including physician assistants (PAs), nurse practitioners (NPs), nurses, psychologists,

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.

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.

- Clinical Trials

**Considering complementary and alternative methods**

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

**Complementary** methods are treatments that are used **along with** your regular medical care. **Alternative** treatments are used **instead of** standard 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 harmful.

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 58 T2gk)am abouo thy meth,rn ichut

Surgery on brain and spinal cord tumors may be done to:

- Get a biopsy[1] sample to determine the type of tumor[2]

although it may be used to get a biopsy sample 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 be shaved before surgery. The neurosurgeon first makes a cut in the scalp over the skull near the tumor, and folds back the skin. 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 see the parts of the brain needed to operate safely. The surgeon may need to cut into the brain itself to reach the tumor. The surgeon might use MRI or CT scans[5] 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 different ways depending on how hard or soft it is, and whether it has many or just a few blood vessels:

- Many tumors can be cut out with a scalpel or special scissors.
- Some tumors are soft and can be removed with suction devices.
- In other cases, a handheld ultrasonic aspirator can be placed into the tumor to break it up and 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. MRI or CT scans[6] 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 while trying not to affect brain functions. The surgeon can use different techniques to lower the risk of removing vital parts of the brain, such as:

- **Intraoperative cortical stimulation (cortical mapping):** In this approach, the surgeon electrically stimulates parts of the brain in and around the tumor during the

ventricle of the brain (an area filled with CSF) and the other end is placed in the abdomen or, less often, the heart (and would then be referred to as a **ventriculoatrial shunt**). 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 can 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 might develop, such as bleeding or infection. Strokes are

## 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 any type of surgery can include bleeding, infections, or reactions to anesthesia, although these are not common.

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

Seizures are also possible after brain surgery. Anti-seizure medicines can help lower this risk, although they might not prevent them completely.

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

5. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
6. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
7. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
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10. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/after-treatment/follow-up.html
11. www.cancer.org/cancer/managing-cancer/treatment-types/surgery.html
12. www.cancer.org/cancer/managing-cancer/side-effects.html

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Last Revised: May 5, 2020

# Radiation Therapy for Adult Brain and Spinal Cord Tumors

- External radiation therapy
- Brachytherapy (internal radiation therapy)

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

A head frame might be 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, thin 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 a machine that uses this technique 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.

SRS typically delivers the whole radiation dose in a single session, though it may be repeated if needed. For SRT (sometimes called **fractionated radiosurgery**), doctors give the radiation in several treatmentradin 4405 gs (), doctors)Tj 0 g 1 ngle9hbremrs

repeated if needed.296.66 t4. sus m90 ng 508 in thi0 g 1 0 00 0mlumb0 0puncture fim es.jonatm /F3Tile

made mainly of collagen, which have small radioactive ‘seeds’ in them. They are placed in the lining of the open space that is created when a brain tumor is removed. The radiation they give off travels only a short distance, so it’s not likely to affect other parts of the brain. Over time, the tiles themselves are absorbed by the body, while the seeds lose their radioactivity and can be left in place.

A possible advantage of this approach is that it allows radiation to be given to the area right after surgery, as opposed to having to wait several weeks, which is often the case with external radiation. However, this approach also has some limits, such as not being able to reach tumor cells that are farther away from the original tumor.

## 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, which can lead to side effects.

**Side effects during or soon after treatment:** Some people become irritable and tired during the course of radiation therapy. Nausea, vomiting, and headaches are also possible side effects but are uncommon. Sometimes dexamethasone (a corticosteroid) or other drugs can help relieve these symptoms. Some people might have hair loss in areas of the scalp that get radiation. Other side effects are also possible, depending on where the radiation is aimed.

**Problems with thinking and memory:** 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.

**Radiation necrosis:** Rarely after radiation therapy, a mass of dead (necrotic) tissue forms at the site of the tumor in the months or years after radiation treatment. This can often be controlled with corticosteroid drugs, but surgery may be needed to remove the necrotic tissue in some instances.

**Increased risk of another tumor:** Radiation can damage genes in 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 develops, it's usually many years after the radiation is given. This small risk should not prevent those who need radiation from getting treatment.

