PATIENT RESOURCE

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Third Edition

UNDERSTANDING BRAIN TUMORS

A TREATMENT GUIDE FOR PATIENTS AND THEIR FAMILIES

Pineal gland tumors
Pituitary adenomas
Meningiomas
Glioblastomas
Germ cell tumors
Schwannomas

WHERE INFORMATION EQUALS HOPE

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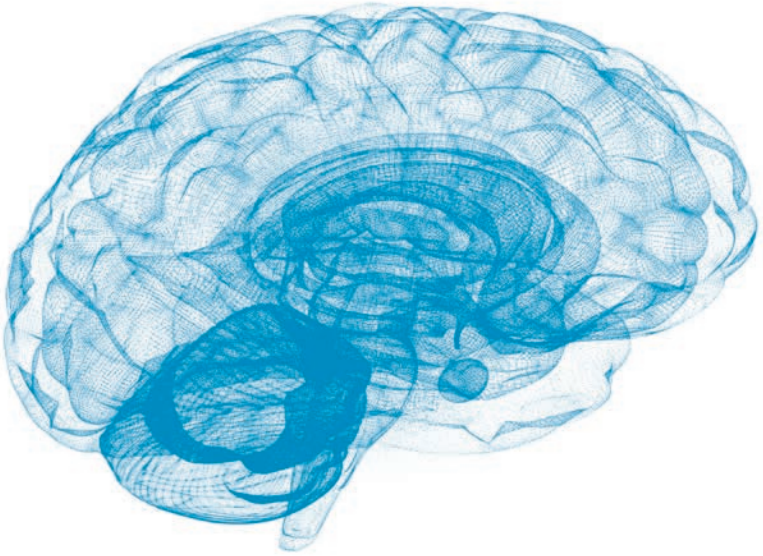
A Study for Management of Eye Side Effects in Patients with EGFR-Amplified Glioblastoma Receiving Depatuxizumab Mafodotin (ABT-414)

Glioblastoma (GBM) Research Study



Do you or someone you know have a glioblastoma?

This study evaluates the effect of several eye treatments for the management of eye side effects in patients treated with depatuxizumab mafodotin (Depatux-M). All participants will receive Depatux-M along with 1 of 3 eye treatments.

Patients must meet the following criteria:

- Be ages 18 or older
- Newly diagnosed GBM and have not already started treatment
- GBM tumor tested positive for EGFR amplification (about half of people with GBM tumors have EGFR amplification)
- Not pregnant or breastfeeding
- Other criteria must also be met

For more information, ask your doctor about the Ocular Side Effect Study or visit **www.clinicaltrials.gov** (NCT03419403) to see if you qualify.

Depatuxizumab Mafodotin is an investigational medicine that is not approved by the FDA. Safety and efficacy have not been established.

UNDERSTANDING BRAIN TUMORS

Third Edition

IN THIS GUIDE

PEDIATRIC BRAIN TUMORS

ADULT BRAIN TUMORS

~ Jeannie Gaffigan,
brain tumor survivor and author of "When Life Gives You Pears"

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Educate yourself about the basics of a brain tumor diagnosis

Learning you have a brain tumor can be overwhelming. Stop and take a deep breath. You will not go through this alone. You will be surrounded by a skilled health care team of many specialists trained in multiple fields to assist you along the way. Accept help from supportive friends and family as you make necessary choices about your care. You will likely face many decisions ahead, and the more you know about the brain and your diagnosis, the more empowered you'll feel moving forward.

This guide focuses on brain tumors, from how they are diagnosed and common treatment options to managing side effects and preparing for survivorship. A survivor shares her inspiring story, and a pediatric section addresses brain tumors in children (see *Pediatric Tumor Types,* page 14).

ABOUT THE BRAIN

The brain is an amazingly complex organ that controls the body's functions and allows us to understand the outside world through intelligence, creativity and memory. The components of the brain include the cerebrum, cerebellum and brain stem, and they each have separate responsibilities.

The cerebrum is the large outer part of the brain. It is made up of two hemispheres (halves) and is further divided into four lobes. Frontal lobes are located behind the forehead. Parietal lobes are located just behind the frontal lobes. Temporal lobes are responsible for memory and hearing; they are located under the frontal and parietal lobes. Occipital lobes are located at the back of the brain and process visual images from your eyes.

The cerebellum lies under the cerebrum at the back part of the brain. It helps coordinate movement and balance.

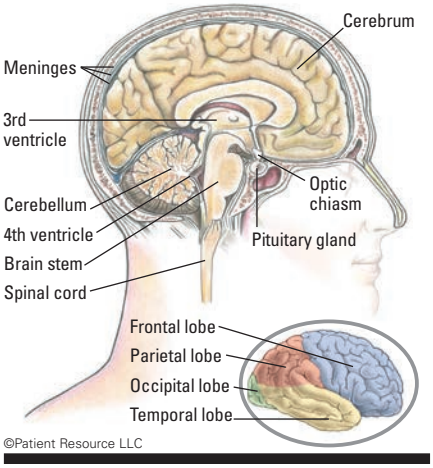
The brain stem is the lower part of the brain that is connected to the spinal cord. It controls the nerves and muscles that are responsible for involuntary functions, such as breathing, heartbeat, blood pressure and body temperature.

The spinal cord is made up of nerve fibers that are protected by membranes and the bones of the spine. The spinal cord allows the brain to send and receive signals from the rest of the body to control muscles, sensation and feeling.

The cranial nerves emerge directly out of the base of the brain. These nerves allow direct communication to occur between the brain and the face, eyes, ears, tongue, mouth, neck and other areas.

The brain and spinal cord are surrounded by three protective membranes (layers of tissue) collectively known as the meninges. Cerebrospinal fluid, which also protects the central nervous system (CNS), flows through a network of cavities in the brain called ventricles.

BRAIN ANATOMY



BRAIN TUMORS 101

Tumors that originate in the brain or spinal cord are known as primary brain tumors. These are distinctly different from metastatic brain tumors (also known as secondary tumors), which are made up of cancer cells that have spread to the brain from another site.

Primary brain tumors may be considered benign (noncancerous) or malignant (cancerous). Benign tumors are slow growing, appear to have mostly normal cells when examined under a microscope and have distinct borders, meaning they're less likely to spread into surrounding tissues. However, a benign tumor can be just as dangerous or life-threatening as a malignant tumor if it's located in or near an area of the brain that controls crucial functions, or if it has a tendency to keep returning.

Malignant brain tumors grow rapidly and are invasive. They may have "roots" that extend into surrounding tissue, making the tumor borders less defined and more difficult to remove surgically. Although brain tumors rarely spread to distant organs, malignant tumors may spread to other areas of the brain or spine through the cerebrospinal fluid.

When doctors refer to brain tumors, they also include the spine and spinal cord. Together, the spine, spinal cord and brain make up the CNS, which controls our personality, senses, movements and other basic bodily functions. The brain and spinal cord are composed of multiple types of tissues and cells, and primary brain tumors can start in any of them.

MEET YOUR HEALTH CARE TEAM

After learning you have a brain tumor, life changes in many ways. Because it can affect areas of the brain responsible for the physical, emotional and cognitive aspects of your life, you may see a number of specialists.

- **Neuropathologists** identify brain tumors by studying cells and tissues under a microscope.
- **Neuroradiologists** create and interpret pictures of the CNS that are produced using forms of radiation, such as X-rays, sound waves or other types of energy.
- **Neuro-oncologists** diagnose and treat brain tumors.
- **Neurosurgeons** perform surgery on the brain, spine and other parts of the CNS.
- **Neuropsychologists** diagnose and treat behavioral and other problems related to the way the brain works. These may include problems with social interactions, ability to control emotions and behaviors, and cognitive abilities, such as thinking, learning, remembering and problem solving. These problems may be caused by the tumor or its treatment.
- **Nurse practitioners** oversee patient care management.
- **Nurse navigators** identify education and support resources for you and your family.
- **Social workers** may help you and your caregiver with various tasks, such as finding services or working with insurance companies.
- **Rehabilitation specialists** may be involved with your care depending on your specific diagnosis. These specialists can provide physical, occupational or speech therapy.

Take advantage of your support system. Rely on the help of your family, friends and your medical team to help you become comfortable making decisions regarding your treatment and care. For additional support and organizations to help with your specific needs, explore the resources on page 20. ■

Thorough testing provides personalized tumor details

Determining your best treatment options begins with learning the location and size of the brain tumor. Several diagnostic tests may be performed along with a physical and neurological exam, including imaging tests and a biopsy. Your doctor may include any of the following tests to diagnose your tumor and begin planning your treatment.

IMAGING TESTS

Angiogram uses X-rays and contrast injected into your arteries and/or veins to identify the network of blood vessels that supply the tumor.

Computed tomography (CT) produces three-dimensional, cross-sectional X-ray images. It may be used to measure the tumor's size, look for changes to the skull and find bleeding or enlarged ventricles.

Electroencephalography (EEG) is a noninvasive test to measure and record the electrical activity that is produced when brain cells communicate with each other. Special sensors, called electrodes, are attached to the outside of your head and are connected to a computer that displays the activity in wavy lines.

Hemodynamic imaging measures the brain's blood flow and supply. The photos taken are used to create images of the blood flow into the tumor, allowing the doctor to see the tumor's blood supply.

Magnetic resonance imaging (MRI) uses magnetic fields to create visual images of internal structures of the body. Multiple types of MRI exist and function differently, including functional MRI (fMRI), flow-sensitive MRI (FS MRI), dynamic MRI (also called perfusion MRI), diffusion weighted imaging and spinal MRI.

Magnetic resonance spectroscopy (MRS) measures metabolites (substances produced by living tissue) to create images that represent patterns of activity in the brain. These patterns can be helpful in diagnosing specific types of brain tumors or to help determine whether a tumor is malignant.

Positron emission tomography (PET) images are not as finely detailed as those from CT or MRI but can provide helpful information to supplement those results and determine tumor grade. This test may be used to determine if the tumor is primary or a metastasis from elsewhere in the body.

Single photon emission computed tomography (SPECT) is similar to PET but uses a special camera to detect radioactive material that has been injected into the body. It is rarely used to diagnose brain tumors but may help the doctor distinguish between low- and high-grade tumors.

LUMBAR PUNCTURE (SPINAL TAP)

A spinal tap is used to collect a sample of cerebrospinal fluid, which is examined for the presence of tumor cells, blood infection and proteins. This procedure may be used to help diagnose pineal region or meningeal tumors or central nervous system lymphoma, as well as tumors that have spread after surgery.

