Treating Brain and Spinal Cord Tumors in Adults

How are brain and spinal cord tumors treated?

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

- Surgery for Adult Brain and Spinal Cord Tumors
- Radiation Therapy for Adult Brain and Spinal Cord Tumors
- Chemotherapy for Adult Brain and Spinal Cord Tumors
- Targeted Drug Therapy for Adult Brain and Spinal Cord Tumors
- Other Drug Treatments for Adult Brain and Spinal Cord Tumors
- Alternating Electric Field Therapy for Adult Brain and Spinal Cord Tumors

Common treatment approaches

Treatment is based on the type of tumor and other factors, and often more than one type of treatment is used. Typically a team of doctors plan each person's treatment individually to give them the best chance of treating the tumor while limiting the side effects as much as possible.

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

Who treats brain and spinal cord tumors?

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, social workers, rehabilitation specialists, and others.

- Health Professionals Associated With Cancer Care

Making treatment decisions

It's important to discuss all of your treatment options, including their goals and their possible side effects, with your treatment team to help make the decision that best fits your needs. Some important things to consider include:

- Your age and overall health
- The type and location of your tumor
- The likelihood that treatment will cure your tumor (or help in some other way)
- Your feelings about the possible side effects from treatment

You may feel that you need to decide quickly, but it's important to give yourself time to think about the information you have learned. It's also very important to ask questions if there is anything you're not sure about.

- Questions to Ask About Adult Brain and Spinal Cord Tumors
- Seeking a Second Opinion

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're 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.

- Clinical Trials

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 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 not known) about the method, which can help you make an informed decision.

- Complementary and Alternative Medicine

Help getting through cancer treatment

People with cancer need support and information, no matter what stage of illness they may be in. Knowing all of your options and finding the resources you need will help you make informed decisions about your care.

Whether you are thinking about treatment, getting treatment, or not being treated at all, you can still get supportive care to help with pain or other symptoms. Communicating with your cancer care team is important so you understand your diagnosis, what treatment is recommended, and ways to maintain or improve your quality of life.

Different types of programs and support services may be helpful, and can be 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, 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.

- Palliative Care
- Find Support Programs and Services in Your Area

Choosing to stop treatment or choosing no treatment at all

For some people, when treatments have been tried and are no longer controlling the cancer, it could be time to weigh the benefits and risks of continuing to try new treatments. Whether or not you continue treatment, there are still things you can do to help maintain or improve your quality of life.

Some people, especially if the cancer is advanced, might not want to be treated at all. There are many reasons you might decide not to get cancer treatment, but it's important to talk to your doctors and you make that decision. Remember that even if you choose not to treat the cancer, you can still get supportive care to help with pain or other symptoms.

- If Cancer Treatments Stop Working

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

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

- Get a biopsy[1] sample to determine the type of tumor[2]
- Remove the tumor (or as much of it as possible)
- Help prevent or treat symptoms[3] or 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

Most often, the first step in brain or spinal cord 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 types of tumors, including some low-grade astrocytomas, ependymomas, craniopharyngiomas, gangliogliomas, and meningiomas.

Tumors that tend to spread widely into nearby brain or spinal cord tissue, such as anaplastic astrocytomas or glioblastomas, typically cannot be cured by surgery. But surgery is often done first to 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 can also be done to help relieve some of the symptoms[4] 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 to remove the tumor may not be a good option in some situations, such as if the tumor is deep within the brain, if it's 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 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 operation and monitors the response. This can show if these areas control an important function (and therefore should be avoided).
- **Functional MRI:** This type of imaging test (described in Tests for Brain and Spinal Cord Tumors in Adults[7]) 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.
- **Fluorescence-guided surgery:** For some types of tumors, such as glioblastomas, the patient can be given a special fluorescent dye before surgery. The dye is taken up by the tumor, which then glows when the surgeon looks at it under fluorescent lighting from the operating microscope. This lets the surgeon better separate tumor from normal brain tissue.
- **Newer techniques:** Newer types of MRI, as well as newer surgical approaches,

might be helpful in some situations. Some of these are described in What's New in Adult Brain and Spinal Cord Tumor Research?[8]

Once the surgery is complete, 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 [and will not set off metal detectors].)

You might 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. These 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 help with CSF flow bloackage

If a tumor blocks the flow of cerebrospinal fluid (CSF), it can increase pressure inside the skull (known as increased intracranial pressure, or ICP). This can cause symptoms[9] like headaches, nausea, and drowsiness, and may even be life-threatening. Surgery to remove the tumor can often help with this, but there are also other ways to drain away excess CSF and lower the pressure if needed.

For example, 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 (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 as well. 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.

Another option to treat increased pressure in the skull in some cases is an **endoscopic third ventriculostomy (ETV)**. In this operation, an opening is made in the floor of the

third ventricle at the base of the brain to allow the CSF to flow again. This operation is done through a small hole in the front of the skull. An advantage of this approach is that it does not require a shunt. But there is also a chance that the opening made in the ventricle might close up again, which is more likely in people with brain tumors.