## More information about radiation therapy

To learn more about how radiation is used to treat cancer, see Radiation Therapy[3].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[4].

## Hyperlinks

1. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/signs-and-symptoms.html
2. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
3. www.cancer.org/cancer/managing-cancer/treatment-types/radiation.html
4. www.cancer.org/cancer/managing-cancer/side-effects.html

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[5]Dorsey JF, Salinas RD, Dang M, et al. Chapter 63: Cancer of the central nervous system. In: Niederhuber JE, Armitage JO, Doroshow JH, Kastan MB, Tepper JE, eds. *Abeloff's Clinical Oncology*

- Irinotecan
- Lomustine (CCNU)
- Methotrexate
- Procarbazine
- Temozolomide
- Vincristine

These drugs can be used alone or in combinations, depending on the type of brain tumor. Chemo is given 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 chemo 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 chemo 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 can cause side effects. These depend on the type and dose of drugs, and how long treatment lasts. Common 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 usually go away after treatment is finished. There are often ways to lessen these side effects. For example, drugs can often help prevent or reduce nausea and vomiting.

Some chemo drugs can also 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 getting these drugs. Some of these side effects might last after treatment is stopped.

Be sure to report any side effects to your medical team while getting chemo, so you can be treated promptly. Sometimes, 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.

## More information about chemotherapy

For more general information about how chemotherapy is used to treat cancer, see Chemotherapy

# Targeted Drug Therapy for Adult Brain and Spinal Cord Tumors

As researchers have learned more about the inner workings of cells that cause tumors or help tumor 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 side effects.

Targeted drugs don't yet play a large role in treating brain or spinal cord tumors, but some of them might be helpful for certain types of tumors.

bleeding, heart problems, and holes (perforations) in the intestines. This drug can also slow wound healing, so usually it can't be given within a few weeks of surgery.

## Drugs that target tumors with *IDH* gene changes

In people with some types of brain tumors, the tumor cells might have a change (mutation) in either the *IDH1* or *IDH2* gene. These genes help the cells make certain proteins, which are also called IDH1 and IDH2. Mutations in one of these genes can stop the tumor cells from maturing the way they normally would.

**Vorasidenib (Voranigo)** is a type of targeted drug known as an **IDH inhibitor**. It blocks abnormal IDH1 and IDH2 proteins, which seems to help the tumor cells mature into more normal cells.

This drug can be used after surgery in people with a grade 2 astrocytoma or oligodendroglioma[2], if the tumor cells are found to have an *IDH1* or *IDH2* gene mutation. Your doctor can get tests of the tumor cells to see if they have one of these mutations.

This drug is taken by mouth as tablets, once a day.

Common **side effects of vorasidenib** can include feeling very tired, headache, nausea, muscle aches or stiffness, diarrhea, seizures, and changes in lab tests showing the drug is affecting the liver.

Sometimes this drug might have more serious effects on the liver, which could lead to symptoms such as jaundice (yellowing of the eyes and skin), dark urine, loss of appetite, or pain in the upper right side of your belly. It’s important to let your health care team know if you have any of these symptoms.

## Everolimus

Everolimus (Afinitor) 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, This drug 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 a pill taken once a day.

Common **side effects of everolimus** can 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.

Wen PY. Systemic treatment of recurrent meningioma. UpToDate. 2020. Accessed at https://www.uptodate.com/contents/systemic-treatment-of-recurrent-meningioma on February 17, 2020.

Last Revised: August 8, 2024

# Other Drug Treatments for Adult Brain and Spinal Cord Tumors

Some drugs commonly used in people with brain or spinal cord tumors do not treat the tumors directly, but they may help lessen symptoms caused by 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 (anticonvulsants)

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

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treatment. It hasn't been shown to help people live longer than chemotherapy in this situation, but it tends to have much milder side effects.

### Possible side effects

Side effects of the device used for TTFields tend to be minor, and can include skin irritation at the electrode sites, trouble sleeping, mood changes, and a slightly increased risk of headaches and seizures.

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Last Revised: August 8, 2024

# Treatment of Adult Brain and Spinal Cord Tumors, by Type

The treatment options for brain and spinal cord tumors depend on several factors, including the type[1] and location of the tumor, how far it has grown or spread[2], whether the tumor cells have certain gene or chromosome changes[3], and a person's age and

overall health.