BIOPSY

A biopsy is the removal of tissue from a suspected tumor or removal of the entire tumor during surgery. Three types are generally used for brain tumors: needle biopsy, open biopsy and stereotactic biopsy. Your pathologist may perform biomarker testing on the tissue sample to provide more information about the type of brain tumor. ■

ADDITIONAL RESOURCES

- **Accelerate Brain Cancer Cure:**
  www.abc2.org
  Diagnosis
- **American Brain Tumor Association:**
  www.abta.org
  Molecular Testing: How it is Improving Brain Tumor Diagnosis
- **Brain Tumor Foundation:**
  www.braintumorfoundation.org
  Educate Yourself
- **Brain Tumor Network:**
  www.braintumornetwork.org
  About Brain Tumors

Research uncovers genetic information about brain tumors

Doctors now understand that genetic mutations are involved with some brain tumors. These mutations can be detected through molecular testing of the tumor or a sample of its tissue, which shows the unique DNA of the tumor. Your doctor may also order genetic testing from a blood sample to examine your individual genetic material for any mutations.

Biomarkers are substances produced by cancer cells or other cells in the body in response to cancer. These can include specific genes, proteins or molecules of the tumor and can be measured in the blood, plasma, urine, cerebrospinal fluid or other body fluids or tissue.

Pathologists, who have special training in identifying cells and tissues under a microscope, look for specific biomarkers in the sample. While examining a sample for biomarkers, the pathologist will look for certain genetic abnormalities, including chromosomes that change places to extra copies of a gene and mutations (any change in the DNA sequence of a cell).

Doctors use biomarkers to determine a prognosis (outlook), to predict how the person will respond to treatment or to diagnose a tumor. A prognostic biomarker provides information about a person's overall cancer outcome, regardless of therapy, while a predictive biomarker gives information about the effect of a specific treatment approach. Diagnostic biomarkers help determine the type of tumor. Some biomarkers may also help determine how aggressive (fast growing) a tumor is and may predict long-term survival.

Following are the most commonly tested biomarkers in people with brain tumors:

- ***1p/19q* co-deletion.** Genetic changes in chromosomes 1 and 19 can occur in tumor cells (primarily for oligodendrogliomas and anaplastic oligodendrogliomas). The test for this is prognostic, predictive and diagnostic.
- ***Isocitrate dehydrogenase* (*IDH-1*).** This mutated gene may be found in low-grade tumors, specifically oligodendrogliomas, astrocytomas and secondary glioblastomas. The test for this is prognostic and diagnostic.
- ***Methyl guanine methyl transferase* (*MGMT*).** This is a gene involved with DNA repair. The test is most commonly used with glioblastomas and is prognostic and predictive.

Although testing for brain tumor biomarkers is still new and mostly performed in clinical trials, it is becoming more a part of regular clinical practice. Finding new biomarkers may help doctors diagnose brain tumors earlier or direct treatment options. In addition, knowing your biomarkers may help determine eligibility for clinical trials. Ask your doctor if biomarker testing is right for you.

Pathology report identifies crucial tumor information

Results from tests to diagnose your tumor are summarized in a pathology report, and your final diagnosis is usually based on these findings. This essential information becomes a roadmap to guide your medical team in planning the most effective course of treatment based on your tumor's specific characteristics.

The report is compiled by a pathologist, a doctor with specialized training in studying cells or tissue under a microscope, to determine the nature and cause of diseases. The pathologist examines the biopsied tissue or cells, documenting the cells' size, shape and appearance, and may perform tests. In some cases, the entire tumor is examined after it is removed by surgery. Cerebrospinal fluid, found in and around the brain and spinal cord, may be collected to help determine the tumor's grade by examining it for the presence of any tumor cells.

A neuropathologist, who specializes in diagnosing diseases of the central nervous system, may contribute to the report. He or she will examine the specimen to determine the specific tumor type and test for biomarkers and genetic abnormalities (see *Diagnosing and Biomarkers,* page 3). The tumor is then classified according to the system/method typically used for its specific type.

GRADING BRAIN TUMORS

Most types of brain and spinal cord tumors, including gliomas and meningiomas, are classified by grades, which are different from the stages used to classify most other cancers. Tumor grades are based on how closely the cells resemble normal, healthy cells when viewed under a microscope.

Brain tumors are most commonly graded using the World Health Organization (WHO) Classification and Grading System for central nervous system tumors. It ranges from Grade I, indicating slow-growing nonmalignant (noncancerous) tumors, to Grade IV, for rapidly-growing malignant tumors that can spread into surrounding tissue (see Table 1).

Tumor cells resembling normal cells are called well-differentiated. They grow and spread at a slower rate than undifferentiated or poorly differentiated cells, which look very abnormal in comparison. A tumor may sometimes contain different grades of cells, in which case the tumor's overall grade will be based on the highest-grade cells.

CLASSIFYING OTHER TYPES OF TUMORS

Some types of brain tumors, such as germ cell tumors and medulloblastomas, are classified using other methods.

There is no universally accepted system for classifying germ cell tumors, so they are typically evaluated by magnetic resonance imaging (MRI) and tests on cerebrospinal fluid. In general, doctors classify germ cell tumors in adolescents and young adults as either M0 (metastatic-negative) or M+ (metastatic-positive).

For medulloblastomas, doctors base treatment on factors indicating the risk of tumor recurrence (returning after treatment) rather than on a classification system. In general, doctors classify medulloblastomas in children into one of two risk groups, depending on the child's age, how much of the tumor remains after surgery and whether it has spread.

1. **Standard-risk:** A standard- or average-risk tumor is in the very back portion of the brain and hasn't spread to other parts of the brain or spine. This classification is assigned when nearly all of the tumor is removed during surgery.
2. **High-risk:** A high-risk tumor may or may not have spread, but more than 1.5 cc of the tumor remains after surgery. A tumor that initially appears to be standard-risk may be given a high-risk classification after biomarker testing is completed.

Ask your doctor to go over your pathology report with you, and request a copy. Understanding these findings will help you as you and your medical team make shared treatment decisions, including evaluating clinical trials. ■

TABLE 1

BRAIN TUMOR GRADES

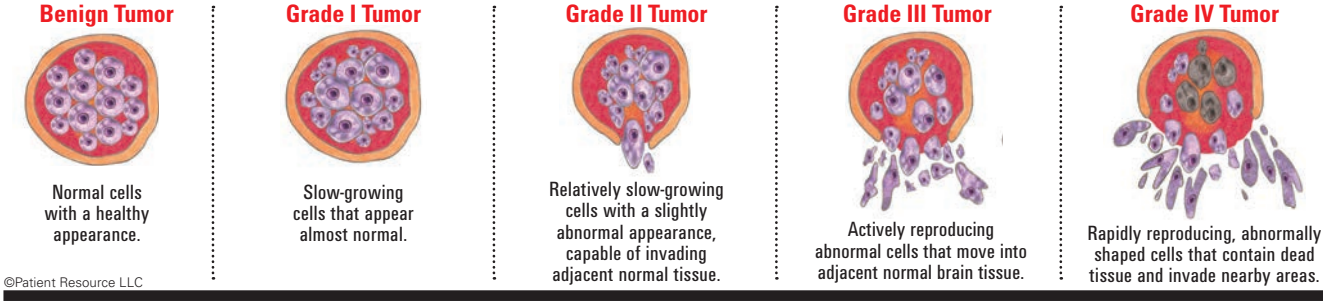
Grade	Description
Grade I	The slowest growing and least malignant (cancerous) tumors, these tumors are often referred to as nonmalignant tumors. They consist of cells that look mostly normal when examined with the use of a microscope. These tumors rarely recur (come back) as a higher grade tumor.
Grade II	These tumors grow relatively slowly and consist of cells that look only slightly abnormal when examined with the use of a microscope. They can spread into nearby normal tissue and may recur later as a higher grade tumor.
Grade III	These malignant tumors quickly reproduce abnormal cells that are likely to spread to nearby normal tissue. They have a higher risk of recurrence and may return as a higher grade tumor. It can sometimes be difficult to differentiate between Grade II and Grade III tumors.
Grade IV	The most rapidly growing type of brain tumor, these malignant tumors reproduce cells that appear completely abnormal and can easily spread into surrounding tissue.

Source: World Health Organization (WHO) Classification and Grading System (2017)

ADDITIONAL RESOURCES

- **American Brain Tumor Association:**
  www.abta.org
  Brain Tumor Education
  Diagnosis
- **American Society of Clinical Oncology:**
  www.cancer.net
  Brain Tumor: Grades and Prognostic Factors

BRAIN TUMOR GRADES



Brain tumors present unique caregiving challenges

Learn about caring for a child with a brain tumor
see page 16

Few people with a loved one undergoing brain tumor treatment have the training or experience for the role of caregiver. You may find you need to assist your loved one as he or she experiences frequent mood swings, emotional outbursts, memory issues, communication difficulties and personality changes caused by the tumor and its treatment.

And all this happens while you're working through your own emotions and fears caused by this serious diagnosis. It's common to feel overwhelmed and unprepared, but keep in mind that you already possess skills for giving encouragement, offering comfort, providing companionship and so much more. You should also accept help from friends, family members and your community. Together, you can make a significant difference for your loved one.

To better understand what is expected of you, learn as much as you can about your loved one's diagnosis, including the specific type and grade of tumor as well as the various treatments planned.

Your duties may include the following, among many others.