If the pressure inside the head needs to be relieved for a short time, an **external ventricular drain (EVD)** might be put in place to allow the excess CSF to drain out. The drain is a small tube. One end is put into a ventricle, and the other end is attached to a collection bag outside the body. Along with collecting the excess CSF, the drain can also be used to measure the pressure inside the skull, as well as to look for tumor cells, blood, or signs of infection in the CSF.

The drain can be placed either during surgery or during a procedure at the patient's bedside. It can be put in place to relieve the pressure in the days before surgery, or to help drain the fluid that collects after an operation. If the pressure inside the skull needs to be lowered for more than a few days, the doctor might need to change this to a VP shunt.

Surgery to put in a ventricular access catheter

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 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 as is safely possible. If problems do arise, it could be right after surgery, or it could be days or even weeks later, so close monitoring for any changes is very important (see Living as a Brain or Spinal Cord Tumor Survivor[10]).

More information about Surgery

For more general information about surgery as a treatment for cancer, see Cancer Surgery[11].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[12].

Hyperlinks

1. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
2. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/about/types-of-brain-tumors.html
3. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/signs-and-symptoms.html
4. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/signs-and-symptoms.html
5. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
6. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
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11. www.cancer.org/treatment/treatments-and-side-effects/treatment-types/surgery.html
12. www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects.html

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Last Medical Review: May 5, 2020 Last Revised: May 5, 2020

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[1] from the tumor

Types of radiation therapy

Most often, 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. This planning session, called **simulation**, usually includes getting imaging tests[2] such as CT or MRI scans.

In most cases, the total dose of radiation is divided into daily amounts (usually given Monday through Friday) over several weeks. At each treatment 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 30 minutes, and 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 while giving 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.

Volumetric modulated arc therapy (VMAT): This newer technique is similar to IMRT. For this treatment, the patient lies on a table, which passes through the machine delivering the radiation. The source of the radiation (the linear accelerator) rotates around the table in an arc, delivering the beams from different angles. A computer controls the intensity of the beams to help keep the radiation focused on the tumor. It’s not yet clear if this approach results in better outcomes than IMRT, although it does allow the radiation to be given over less time in each treatment session.

Conformal proton beam radiation therapy: Proton beam therapy uses an approach similar to 3D-CRT. 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. This lets doctors 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 for tumors that typically grow into or mix with normal brain tissue (such as astrocytomas or glioblastomas). There are a limited number of proton beam centers in the United States at this time.

Stereotactic radiosurgery (SRS)/stereotactic radiotherapy (SRT): This type of treatment delivers a large, precise radiation dose to the tumor area in a single session (SRS) or in a few sessions (SRT). (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.

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 treatments to deliver the same or a slightly higher dose. Frameless techniques are now available to make this more comfortable.

Image-guided radiation therapy (IGRT): For IGRT, an imaging test such as a CT scan is done just before each treatment to help better guide the radiation to its target. IGRT is typically used along with some of the more precise techniques for delivering radiation

described above. It is most useful when the radiation needs to be delivered very precisely, such as when a tumor is very close to vital structures.

Brachytherapy (internal radiation therapy): 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, 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, 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/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/signs-and-symptoms.html
2. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
3. www.cancer.org/treatment/treatments-and-side-effects/treatment-types/radiation.html
4. www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects.html

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Last Medical Review: May 5, 2020 Last Revised: May 5, 2020

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 aren't able to enter the brain and reach tumor cells.

For some brain tumors, drugs can be given directly into the cerebrospinal fluid (CSF, the fluid that bathes the brain and spinal cord), 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 Surgery for Adult Brain and Spinal Cord Tumors).

When might chemotherapy be used?

In general, chemo is used for faster-growing brain tumors. Some types of brain tumors, such as medulloblastoma and lymphoma, tend to respond better to chemo than others. Chemo is not as helpful for treating some other types of tumors, such as spinal cord tumors, so it is used less often for these tumors.

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

Chemo drugs used to treat brain and spinal cord tumors

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

- Carboplatin
- Carmustine (BCNU)
- Cisplatin

- Cyclophosphamide
- Etoposide
- 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[1].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[2].

Hyperlinks

1. www.cancer.org/treatment/treatments-and-side-effects/treatment-types/chemotherapy.html
2. www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects.html

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Last Medical Review: May 5, 2020 Last Revised: May 5, 2020

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.

Bevacizumab (Avastin, Mvasi, Zirabev)

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 (a process known as **angiogenesis**), which they need in order to grow.

This drug is used mainly to treat some types of gliomas (especially fast-growing ones such as glioblastomas) that come back after initial treatment. It might also be useful in treating recurrent meningiomas.

When used alone or added to chemotherapy, this drug can help shrink some tumors or extend the time until they start growing again, although 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. Less tcommon but possibly serious side effects include blood clots, internal 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.

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, 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 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[1].

More information about targeted therapy

To learn more about how targeted drugs are used to treat cancer, see Targeted Cancer Therapy[2].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[3].

Hyperlinks

1. www.cancer.org/treatment/treatments-and-side-effects/clinical-trials.html
2. www.cancer.org/treatment/treatments-and-side-effects/treatment-types/targeted-therapy.html
3. www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects.html

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[4]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*. 6th ed. Philadelphia, Pa: Elsevier; 2020.