- Non-infiltrating (grade I) astrocytomas
- Low-grade (grade II) infiltrating astrocytomas (Diffuse astrocytomas)
- Intermediate-grade (grade III) gliomas (Anaplastic astrocytomas, anaplastic oligodendrogliomas)
- Glioblastomas or GBMs (grade IV astrocytomas)
- Oligodendrogliomas
- Ependymomas and anaplastic ependymomas
- Meningiomas
- Schwannomas (including acoustic neuromas)
- Spinal cord tumors
- Primary CNS lymphomas
- Brain tumors that occur more often in children

## Non-infiltrating (grade I) astrocytomas

These tumors include **pilocytic astrocytomas**, which most often develop in the cerebellum in young people, and **subependymal giant cell astrocytomas (SEGAs)**, which are almost always seen in people with tuberous sclerosis[4]. Many doctors consider these tumors benign because they tend to grow very slowly and rarely grow into (infiltrate) nearby tissues. (**Pleomorphic xanthoastrocytomas (PXAs)**, which are rare grade II tumors, are often treated the same way as these tumors as well.)

Many times, surgeons can't be sure a tumor is one of these types until surgery is done to remove it. But if these tumors can be removed completely by surgery, they can often be cured (although this is less likely in older patients). 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.

If surgery and radiation therapy are no longer good treatment options, chemotherapy (most often with temozolomide or the PCV regimen – procarbazine, CCNU, and vincristine) might be used at some point.

For SEGAs that can't be removed completely with surgery, treatment with the targeted

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 (grade II) infiltrating astrocytomas (Diffuse astrocytomas)

The initial treatment for diffuse astrocytomas is typically surgery to remove the tumor if it can be done. If surgery is not feasible, a biopsy may be done to confirm the diagnosis. 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 all of it can be removed, the person might be cured.

Other types of treatment might be used after surgery. Sometimes lab tests of the tumor[5] are used to help determine which of these treatments should be given.

- 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 need radiation unless the tumor shows signs of growing again. (In some cases, surgery may be tried again 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 (most often with temozolomide or the PCV combination regimen – procarbazine, CCNU, and vincristine) may also be given after surgery. Sometimes lab tests of the tumor[6] are used to help determine if radiation and/or chemotherapy should be given.
  A targeted therapy drug such as vorasidenib might be an option after surgery, if the tumor cells are found have an mos45 rg 30 rg /GS1021 gs ( i(mos45 rg 30 rg /geelpmutine i. d be

people who are in poor health or whose tumor cells have certain gene changes found on _____

If standard chemo drugs are no longer effective, the targeted drug bevacizumab (Avastin, other brand names[11]) may be helpful for some people, either alone or with chemo.

Another option might be tumor treating fields therapy (TTF), also known as alternating electrical field therapy with the Optune Gio device. This can be used along with chemo (after surgery and radiation) as part of the initial treatment, or it can be used by itself (instead of chemo) for tumors that come back after treatment.

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

## Oligodendrogliomas

Oligodendrogliomas are grade F4mo.

treatment can cause side effects related to nerve damage.

Radiation therapy is given after surgery, especially if only part of the tumor was removed (or if it is an anaplastic ependymoma). If surgery cannot be done, radiation therapy is typically the main treatment.

Sometimes the tumor cells can spread into the cerebrospinal fluid (CSF). Patients typically get an MRI of the brain and spinal cord[12] (and possibly a lumbar puncture[13]) 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 isn't usually helpful for these tumors, so it often isn't 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 can be removed completely with surgery. Radiation therapy may be used along with, or instead of,

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## Spinal cord tumors

Different types of tumors can start in the spinal cord. If a spinal cord tumor is small and not causing symptoms, it might not need to be treated right away. When spinal cord tumors do need treatment, it's often similar to what's done for the same type of tumor 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. Chemotherapy might also be an option at some point, if needed.

**Meningiomas** of the spinal canal are often cured by surgery, as are some **ependymomas**. If surgery doesn't remove the tumor completely, radiation therapy is often given.

## Primary CNS lymphomas

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1. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/about/types-of-brain-tumors.html
2. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/staging.html

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