- **Attend medical appointments.** This is a crucial function, as your loved one may find it difficult to absorb and remember information.
- **Provide transportation.** You can also work with a nurse navigator to find alternative transportation options.
- **Share medical updates.** Use a group email or social media site to ensure friends and family receive the same information. This will relieve you from having to repeat updates multiple times.
- **Be alert to side effects.** Learn which side effects to watch for, when they will likely occur and how to manage them (see *Side Effects,* page 12). Minimizing and managing them may improve your loved one's outcome and will improve his or her quality of life. Check with the doctor before using over-the-counter medications. Avoid remedies others suggest; rely on the doctor for advice on the right methods to use. Report side effects as soon as they occur. Your prompt attention could prevent a potentially life-threatening situation.
- **Buy groceries and cook.** Consider any dietary needs and your loved one's preferences when preparing meals. Thoroughly wash all fruits and vegetables. Accept friends' offers to bring meals, and provide detailed information about any dietary restrictions. Meals that can be frozen to serve later are ideal. Meals built on healthy, nutritious foods will help promote healing during treatment.
- **Care for children.** Help your loved one enjoy some downtime by taking the kids on an outing. Entertaining kids doesn't have to be costly — an afternoon at the park or in the library is fine. If your loved one prefers not to be left alone, plan an at-home activity, such as making posters or get well cards for the parent who is undergoing treatment.
- **Become a pet sitter.** Take the dog for a walk or to the dog park. Pet treats and toys are always a nice surprise. Consider boarding pets if your loved one will be away from home for an extended time.
- **Don't forget to take care of yourself.** Many caregivers experience physical and emotional fatigue or burnout from neglecting their own needs for good nutrition, adequate sleep, exercise and social interaction. ■

ADDITIONAL RESOURCES

- **American Brain Tumor Association:**
  www.abta.org
  Caregiving
  Managing Day to Day Life
- **American Society of Clinical Oncology:**
  www.cancer.net
  Caregiving Basics
  Caring for a Person with a Brain Tumor
- **Family Caregiver Alliance:**
  www.caregiver.org
  Brain Tumor
  Caregiving Issues and Strategies

A CAREGIVER'S CHECKLIST FOR MEDICAL VISITS

Appointments can often seem overwhelming because there is so much new information. You can make the experience more positive and productive for your loved one with the help of this checklist.

BEFORE THE APPOINTMENT

Preparing the day before will reduce stress for you both.

- ❑ Confirm date, time and directions to the facility.
- ❑ Make a list of questions.
- ❑ Identify symptoms; summarize concerns.
- ❑ Update medications list.
- ❑ Note contact information for all physicians.
- ❑ Gather medical files, insurance cards, ID, medications list, questions, etc.

DURING THE APPOINTMENT

Encourage your loved one to take the lead.

- ❑ State main concerns first.
- ❑ Help accurately describe symptoms.
- ❑ Note/record doctor's instructions.
- ❑ Ask questions; state any other concerns.
- ❑ Discuss recommendations.
- ❑ Ask when to seek immediate medical attention.
- ❑ Verify next steps.

BEFORE LEAVING THE FACILITY

Confirm that you're authorized to receive the patient's information.

- ❑ Schedule follow-up appointments.
- ❑ Ask if prescriptions are being called in to the patient's pharmacy.
- ❑ Verify you've received all printed instructions, prescriptions, referrals, etc.
- ❑ Ask how/when you'll get lab/test results.
- ❑ Request after-hours contact information if needed.
- ❑ If your loved one's care facility has an electronic patient record (known as MyChart), request access and ask how soon new information is posted.

AFTER THE APPOINTMENT

Immediately stress positive aspects of the appointment.

- ❑ Discuss the visit, referring to your notes.
- ❑ Give your loved one space to process the information.
- ❑ Make a plan together to implement the doctor's recommendations.
- ❑ Pick up prescriptions and/or over-the-counter medications.
- ❑ Update friends and family (if applicable).
- ❑ Update calendar with new appointments.

Treatment planning is guided by informed decisions

Feeling overwhelmed from a brain tumor diagnosis is normal. Lean on your health care team to learn as much as possible about the details of your diagnosis and how that will affect your treatment plan. Ask your health care team if the goal of treatment is to cure the cancer or to keep it under control and relieve symptoms. Ask if clinical trials are an option for you. Understanding the goal, as well as being aware of the benefits and risks of each option, will help you be more prepared to make shared treatment decisions with your doctor.

Many factors will influence your treatment options, including the stage of disease, the location, size and type of tumor, and your overall health status. Once you've agreed on your treatment plan, you will work closely with a multidisciplinary care team, including a neuro-oncologist, neurosurgeon, financial counselor and others (see *Overview,* page 2). Talk openly with them and ask questions about your treatment, including potential clinical trials (see *Clinical Trials,* page 8). Following are the current most common treatment options.

Surgery is typically the first treatment option whether a brain tumor is considered benign (noncancerous) or malignant (cancerous). The main goal is to remove as much of the tumor as possible before drug therapy or radiation therapy. However, it may also be done for other reasons, including taking a biopsy of the tumor, inserting an implant for treatment or alleviating symptoms, such as seizures or pressure inside the skull caused by the tumor.

Several surgical procedures may be used to remove a brain tumor.

- Craniotomy is the most common brain surgery used to treat brain tumors. A piece of the skull is removed to expose the brain so the surgeon can find and remove as much of the tumor as possible. The piece of skull is then replaced.
- Craniectomy is like a craniotomy; however, the piece of skull removed at the beginning of the procedure is not replaced at the end. The surgeon may do a craniectomy in situations where the piece of skull was damaged by the tumor or if the brain is expected to swell after surgery. In cases of expected swelling, the piece of skull may be saved and replaced at a later time, but this rarely happens.
- Complete removal or gross total resection is the removal of the entire tumor. After surgery, diagnostic imaging tests may be performed to look for any remaining tumor. Even if it appears that the entire tumor was removed, tumor cells that are too small to see using current imaging methods may remain. Additional treatment may be recommended to destroy them.
- Partial removal of a tumor may be done to avoid the risk of brain damage. Additional therapy, such as radiation therapy or drug therapy, is often recommended to treat the remaining tumor.
- Debulking surgery is the removal of as much of a tumor as possible when it's unlikely that the entire tumor or multiple tumors can be completely removed. This is typically done to reduce the pressure the tumor is placing on the brain or surrounding structures.
- Neuroendoscopy involves the use of a long narrow tube equipped with a camera and light that is inserted into the hollow pathways of the brain through a small hole drilled in the skull. A laser may also be attached to the endoscope, allowing the surgeon to perform biopsies and remove small tumors, cysts or blockages within the ventricles.
- Laser interstitial thermal therapy (LITT) involves the use of a laser to heat and destroy brain tissue while being monitored by magnetic resonance imaging (MRI). The laser is directed at the tumor through one or more small holes drilled into the skull. This procedure may be used for tumors that pose a health risk or are unreachable with a craniotomy.
- Photodynamic therapy (PDT) is a procedure in which a sensitizing drug, or a drug that will be absorbed by the tumor, is injected into a vein or artery shortly before surgery. The drug contains a compound that allows the cells to glow a fluorescent color. These cells can then be seen with the use of special microscopic filters. During the procedure, the surgeon aims a laser at the glowing cells, which activates the drug and kills the tumor cells.
- Skull base surgery involves the use of specialized techniques, such as neuroendoscopy. This surgery is very difficult because the skull base is a delicate area containing several nerves and blood vessels that are crucial for sensory and motor functions.
- Transsphenoidal surgery is done by going through the nostril to reach the pituitary gland, or by making an incision in the upper lip above the teeth to access the tumor through the sphenoid sinus. It is most often used to treat pituitary adenomas and craniopharyngiomas.
- Embolization is used to stop the flow of blood to tumors that have a large number of surrounding blood vessels. This procedure is done to prevent excessive bleeding during surgery. Before surgery, an angiogram is performed to map the blood vessels around the tumor. The neurosurgeon or interventional radiologist then inserts a plug in the blood vessels feeding the tumor to stop blood flow to the tumor. Surgery to remove the tumor is typically done within a few days.
- Shunt placement involves placing a shunt, or catheter, into one of the four ventricles of the brain or into a cyst to drain fluid that may be causing increased pressure inside the skull. The pressure is often caused by excess fluid buildup or blocked fluid pathways as a result of the tumor itself or swelling caused by the tumor. The shunt drains cerebrospinal fluid or tumor fluid away from the brain and into the body, where it can be absorbed through normal processes. A shunt can be permanent or temporary.
- Ultrasonic aspiration involves the use of vibrations caused by ultrasonic waves to break apart the brain tumor, which is then aspirated (removed with suction).

Chemotherapy uses drugs to destroy cancer cells. It may be used as the primary treatment for certain tumors, before surgery to help shrink the tumor or, more commonly, after surgery to destroy any remaining cells. Chemotherapy is sometimes given with radiation therapy (known as chemoradiation) to make the radiation more effective. It may be given as a single drug or in combination and may be given by mouth (orally), through an IV or injected directly into cerebrospinal fluid, which is called intrathecal chemotherapy.

Using chemotherapy for brain tumors is different from treating any other type of tumor because of the blood-brain barrier, a network of blood vessels and tissue that protects the brain from harmful substances. Only certain

chemotherapy drugs are capable of passing through the barrier to treat the tumor. A process known as blood-brain barrier disruption may be used to temporarily disable the brain's protective barrier. A drug is used to expand the blood vessels in the brain, during which time powerful doses of chemotherapy are injected into an artery or vein. The expanded blood vessels disrupt the barrier and allow the drugs to reach the tumor. As the drug wears off, the barrier is restored.

Other additional methods of delivering chemotherapy directly to the brain tumor are available.

- Ommaya reservoir is a small container attached to a tube that is surgically implanted underneath the scalp. The tube leads into a ventricle or fluid-filled cyst within the brain where chemotherapy may be delivered or fluid may be removed when needed.
- Convection-enhanced delivery (CED) involves a catheter that is surgically inserted into the tumor. The other end is connected to a device that pumps chemotherapy drugs (or other therapeutic substances) into the catheter, allowing the drugs to flow directly into the tumor. CED is currently being studied in clinical trials for use in delivering additional therapies and tracers, which are injected past the blood-brain barrier to improve CT and MRI images of brain tumors that may be otherwise difficult to see.
- Polymer wafer implants contain a chemotherapy drug that may be inserted into the tumor site after surgery to treat remaining tumor cells that may have spread into surrounding tissue. Up to eight of these nickel-sized wafers may be placed into the cavity during the procedure and remain in place until they dissolve and release the drug, which usually occurs over two to three weeks. Wafer implants are most commonly used to treat malignant gliomas.

Radiation therapy uses high-energy X-rays or particles to destroy cancer cells. It may be given as primary treatment for certain brain tumors when surgery is not an option, before surgery to shrink the tumor or after surgery to destroy remaining cancer cells. It may be used with some chemotherapy drugs (chemoradiation) to improve its effectiveness. Radiation therapy may also be used to relieve symptoms caused by the brain tumor.

Types of radiation therapy used to treat brain tumors include conventional radiation therapy, three-dimensional conformal radiation therapy (3D-CRT), intensity-modulated radiation therapy (IMRT), volumetric arc-based therapy (VMAT), craniospinal radiation, stereotactic radiosurgery, fractionated stereotactic radiation therapy and proton therapy.