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Last Medical Review: May 5, 2020 Last Revised: May 5, 2020

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

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.

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Last Medical Review: May 5, 2020 Last Revised: May 5, 2020

Alternating Electric Field Therapy for Adult Brain and Spinal Cord Tumors

Researchers have found that exposing some types of tumor cells to alternating electric fields (also known as tumor treating fields) can interfere with the cells' ability to grow and spread. A wearable device known as Optune, which generates such electric fields, is now an option to help treat some people with glioblastomas.

For this treatment, the head is shaved, and 4 sets of electrodes are placed on the scalp. The electrodes are attached to a battery pack (kept in a backpack) 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.

Optune can be used:

- Along with chemotherapy in people with newly diagnosed glioblastoma after treatment with surgery and radiation therapy. It may help people live longer than if they just get chemotherapy alone.
- Instead of chemotherapy in people whose glioblastoma has come back after initial 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 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 Medical Review: May 5, 2020 Last Revised: May 5, 2020

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

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 xanthroastrocytomas (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 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

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[5] are used to help determine if radiation and/or chemotherapy should be given.

Radiation and/or chemotherapy may be used as the main treatment if surgery is not a good option.

Intermediate-grade (grade III) gliomas (Anaplastic astrocytomas, anaplastic oligodendrogliomas)

Surgery is often the first treatment if an imaging test shows what is likely one of these types of tumors, although the specific type of tumor might not be known until after the operation. As much of the tumor is removed as is safely possible, but because of the way they grow into nearby areas, these tumors are almost never removed completely. Radiation therapy is given after surgery in most cases. Chemotherapy may also be given before, during, or after radiation therapy if a person is healthy enough. For some people who are in poor health or whose tumor cells have certain gene changes found on lab tests[6], chemo may be used instead of radiation therapy.

For tumors that can't be treated with surgery, radiation therapy along with chemo is usually the best option.

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

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

In general, these gliomas can be very hard to control for long periods of time. Because these tumors are so hard to cure with current treatments, clinical trials[7] of promising new treatments may be a good option.

Glioblastomas (grade IV astrocytomas)

Surgery is often the first treatment if an imaging test shows what is likely a glioblastoma,

although the specific type of tumor might not be known until after the operation. As much of the tumor is removed as is safely possible, although these tumors are almost never removed completely because of the way they grow into nearby areas. Radiation therapy is then given in most cases. This may be given with or followed by chemotherapy if a person is healthy enough. For some people who are older or in poor health, or whose tumor cells have certain gene changes found on lab tests[8], just one of these treatments (chemo or radiation therapy) might be used.

For tumors that can't be treated with surgery, radiation therapy along with chemo is usually the best option.

Temozolomide is the chemo 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.

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

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

Another treatment option might be alternating electrical field therapy with the Optune 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 II tumors. (Treatment of anaplastic oligodendrogliomas, which are grade III tumors, is discussed above.)

If possible, surgery is typically the first treatment 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 combination regimen - procarbazine CCNU, and vincristine,) may also be options after surgery.

Oligodendrogliomas tend to respond better to chemotherapy than some other brain tumors.

Radiation therapy and/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, and surgery to remove the tumor is typically the first treatment. Sometimes, patients may be cured by surgery alone if the entire tumor can be removed, but often this is not possible. Spinal cord ependymomas have the greatest chance of being cured with surgery, but 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[9] (and possibly a lumbar puncture[10]) 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, surgery for tumors that can't be removed completely.

For meningiomas that are atypical/invasive (grade II) or anaplastic (grade III), which tend to come back after treatment, radiation therapy is typically given after surgery even

if all of the visible 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 (such as chemotherapy, targeted drug therapy, immunotherapy, or hormone-like drugs) may be tried, 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 with precise radiation therapy techniques such as stereotactic radiosurgery (SRS) or proton beam therapy (see 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 remove as much as is safe, and then the remainder is treated with radiation.

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

Treatment of central nervous system (CNS) lymphomas generally consists of chemotherapy (given into a vein or through a ventricular access catheter, or both) and/or radiation therapy. Treatment is discussed in more detail in Non-Hodgkin Lymphoma[11].

Brain tumors that occur more often in children

Some types of brain tumors that are seen more often in children can also occur occasionally in adults. Some examples include:

- Brain stem gliomas
- Germ cell tumors
- Craniopharyngiomas
- Choroid plexus tumors
- Medulloblastomas and other embryonal tumors

Treatment of these tumors is described in Brain and Spinal Cord Tumors in Children[12].

Hyperlinks

1. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/about/types-of-brain-tumors.html
2. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/staging.html
3. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
4. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/causes-risks-prevention/risk-factors.html
5. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
6. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
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9. www.cancer.org/cancer/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
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11. www.cancer.org/cancer/non-hodgkin-lymphoma.html
12. www.cancer.org/cancer/brain-spinal-cord-tumors-children.html

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Last Medical Review: May 5, 2020 Last Revised: May 5, 2020

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