Delivering radiation to the same place every time is crucial. You may be fitted with a radiation mask to help hold your head in place during the treatment session. The mask is made with a mesh material and will be shaped to your face. Marks made on the mask or tattooed onto your skin (if a mask is not used) will indicate exactly where treatment needs to be delivered.

Just like any other tissue in the body, the brain can only withstand a certain amount of radiation. To increase the effectiveness of radiation therapy, a radiation boost (a type of local radiation) may be used in addition to conventional radiation. Drugs called radiosensitizers may also be given to make the cells more likely to be destroyed by radiation.

Targeted therapy drugs attack specific substances in or around cancer cells that help the cancer cells grow. They may be given to shrink the tumor or slow its growth for some time, especially if it cannot be completely removed surgically. Targeted therapy may be used with chemotherapy to help prolong the time before certain types of brain tumors (especially glioblastomas) begin to grow again after surgery. These drugs may work when chemotherapy does not.

To determine if targeted therapy is a good option for you, your doctor will run biomarker tests for specific targets, such as vascular endothelial growth factor *(VEGF)* or neurotrophic receptor tyrosine kinase *(NTRK)* gene fusion. One monoclonal antibody drug blocks the *VEGF* protein. Blocking *VEGF* may prevent the growth of new blood vessels, including normal blood vessels and blood vessels that feed tumors. Another drug works by blocking a cell protein that normally helps cells grow and divide into new cells. The newest targeted therapy to treat brain tumors inhibits *NTRK* fusion and is a more recent discovery.

Alternating electric field therapy using tumor treating fields (TTFields) prevents cancer cells from reproducing and causes them to die with the goal of preventing a recurrence, specifically in glioblastomas. This portable, non-invasive device resembles a swim cap and attaches to the scalp to deliver low-intensity, intermediate frequency alternating electric fields. To use this device, the head must be shaved. Four sets of electrodes are placed on the scalp. The electrodes are attached to a battery pack and are worn for most of the day. Because no drugs enter the bloodstream, this treatment seems to cause few or no side effects.

Immunotherapy uses the body's own immune system to fight cancer cells. Immunotherapy is currently approved to treat a rare type of pediatric brain tumor, and researchers continue to evaluate other forms of immunotherapy through clinical trials. ■

COMMONLY USED MEDICATIONS

CHEMOTHERAPY
- carmustine (BCNU)
- carmustine implant (Gliadel Wafer or polifeprosan 20 with carmustine implant)
- cyclophosphamide
- lomustine (CCNU, Gleostine)
- temozolomide (Temodar)
- vincristine sulfate PFS

COMBINATION THERAPY
- PCV: procarbazine hydrochloride (Matulane), lomustine (CCNU, Gleostine) and vincristine sulfate PFS

CORTICOSTEROID
- dexamethasone

TARGETED THERAPY
- bevacizumab (Avastin)
- bevacizumab-awwb (Mvasi)
- everolimus (Afinitor, Afinitor Disperz)
- larotrectinib (Vitrakvi)

IMMUNOTHERAPY
- dinutuximab (Unituxin*)

**Indicated for a specific type of high-risk pediatric neuroblastoma.*

As of 4/26/19

Follow-up care will include monitoring for recurrence

➡ **Even after successful treatment,** brain tumors have the potential to recur (return). As part of your follow-up care, you'll continue to receive imaging scans to monitor for this. Recurrent brain tumors often return near where the first tumor was found but can show up in another location. If a tumor returns, a new cycle of diagnostic tests will be done. Treatment for a recurrent tumor may require a new approach. Ask your doctor for more information about your risk of recurrence and what to watch for, as it is critical to contact your doctor at the first sign of the return of cancer.

Research studies may provide access to new treatments

A surge in brain tumor research is yielding promise through medical studies called clinical trials. Now in development are targeted drugs that seek out gene mutations linked to tumor growth, vaccines that retrain the immune system to fight cancer, new and specific biomarkers, gene therapy, enhanced imaging tests, genetic research and more supportive care options to reduce symptoms.

Treatment-focused clinical studies test the safety and effectiveness of new or improved medical approaches, interventions and drugs. They may offer you access to leading-edge treatments not yet widely available. Standard therapies used today to treat brain and spinal cord tumors were once experimental treatments in these research studies.

During a clinical trial, the safety of all participants is top priority. The U.S. Food & Drug Administration (FDA), the Data and Safety Monitoring Board and Institutional Review Boards dictate strict safety measures to protect participants. Additionally, the Informed Consent document you'll receive before starting the trial will describe its safeguards. The form provides comprehensive information on the purpose of the study, your role, the treatment being investigated, benefits and risks, potential side effects and other details. Go over the form carefully and ask questions. Before you sign, contact your health insurance provider so you'll be aware of any out-of-pocket costs. Signing the form won't lock you into the study. You can choose to leave at any time, for any reason, and receive standard of care treatment.

Talk with your doctor to see if a clinical trial is a treatment option for you. ■

ADDITIONAL RESOURCES

- **Accelerate Brain Cancer Cure:** www.abc2.org
- **Brains for the Cure:** www.brainsforthecure.org
- **National Brain Tumor Society:** www.braintumor.org
- **National Cancer Institute:** www.cancer.gov
  Brain Tumors

» SEARCH ONLINE FOR CLINICAL TRIALS

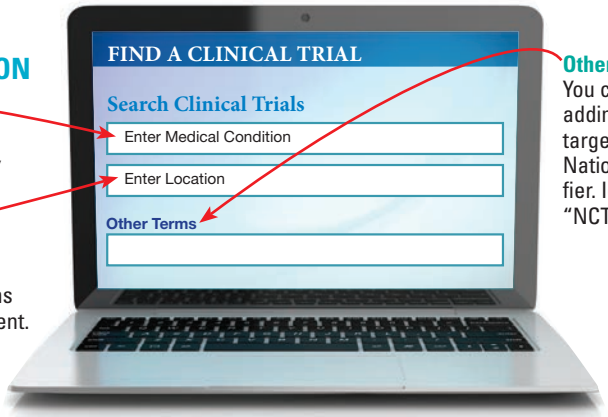
► Your oncologist may recommend specific clinical trials as potential treatment options, but you can also research online on your own. However, using search tools to navigate research studies that apply to you among more than 120 types of brain tumors can be overwhelming. These screenshots of a mock search site for clinical trials and step-by-step instructions will help guide you through the process.

Start by having your exact diagnosis, pathology report and details of previous treatments handy. If you don't find a good fit during your initial search, continue to check because new clinical trials are posted all the time. You may also keep searching while you move ahead with your current treatment plan (see *Assistance*, page 20).

[STEP 1] FILL IN YOUR INFORMATION

Your Diagnosis
For example, enter "brain tumor." To create more options, you can also search for "glioma" or "oligodendroglioma" and compare results.

Desired Location
If you prefer a clinical trial close to home, enter your address. Enter additional locations if you're willing and able to travel for treatment.



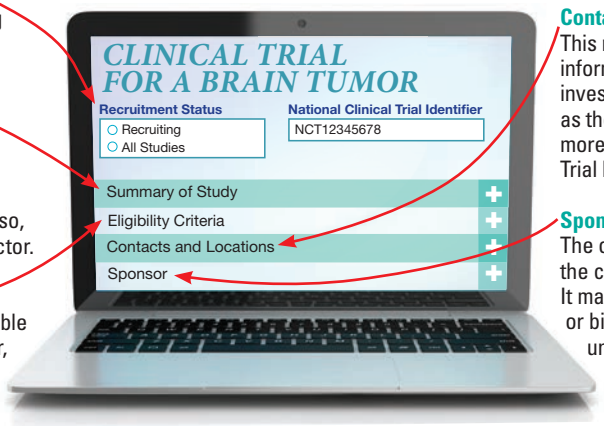
Other Terms
You can refine your search by adding a treatment type such as targeted therapy, a specific drug or National Clinical Trial (NCT) identifier. Identifiers begin with the letters "NCT" followed by eight numbers.

[STEP 2] READ YOUR SEARCH RESULTS

Recruitment Status
This indicates whether the trial is actively seeking patients, not yet recruiting or otherwise inactive. The status will change, so check for updates.

Summary of Study
Here you'll find details about the purpose of the clinical trial and the treatment being studied. This section is usually written for health care providers, so it may be difficult to understand. If so, print out the information to discuss with your doctor.

Eligibility Criteria
This outlines the criteria you must meet to be eligible for the trial, such as type and grade of brain tumor, previous treatments, age and overall health requirements.

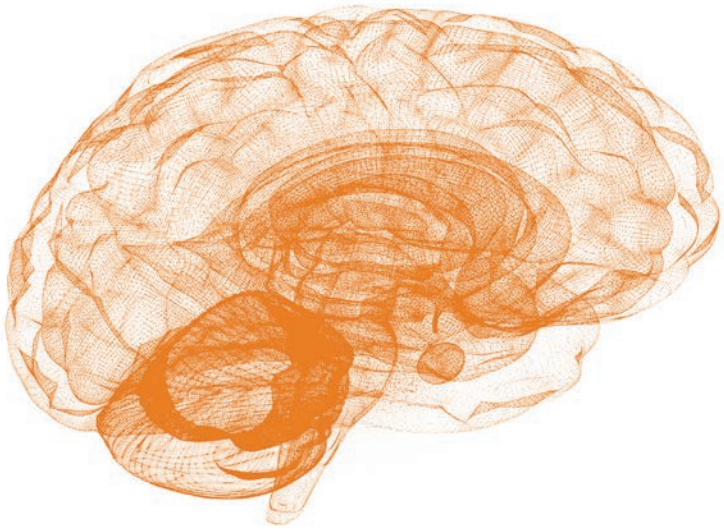


Contacts and Locations
This may contain contact information for the clinical trial investigators, staff and sponsors, as they may be able to provide more details about the study. Trial locations may also be listed.

Sponsor
The organization responsible for the clinical trial is listed here. It may be a pharmaceutical or biotechnology company, a university or the National Cancer Institute.

INTELLANCE2 SUB-STUDY
Study in Pediatric Patients with High Grade Gliomas (HGG) with Epidermal Growth Factor Receptor (EGFR) Amplification

Pediatric High Grade Gliomas (HGG) Research Study



Do you or someone you know have a child with a high grade glioma that is EGFR Amplified?

The INTELLANCE2 sub-study is a research study evaluating the pharmacokinetics, safety and tolerability of a novel therapy for children with a high grade glioma that is EGFR amplified.

Patients must meet the following criteria:

- Less than 18 years of age
- Newly diagnosed or recurrent high grade glioma (grade III glioma, grade IV glioma or diffuse intrinsic pontine glioma (DIPG))
- Sufficiently recovered from previous therapy
- No current or recent treatment with another investigational drug
- Other criteria apply

For more information, ask your doctor about the INTELLANCE2 Pediatric Sub-Study or visit **www.clinicaltrials.gov** (NCT02343406) to see if you qualify.

Even in her wildest dreams, comedy writer and producer Jeannie Gaffigan never imagined she'd have a brain tumor. Surrounded by an incredible support system, she credits her recovery to the coming together of her community, spirituality and science.

Photo: Asia Geiger

Jeannie Gaffigan

My story of hope

During a regular medical appointment with our kids in April 2017, I mentioned to our pediatrician that I'd lost the hearing in my left ear a couple months earlier. She urged me to see an ear, nose and throat specialist. After several tests, my ENT couldn't find any reason for the hearing loss so he scheduled an MRI. My husband, Jim, and I were shocked when he told us I had a mass in my brain.

Because this discovery was out of his realm, he referred me to a few neurosurgeons, explaining that he was skipping a neurologist because the mass would likely need to be resected. At this point, he still hadn't used the word "tumor," and it was difficult to conceive that he was actually talking about surgery on my brain.

I felt like this had come straight out of left field. I'd dismissed symptoms, such as fatigue, headaches and allergies, for a long time because they seemed like normal issues to have, especially when you have five kids, a husband and a career.

Like most people, I didn't know a brain surgeon, so I called one of the neurosurgeons he recommended and got as far as the receptionist. The first appointment was a month out. I had no idea if waiting a month was okay. On the one hand, I thought perhaps they were telling me it wasn't a big deal and that I could wait a month, but I just wasn't sure. I called the next referral to see if I could get in any earlier, and it turned out to be a different doctor in the same office. The same receptionist answered the phone! The second doctor, however, had a spot open a week earlier so I took it. In the meantime, I was instructed to pick up a copy of my scan to bring to the appointment.

When I picked it up, I hoped I could look at it to learn a little more, but it wasn't just something I could pop in to my DVD player. I felt like I was in limbo. I knew I had this mass in my brain and it was extensive enough that I needed surgery, but I hesitated to share the news, even with my parents and our children, because I couldn't tell

▶ *Read more about Jeannie's experience in her new book,* "When Life Gives You Pears," *currently available for pre-order at your local bookseller or the bookseller of your choice.*

them anything about it. I also wondered if anyone else in the world had been through the same thing and was actually walking around just fine. I just needed more information, and I remembered that a childhood friend became a neurologist in Milwaukee. I called him, and he asked for the report and the scan.

I did something next that has gotten me through my most difficult times. I prayed, asking for guidance because I was lost. I called a family member who I felt could help me in that area. I explained what little I knew and told her I needed the help of a higher power. I had five kids and a husband who needed me, so I asked her to spread the word and, basically, storm heaven. As we talked, she recommended a hospital in New York City, far from our home. I told her I actually had my appointment but appreciated the thought.

The next day, my friend from Milwaukee called and told me I needed to get into an operating room immediately. I asked him how that was even possible because I didn't have a doctor. He told me to identify the best neurosurgery department in New York City, take my scans and go to that emergency room. The ER staff would get me to the right place.

I called my ENT and told him what I was doing, and he suggested where to go. Through a series of happy accidents, I ended up in the office of the chairman of the neurosurgery department at the same hospital my family member had recommended.

After having more tests, we learned the tumor was a papilloma of the choroid plexus. It was very large, about the size of a pear, sitting on my brain stem. Although it had an 80 percent chance of being benign, it was in a very precarious position. It had to be removed because it was intertwined with lots of cranial nerves and was compromising key functions, such as the hearing in my left ear.

The neurosurgeon explained his treatment plan thoroughly, approaching how he'd remove the tumor. When his physician's assistant asked if I'd like to seek a second opinion, I declined because I knew I was in the right place. Just like you know when you fall in love, or land the best job or pick the perfect school, I knew he was the right doctor for me.

> *I've seen the goodness in people.*

We had two days to prepare for the craniotomy. Jim and I were in this together, and we got very practical. I made sure he knew things like my computer passwords and what the kids liked to eat. I called school and told them I wouldn't be at drop off for a while because I had a brain tumor. We took everything day by day and focused on normalcy.

At the time, our five kids ranged in age from 4 to 12. We had different age-appropriate conversations with each of them that boiled down to Grandma coming to stay while I went to the hospital to have something taken out, like what happened with their tonsils. The youngest was concerned I may need a shot, but the next youngest thought that'd be okay because I'd probably get to pick a prize out of the treasure chest. The older kids understood the gravity of the situation, but all the conversations were extremely positive. We've laid a foundation based on honesty with our kids, and it made this difficult discussion a little easier to have. We told them that with all of the love in our family, we'd get through it, and we spent the next two days doing things we usually did and enjoying every minute of it. We couldn't know the outcome, but if something unexpected did happen, we wanted their last memory of me to be of something really good.

Jeannie, Jim and the kids enjoying Australia during the *Jim Gaffigan: Quality Time Tour*

The surgery was a success, and my recovery is nothing short of miraculous. I had some serious challenges, and I'm managing long-term effects. For a time, I couldn't breathe, swallow or eat on my own. I needed a tracheotomy and a feeding tube. I still have limited swallowing capabilities, but I work with a speech and swallow therapist. I have residual paralysis in my vocal chords, and I sound a little slurry. According to Jim, it sometimes sounds like I've had a little too much to drink. Physical therapy is helping me manage weakness on one side, and I'm working hard at learning not to overdo. I get more fatigued than normal, so I'm moving a bit slower and appreciating smaller accomplishments a little more. And, I have an MRI every six months as part of my follow-up plan.

During the highest crisis times at the hospital and at home while I was immobile, I had incredible help from Jim, dear friends and my eight siblings who came from all corners of the country. They brought food, took our kids to birthday parties and visited. I'm used to taking care of everything, and I had to admit that I needed help and not be embarrassed by it. That's the true definition of humility, and I'm so lucky to have such a wonderful support system. One friend said she finally understood why I had so many darn kids.

I share more details in my upcoming book *When Life Gives You Pears*, but my advice to anyone in a similar situation is to advocate for yourself. Find an expert you're comfortable with because this will be one of the most vital relationships you'll ever have. Next, make sure you have a plan, and don't stop until you feel informed and know what to do.

Mine really is a story of hope. I still sweat the small stuff, but at least now I'm aware I'm doing it. I don't spend one day taking for granted how it all turned out because I know it could have been much different. During this time of unrest, experiences like this make us realize the human spirit is stronger than any of us know. I've seen the goodness in people. ■

Knowing what to expect is the first line of defense

Various therapies used to treat a brain tumor are accompanied by side effects. They differ from person to person, even among those who receive the same treatment. Ask your health care team what side effects to expect and how to prevent or manage them, then report new symptoms when they start. Addressing side effects as soon as possible may stop them from escalating and help you be more comfortable.

ALOPECIA (HAIR LOSS)

Surgery and radiation therapy typically result in hair loss in the area being treated. In addition, some drug treatments may cause loss of hair on the head, face and other parts of the body. Be gentle with your scalp and hair. Ask when it's safe to wash your hair and how best to do it. Your doctor may recommend using only warm water initially, and then mild shampoo with few perfumes and dyes, such as baby shampoo.

DIARRHEA

Some treatments may cause diarrhea. When mild, diarrhea is an inconvenience. If left untreated, it can lead to serious problems, such as dehydration, loss of important nutrients, weight loss and fatigue. Over-the-counter medicines and supplements may help, but ask your doctor before taking anything. If diarrhea is severe, your doctor may prescribe other medications.

FATIGUE

Your body needs extra energy to repair the healthy tissue damaged by cancer treatment, resulting in fatigue. Additionally, other side effects of treatment, such as pain, diarrhea and vomiting, can cause or worsen it. Increasing activity and performing regular exercise (even 10 minutes of walking per day) will help you feel more energetic.

FERTILITY ISSUES

Certain cancer treatments can affect the ability to start or maintain a pregnancy. For both men and women, fertility options become much more limited after treatment starts, so it's wise to talk to your doctor about fertility preservation before you begin any type of treatment, if possible.

HEADACHES

Surgery and radiation therapy, as well as pressure caused by the tumor itself, may cause headaches. Try over-the-counter pain relievers and get plenty of rest. If your headache is severe, keep a pain log to share with your doctor. Include the time of day your headache starts, how long it lasts and where it occurs (forehead, temples, back of head, etc.).

MOUTH SORES

Drug therapies may cause mouth sores that form in the lining of the mouth, affecting the gums, tongue, roof of mouth or lips. Pain may be mild to severe, making it difficult to talk, eat or swallow.

Try to keep your mouth and lips moist. Avoid spicy, acidic or rough-textured foods. Over-the-counter medications may help relieve discomfort. Your doctor may suggest a special mouth rinse or may prescribe a medication that coats the lining of your mouth or can be applied topically.

NAUSEA AND VOMITING

Drug therapy and radiation therapy may cause you to feel sick to your stomach or vomit. Because these side effects are much easier to prevent than to control once they've started, talk with your doctor about taking antiemetics (anti-nausea drugs). Peppermint and ginger lozenges may settle your stomach. Severe vomiting can lead to dehydration and interrupt treatment. If necessary, talk with your doctor about ways to make you more comfortable.

SKIN REACTIONS

Your scalp and skin may become red, dry and irritated during and after treatment. Avoid soaps, lotions and makeup that contain perfumes or dyes. Ask your doctor to recommend specific products that are safe to use. ■

ADDITIONAL RESOURCES

- **American Brain Tumor Association:**
  www.abta.org
  Living with a Brain Tumor
  Side Effects
- **American Society of Clinical Oncology:**
  www.cancer.net
  Brain Tumor – Coping with Treatment

Managing the challenges of the tumor itself

➡ **When a tumor grows** into or presses on an area of the brain, it may stop that part of the brain from working the way it should. As a result, you may feel different physically and emotionally. Managing these complex side effects is important. Tell your health care team immediately if you experience any of these conditions so they can help you maintain a better quality of life.

MEMORY AND COGNITIVE CHANGES A brain tumor and its treatments may affect your ability to think, reason, concentrate, process and remember information. Fatigue can zap the energy you need for thinking and remembering. These changes may make it difficult for you to focus on tasks or follow conversations, plan or organize your thoughts, learn new things or remember names and dates.

Let friends and family know you're having trouble remembering things, and ask for their help. A daily planner may help you keep track of events and appointments. Don't multitask. Instead, focus on one thing at a time.

Talk with your doctor about your concerns. He or she likely will schedule an evaluation to help determine the best ways to train or retrain the brain to perform cognitive skills that may have been lost or affected during treatment.

EMOTIONAL CHANGES An interference with brain function may cause unexpected changes in personality and feelings. Your moods may differ, and you may deal with anxiety, anger or stress differently. You may feel depressed. Depression is more complex than just feeling sad or hopeless and can result from the tumor, its treatments or the diagnosis.

Spend time with family and friends who can help you cope better with daily life. Join an online or in-person support group for brain tumor survivors. Perform regular physical activity, breathing exercises or meditation. Consider talking with a licensed therapist. If you have thoughts of hurting yourself or others, talk with your doctor immediately.

PHYSICAL CHALLENGES Muscle weakness, changes in motor skills and difficulty with speech may occur. See *Survivorship Plan,* page 13, for more information about the benefits of physical, occupational and speech therapies.

Moving forward: Create a plan for life after a brain tumor

Treatments you received and the brain tumor itself may have caused temporary or permanent physical, mental, emotional or behavioral changes. As a result, as you transition from active treatment to post-treatment, it may be challenging to return to the way life used to be before your diagnosis. Instead, it may be more realistic to prepare for a "new normal," and that will be easier if you have a plan in place.

YOUR SURVIVORSHIP PLAN

Survivorship plans aren't one size fits all. Just like your treatment plan, yours will be designed uniquely for you by you and your health care team. Several physical and mental capabilities will be evaluated as part of your survivorship plan.

COGNITION AND FUNCTION

Specialized tests can help your health care team assess how the tumor and your treatment regimen may have affected your cognitive skills (thinking, remembering, learning and problem-solving) and how you function physically (motor skills, range of motion, etc.). These evaluations are often performed by a neuropsychologist, a specialist in identifying and treating brain-related issues. These rehabilitative therapies may be recommended.

- **Cognitive behavioral therapy (CBT).** This type of therapy can help manage the challenges related to thinking, memory and behavior, as well as the ability to absorb and retain new information. You may also learn strategies to help with the emotional outbursts and changes in mood or personality.
- **Language and speech therapy.** Depending on where your tumor was located, you may experience language and speech impairment that affect your ability to express yourself and to understand others. Rehabilitation with a speech pathologist can help you find ways to improve these communication skills.
- **Physical rehabilitation.** Treatments you received plus inactive periods during hospitalization and recovery take a toll on your body. A physical therapist can develop an exercise plan to increase your stamina, regain strength and improve balance and coordination.
- **Occupational therapy.** You may need to relearn how to tackle certain day-to-day tasks, from getting dressed and in and out of the bathtub to buying groceries and cooking. An occupational therapist can assess your level of function, pinpoint which daily living skills have been affected by the tumor and/or treatment, and help you improve your self-sufficiency by finding new or different ways to perform these activities.

FOLLOW-UP CARE SCHEDULE

As a brain tumor survivor, you will need to monitor your health carefully for the rest of your life, as many types of brain tumors carry significant risk of recurrence (returning after treatment). When your active treatment ends, your doctor will discuss your follow-up schedule. This details the need for future appointments, lab work, scans and/or ongoing maintenance therapy.

These routine follow-ups will help your doctors identify any signs of recurrence early and will allow them to check for symptoms of late effects, which are side effects that can occur weeks, months or even years after your treatment ends. Ask your doctor what to expect related to your specific type and grade of brain tumor and treatments you received.

Add these periodic medical appointments to your follow-up care plan, as necessary.

- **Audiology.** Hearing loss or tinnitus (ringing in the ears) could occur after treatment, so it's important to have regular audiology testing. If necessary, hearing aids may help.
- **Eye care.** Your risk of vision loss or cataracts may be increased. Be sure to have your eyes checked.
- **Dental care.** You are likely at increased risk for cavities, thinning tooth enamel and problems with the roots of your teeth, so visit your dentist regularly.
- **Hormone levels.** These levels should be checked periodically, as reproductive issues or osteoporosis may occur.

CAREER AND OTHER PURSUITS

You may or may not find it difficult to successfully manage the same job or type of job you had before your diagnosis. Before you go back to work, take an honest look at your abilities as related to your previous work and workload. Talk to your doctor about how your follow-up care schedule and any potential long-term side effects could interfere with your ability to perform at previous levels. Then re-evaluate your life priorities, including your career goals. If you return to your previous job and have any concerns, talk to your supervisor immediately about your responsibilities, and be realistic about what you can manage.

These same considerations may apply to any plans, such as taking classes, retiring, starting a home-based business, being a full-time caretaker or traveling for long stretches of time away from health care providers.

FINANCIAL CONCERNS

The expense of maintenance therapies and ongoing follow-up appointments, lost income and other unexpected medical costs can add to the stress you may already feel. Don't let financial anxiety prevent you from getting the follow-up care or ongoing medication you need.

Ask your nurse navigator or social worker at your treatment facility about resources that may be available to help reduce or manage your treatment-related expenses. Research online, and check out the resources in this guide (see *Assistance*, page 20). ■

ADDITIONAL RESOURCES

- **American Society of Clinical Oncology:** www.cancer.net
  ASCO Cancer Treatment and Survivorship Care Plans
- **National Comprehensive Cancer Network:** www.nccn.org
  Life After Cancer

Gaining focus: Understanding your child's diagnosis

After discovering your child has a brain tumor, one of the first things you can do is learn more about his or her unique situation. The information and resources in this guide will get you started. The more you know, the more prepared and comfortable you will be moving forward.

Brain and spinal cord tumors are the second most common type of childhood cancer. Although their cause is unknown, doctors know they occur when abnormal cells form in the tissues of the brain or spinal cord. They may be low grade or high grade. Both types may grow and press on nearby areas of the brain, but low-grade tumors rarely spread. Both, however, typically need treatment.

The brain and spinal cord make up the central nervous system (CNS). When a tumor grows into or presses on an area of the brain or spine, it may stop that part of the brain or spine from working the way it should. The brain is made up of the cerebrum, cerebellum and brain stem. Each controls critical functions in the body (see *Overview,* page 2).

The signs and symptoms of childhood brain and spinal cord tumors differ in every child, depending on the following:

- Where the tumor arises — in the brain or spinal cord
- The size of the tumor
- How fast the tumor grows
- The child's age and development

DIAGNOSING AND TREATING A BRAIN TUMOR

A variety of tests and procedures may be used to diagnose brain and spinal cord tumors (see *Diagnosing and Biomarkers,* page 3). A biopsy may be done to remove a sample of tissue. Most childhood brain tumors are diagnosed conclusively through a biopsy or resection. The biopsy is often done through a small needle while a resection is achieved by removing part of the skull to identify and remove some or all of the tissue.

A pathologist views the tissue under a microscope to identify the type of cancer cells. This helps guide the neurosurgeon in the type of resection needed. The grade of the tumor is based on how abnormal the cancer cells look under a microscope and how many of the tumor cells are actively dividing.

After a diagnosis is made, finding a doctor or treatment facility that specializes in treating your child's type of brain tumor is important because treating children with brain tumors is not just treating cancer in smaller adults. Children don't have the same mutations that cause adult brain tumors, and they don't respond to treatment the same way.

Your child's medical team will likely include a variety of specialists, such as medical oncologists, radiation oncologists, neurologists, neurosurgeons, pathologists, rehabilitation specialists and more. They are specially trained to work with children, which will be evident in their medical expertise and their bedside manner. They will work closely with you on the treatment plan they feel is best for your child's unique situation after considering the type of tumor, your child's age and overall health, how fast the tumor is growing, where the tumor has formed and if it has spread to nearby tissue or to other parts of the body.

You may find comfort in the fact that advances surrounding pediatric brain tumor treatment are offering a great deal of promise. In the last five years, researchers have discovered changes in genes, chromosomes and proteins inside brain tumor cells that can be used to help predict a child's prognosis (outlook) and help guide treatment.

Other advances include new and refined surgical techniques that have made surgeries safer and more successful; innovative ways for chemotherapy drugs to cross the blood-brain barrier (the network of blood vessels and tissue that protects the brain from harmful substances); targeted therapy drugs to inhibit the gene changes that help tumors grow; and vaccines to stimulate the body's immune cells to recognize and destroy brain tumor cells. Additionally, multiple clinical trials on other areas of research are underway.

As you discuss treatment options with your medical team, ask about potential side effects and late effects, which are side effects that can occur months or even years after treatment ends.

Strive for routine + flexibility

Keeping daily life as normal as possible for your child is important. Although change can be difficult, try being open to doing things differently. Lean on family and friends. Find a support group. Advocacy organizations can put you in touch with parents of other pediatric brain tumor patients who can be a wealth of help because they know just what you're going through. The following suggestions may help you manage the unique challenges that come with caring for a child with a brain tumor:

- **Get creative with food.** Traditional meals and mealtimes may go by the wayside for the time being, and that's OK. Changes in appetite are common. Instead of stressing about it, let your child eat whenever he or she feels hungry. Offer high- or low-calorie snacks, as appropriate, throughout the day. Make mealtimes fun by serving food in different shapes on brightly colored plates. Spread a blanket on the family room floor for a family picnic.
- **Help your child stay connected.** Arrange playdates for a younger child and encourage your older child to invite friends over to watch a movie. Phone calls, texts, video chats and social media platforms make it easier for your child to stay in touch with friends, especially when an in-person visit may not be possible.
- **Explore new hobbies.** Keep your child entertained with activities that can be done during hospital stays or at home when visitors aren't recommended. If you notice your child is frequently sad or appears to be depressed, call the doctor.
- **Be positive.** Show your child that you're optimistic about the future. Children typically take cues from their parents' behavior. Your upbeat attitude may rub off. If you're having a rough time, talk with your child's medical team about support groups, a therapist or other resources.

COMMON PEDIATRIC BRAIN TUMORS

Below is information on many types of brain tumors diagnosed in children.

CHILDHOOD CENTRAL NERVOUS SYSTEM EMBRYONAL TUMORS

Central nervous system (CNS) embryonal tumors may begin in embryonic (fetal) cells that remain in the brain after birth. They tend to spread through the cerebrospinal fluid (CSF) to other parts of the brain and spinal cord. There are different types of CNS embryonal tumors.

Medulloblastomas

These fast-growing tumors that form in brain cells of the cerebellum are the most common CNS embryonal tumors. These tumors can spread through the spinal fluid to other parts of the brain and spine. In rare cases, medulloblastomas can spread to the bone, bone marrow, lung or other parts of the body.

Non-medulloblastoma embryonal tumors

Non-medulloblastoma embryonal tumors are fast-growing tumors that usually form in brain cells outside of the cerebellum in the cerebrum. They may also form in the brain stem or spinal cord. There are four types of these tumors.

- Embryonal tumors with multilayered rosettes (ETMR) are rare tumors that form in the brain and spinal cord. ETMRs most commonly occur in young children and are fast growing.
- Medulloepitheliomas are fast-growing tumors that usually form in the brain, spinal cord or nerves just outside the spinal column. They occur most often in infants and young children.
- CNS neuroblastomas are very rare tumors that form in the nerve tissue of the cerebrum or the layers of tissue that cover the brain and spinal cord. CNS neuroblastomas may be large and spread to other parts of the brain or spinal cord.
- CNS ganglioneuroblastomas are rare tumors that form in the nerve tissue of the brain and spinal cord. They may form in one area and be fast growing, or form in more than one area and be slow growing.

CNS embryonal tumors, including medulloblastomas, are typically treated with surgery, radiation therapy and/or chemotherapy. A type of immunotherapy may be used to treat a certain form of high-risk neuroblastomas. Because of the damage radiation therapy can cause to the brains of infants and young children, radiation therapy may not be used.

GLIOMAS

Glioma is a general term for any cancer that develops from the glial cells. There are multiple types of glial cells: astrocytes, oligodendrocytes and ependymal cells. Glial cells hold nerve cells in place and help protect them. Following are some of the more common types of gliomas that affect children.

Astrocytomas

Astrocytomas are tumors that begin in star-shaped brain cells called astrocytes. They are the most common type of glioma diagnosed in children and can form anywhere in the central nervous system (brain, brain stem and spinal cord).

An astrocytoma is typically treated with surgery and, if low-grade, observation. Radiation therapy, with or without chemotherapy, is usually needed for high-grade tumors. If necessary, a cerebrospinal fluid diversion procedure may also be required. As a result of the discovery of specific mutations in some pediatric astrocytomas, the use of targeted therapy is now being tested.

Ependyomas

Ependymomas form from ependymal cells that line the ventricles and passageways in the brain and the spinal cord. The part of the brain that is affected depends on where the ependymomas develop.

Surgery and radiation therapy are standard treatments for these tumors. Chemotherapy may be used if the surgeon cannot remove all of the tumor at the time of diagnosis.

Brain stem gliomas

Childhood brain stem gliomas are most often one of two types.

- Diffuse intrinsic pontine gliomas (DIPGs) are high-grade tumors of the pons. The pons is located in the middle part of the brain stem and is the primary control center for many critical functions, such as breathing, heartbeat, alertness (wakefulness), control of movement of the eyes and mouth and swallowing. DIPGs are fast growing and spread aggressively by invading adjacent areas of the brain and spine. They are hard to treat because of their location.
- Focal gliomas are slow growing and can be found in multiple areas of the brain stem. These are usually low grade and are very responsive to therapy.

Surgery, radiation therapy, chemotherapy, cerebrospinal fluid diversion, observation and/or targeted therapy are the standard treatments for these brain tumors.

CENTRAL NERVOUS SYSTEM GERM CELL TUMORS

CNS germ cell tumors form in the brain or spinal cord from germ cells, a type of cell present in an unborn baby. CNS germ cell tumors commonly form near the pineal gland and/or in an area of the brain that includes the pituitary gland and the tissue just above it. Three types of treatment are used, including surgery, radiation therapy and chemotherapy.

- Germinomas are the most common type of childhood CNS germ cell tumors. One type of germinoma is an intracranial germinoma, which is also known as a dysgerminoma or an extra-gonadal seminoma.
- Nongerminomas are less common and often make certain proteins or hormonal markers. Types include embryonal cell carcinomas, choriocarcinomas, yolk sac tumors, teratomas and mixed germ cell tumors.

CRANIOPHARYNGIOMAS

These rare, benign brain tumors are found near the pituitary gland. They are usually part solid mass and part fluid-filled cyst. They are noncancerous and do not spread to other parts of the brain or to other parts of the body. They can, however, cause permanent damage to the parts of the brain where they arise. As they grow and press on nearby parts of the brain or other areas, they may affect hormone production (too much or too little), growth and vision. Treatments include surgery (resection), followed by focal radiation therapy in some patients.

CHOROID PLEXUS TUMORS

The choroid plexus is a network of blood vessels and cells in the ventricles (fluid-filled spaces) of the brain that make cerebrospinal fluid. These rare tumors can occur in children and adults, but are more common in children. When these tumors form, they can block cerebrospinal fluid pathways in the brain, grow and compress important brain structures, and/or overproduce cerebrospinal fluid.

The majority of choroid plexus tumors are benign (non-cancerous) but can sometimes become malignant (cancerous). Choroid plexus papillomas are Grade I and mostly benign. Atypical choroid plexus papillomas are Grade II. Choroid plexus carcinomas are Grade III, the rarest type of choroid plexus tumor, and are malignant. ■

Caring for your child with support and strength

Parents instinctively feel they should be able to fix what ails their child, so it's understandable that you may feel helpless right now. You're not. Although this experience is overwhelming, helping your child – and your family – adapt to daily life during and after treatment is vital. Accept help when it's offered, and trust your instincts.

- **Maintain the household routine.** Stick to the family schedule as much as you can. Kids – and adults – need to feel some sense of normalcy during a time of family stress. That means school activities, social events and family dinners must go on, as much as possible. Accept offers of help for errands, meals and carpooling from neighbors, family members or friends. At home, ask everyone to do their part to keep the household running.

- **Include siblings in the conversation.** Telling your kids that their sibling has cancer may be difficult, but you know better than anyone how they may react and how best to support them. The basic information all kids will likely need is the name of the cancer, the body part it affects, how it will be treated and how their lives will be affected. Use age-appropriate language. Younger children may only understand that their brother or sister is sick and needs medicine to get better, whereas older children will likely want more information. Siblings can even help with caregiving. Just keep the responsibilities age appropriate. Keep in mind that teens still need to be teens. Although they may be very capable of picking up more slack, time to hang out with their friends is essential. Your child's siblings may feel a variety of emotions, from fear and guilt to anger. Encourage them to share their feelings and ask questions. It's important to address their concerns. Set aside time for each child and involve them in caregiving, as appropriate.

- **Understand cognitive issues.** Your child may have difficulties with thinking, remembering and other cognitive skills. This could make it more difficult to concentrate on any number of tasks. In some cases, it may result in a learning disability. If that is the case, your medical team will talk with you about the best way to manage it. Children's brains are still developing, and it may be possible to train certain parts of the brain to do things they normally wouldn't do.

- **Manage emotional issues.** Talk with a therapist on your child's medical team about how to address the changes in your child's mood and behavior and what to do if new symptoms arise. Additionally, your child – and you – may fear the possibility of recurrence. This feeling may cause anxiety and stress. Consider yoga or other relaxation techniques. Your child's therapist can recommend additional coping strategies.

- **Prepare for returning to school.** Your child's doctor will determine if returning to school is medically appropriate for your child. If so, it's a good idea to work with the doctor and the school to determine the best course of action. It may help to have a member of the medical team contact the school to explain necessary precautions, make a plan for managing side effects and answer any questions they may have. Cognitive and speech impairment issues may make school work more challenging. Talk with your child's school about developing an individualized education plan (IEP) to address challenges and how to overcome them. Consider getting a tutor to keep your child from falling behind. Keep in mind that although your child may be excited to return to school, he or she might also be afraid of how classmates will react. Sometimes kids don't know how to act around someone who is or has been ill. Make a plan for how your child can respond to or ignore those instances.

- **Learn about late effects.** Also referred to as long-term side effects, late effects can begin weeks, months or even years after treatment. Ask your medical team about what to expect and what to do if and when one begins.

- **Make a comprehensive follow-up plan.** Children who are treated for any type of cancer should have a long-term, even lifelong, plan for checkups to monitor for recurrence (cancer that comes back). Hearing and vision issues are common after treatment for a brain tumor, making regular testing necessary. Regular dental checkups become more important after cancer treatment because of an increased risk for cavities, thinning of tooth enamel and problems with the roots of teeth. Make sure your child's current and future doctors and dentists are informed about your child's medical history.

- **Monitor hormonal status.** Children should be monitored closely during puberty and afterward to check for growth issues and reproductive issues. Especially if your child is very young, you may think fertility issues aren't a concern. However, it's important to have an endocrinologist be involved in your child's ongoing care as fertility issues may arise as a result of the tumor or its treatment.

- **Rely on the resources available.** Your child's medical team is specially trained to guide you and your child through treatment and rehabilitation to follow-up care and emotional support. Ask for their help. Pediatric brain tumors offer a unique set of challenges, and you will be better equipped to manage them if you have a solid support system.

- **Take care of the caregiver.** This means you. Keep up with your medical appointments. Exercise daily, even if it's just for 10 minutes. Relax and think about something completely unrelated to cancer. Join a support group for parents of children with brain tumors. Don't feel guilty about focusing on yourself. You must tend to your own physical and emotional needs to be your best self for your child. ■

Understanding the most common brain tumors found in adults

Brain tumors often have long, strange names. They may be less confusing once you realize they are named after the type of cell where the primary tumor developed, the location of the tumor, whether it is benign (noncancerous) or malignant (cancerous) and whether it is fast growing (aggressive) or slow glowing. The brain and central nervous system (CNS) are very complex and are made of many different types of cells. Tumors may contain one cell type or can also contain a mixture of cell types.

Research shows that more than 120 types of brain tumors may exist. This section highlights some of the most common brain tumors and their subtypes, where they are located and their notable characteristics.

GLIOMAS

The most common type of brain tumor is a glioma, which develops from glial cells. These cells are the most common and abundant cell type within the CNS, and they have many functions, including surrounding, protecting and supporting neuron cells with nutrients and oxygen. Any cancer that develops from glial cells is referred to as a glioma, but there are several types of glial cells, including astrocytes, oligodendrocytes and ependymal cells. These tumors are called astrocytomas, oligodendrogliomas and ependymomas.

Astrocytomas

Astrocytes are star-shaped cells that compose the supportive tissue of the brain. Astrocytomas begin in astrocytes and make up the majority of gliomas. They can develop in various parts of the brain and CNS, including the cerebellum (back part of the brain), the cerebrum (large front portion of the brain), and central areas of the brain, brain stem and spinal cord.

Astrocytomas may be difficult to remove surgically because they spread widely throughout the brain and infiltrate and blend into normal brain tissue. In some cases, they spread along the cerebrospinal fluid (CSF) pathways, but they rarely spread outside of the brain or spinal cord.

Astrocytomas are graded on a scale from I to IV based on how abnormal the cells look under a microscope. Low-grade astrocytomas are typically contained in one location and grow slowly. High-grade astrocytomas grow rapidly, spread into surrounding tissues and are typically found in adults.

Following are the most common types of astrocytomas, from low grade to high grade.

- Pilocytic astrocytomas are typically classified as Grade I. They are considered the most benign (noncancerous) of all of the astrocytomas. They tend to stay in the location where they begin and do not spread. Although they are usually slow growing, these tumors can become very large.
- Diffuse astrocytomas, also known as astrocytoma Grade II, are low grade. With Grade II, more cells look abnormal when examined under a microscope than with Grade I. The tumors can spread to nearby tissues but are more likely to invade surrounding tissue than a Grade I tumor. They tend to grow at a relatively slow pace. They typically contain the *IDH* and *1p/19q* molecular markers.
- Anaplastic astrocytomas are considered Grade III tumors and are fairly rare. They are malignant and often require more aggressive treatment than pilocytic and diffuse astrocytomas. Anaplastic astrocytomas may develop in any area of the CNS but are more likely to begin in the cerebrum, including any of the lobes (frontal, temporal, parietal or occipital). Other common sites for anaplastic astrocytomas include the part of the brain that contains the thalamus and hypothalamus, the lower area of the brain near the back of the neck that controls movement and balance (cerebellum) and the spinal cord. These tumors tend to have tentacle-like projections that grow into surrounding tissue, making them difficult to completely remove during surgery.
- Glioblastomas are considered high-grade tumors (Grade IV). They are also known as astrocytoma Grade IV or glioblastoma multiforme (GBM) because the cells may take a variety of appearances under the microscope. There are two types of glioblastoma — primary and secondary. Primary tumors are very aggressive and are the most common form of astrocytoma Grade IV. Secondary tumors begin as lower-grade tumors and evolve into Grade IV tumors (see Figure 1).

Glioblastomas usually contain a mix of cell types. They increase in frequency with age and affect more men than women. They have finger-like tentacles and single cells that can migrate long distances, and they are difficult to completely remove, particularly when they are near parts of the brain that control functions such as language and coordination.

Although glioblastomas can be found anywhere in the brain or spinal cord, they are generally found in the cerebral hemispheres of the brain. They are usually highly malignant (cancerous) because the cells reproduce quickly and migrate into the brain substance, and they are supported by a large network of blood vessels. These cells are able to easily invade and live within normal brain tissue. However, they rarely spread elsewhere in the body.

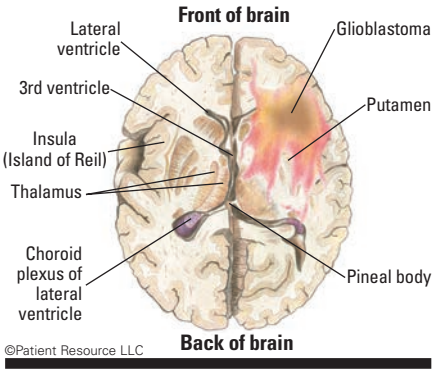
Oligodendrogliomas

These tumors develop from fried-egg-shaped cells called oligodendrocytes. Oligodendrogliomas, which contain the *IDH* and *1p/19q* molecular markers, are classified as oligodendrogliomas and anaplastic oligodendrogliomas.

- Oligodendrogliomas are considered low grade (Grade II). Because of their generally slow growth, they often are present for years before they are diagnosed.
- Anaplastic oligodendrogliomas are malignant and more aggressive (Grade III).

The frontal and temporal lobes are the most common locations for these tumors, but they can be found anywhere within the cerebral hemisphere of the brain. Tumors typically appear soft and grayish-pink, and they often contain mineral deposits (calcifications), areas of hemorrhage (bleeding) and/or cysts.

FIGURE 1
GLIOBLASTOMA



Ependymomas

Ependymomas develop from ependymal cells, which line the ventricles of the brain and the middle of the spinal cord. The ventricles are the passageways where cerebrospinal fluid is made and stored. These tumors range from low grade, which are less aggressive, to high grade, which are more aggressive.

- Ependymomas can be either Grade I or II, are less aggressive and typically grow slowly with mostly normal cells when viewed under a microscope. They usually are located along, within or next to the ventricular system. Grade I ependymomas can be either myxopapillary ependymomas or subependymomas. Grade II ependymomas grow into the ventricles.
- Anaplastic ependymomas grow quickly and may spread into surrounding tissues. When viewed under a microscope, the cells look different than normal cells. This type is rarely found in the spinal cord.

Because ependymomas form in the cells that line the ventricles, they most often spread along the cerebrospinal fluid pathways but rarely spread outside the brain or spinal cord. They are typically soft and grayish or red and may prevent cerebrospinal fluid from leaving the ventricles, which causes the ventricles to enlarge.

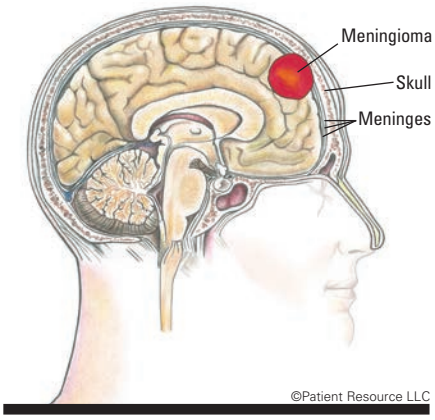
MENINGIOMAS

The most common primary brain tumor in adults, meningiomas develop in the meninges, which consist of three layers of tissue that cover the outer part of the brain inside the skull and spinal cord. Because the meninges surround the brain, meningiomas are usually found in the layers on the top of the brain and the outer curve (see Figure 2). They may form at the base of the skull as well.

Meningiomas sometimes occur in families who have neurofibromatosis, a genetic syndrome in which many benign tumors of nerve tissue develop. These tumors are more likely to be found in adults older than 60, and the incidence appears to increase with age.

The majority of meningiomas are benign (noncancerous), but some may be classified as malignant (cancerous). Although rare, malignant meningiomas may be highly aggressive. Even if the meningioma is benign, it can cause problems if it grows into nearby areas of the brain. These tumors typically grow slowly and inward, putting pressure on the brain or spinal cord, which can interfere with normal brain function. However, they also can grow outward toward the skull and cause it to thicken. Some contain sacs of fluid (cysts), mineral deposits (calcifications) or tightly packed bunches of blood vessels.

FIGURE 2
MENINGIOMA



These tumors are graded from Grade I to Grade III. Grade I meningiomas are benign and look mostly normal under a microscope. Grade II meningiomas may be considered atypical or invasive, and the cells look more abnormal than Grade I tumors. These can grow beyond the meninges and into the brain's tissues. Grade III meningiomas may be considered anaplastic or malignant and look mostly abnormal under a microscope. These grow quickly, can grow into other parts of the brain and bone, and can return after treatment.

It is estimated that a majority of meningiomas contain an abnormal chromosome 22 that typically suppresses tumor growth. The exact cause of this abnormality is unknown. Research has found that meningiomas typically have extra copies of the platelet-derived growth factor (PDGF) and its receptor (PDGFR) and epidermal growth factor receptor *(EGFR)* genes, which may cause these tumors to grow. This may be the subject of further research in clinical trials.

CHOROID PLEXUS TUMORS

The choroid plexus is a network of blood vessels and cells in the ventricles (fluid-filled spaces) of the brain. The blood vessels are covered by a thin layer of cells that make cerebrospinal fluid. Choroid plexus tumors are rare and can develop in both children and adults, but are more common in children. These tumors mostly form inside the ventricles, but may also be found in other regions of the CNS, and may have a "cauliflower-like" appearance on imaging tests.

The majority of choroid plexus tumors are benign (non-cancerous) but can sometimes become malignant (cancerous). They are grouped into three grades based on how fast the cells are growing.

- Choroid plexus papillomas are considered Grade I and mostly benign. The cells grow slowly and rarely spread to other parts of the brain or spinal cord. They represent the majority of all choroid plexus tumors.
- Atypical choroid plexus papillomas are considered Grade II and are more likely to return after surgery.
- Choroid plexus carcinomas are considered Grade III and are the rarest of the choroid plexus tumors. They are malignant. The cells are fast growing and may spread to other nearby tissues.

When these tumors form, they can cause an overproduction of cerebrospinal fluid. The tumor can cause fluid buildup and/or press on the brain, resulting in nausea, vomiting, headaches, extreme fatigue, blurred or double vision, seizures or hearing loss. Although some genetic changes have been associated with these tumors, their cause is still unknown.

PINEAL GLAND TUMORS

The pineal gland is a small endocrine gland that sits between the cerebral hemispheres. It makes melatonin, a hormone that regulates sleep, in response to changes in light. The pineal gland is located inside the brain, yet it is not considered part of the brain. A tumor that develops in this area often affects other areas of the brain that surround this gland.

Tumors in the pineal region are rare. Although they typically remain confined to the pineal gland and nearby tissues, a small percentage of the tumors, particularly pineoblastomas, can potentially spread through the cerebrospinal fluid. When this occurs, it is typically late in the disease.

- Pineocytomas are considered Grade I or II, are less aggressive and typically grow slowly with mostly normal cells when viewed under a microscope. They can be relatively benign.
- Pineal astrocytomas can be any grade and form in the tissue surrounding the pineal gland.
- Pineal parenchymal tumors of intermediate differentiation are considered Grade II or III and fall between pineocytomas and pineoblastomas, which are Grade IV. Parenchymal cells (pineocytes) are the cells that make up most of the pineal gland. The tumor cells may spread into nearby tissue or the cerebral spinal fluid. These cells

look very different under a microscope.

- Papillary tumors of the pineal region are relatively uncommon and have only recently been recognized by the World Health Organization. They do not develop within the pineal gland but, instead, may grow from regions or structures around the pineal gland. Grades have yet to be determined for this group, but it is believed they are close to Grade II or III.
- Pineoblastomas are Grade IV, malignant (cancerous) and the most aggressive. Their cells look very different under a microscope, and their cells may even contain dead regions. They may resemble medulloblastomas and retinoblastomas.

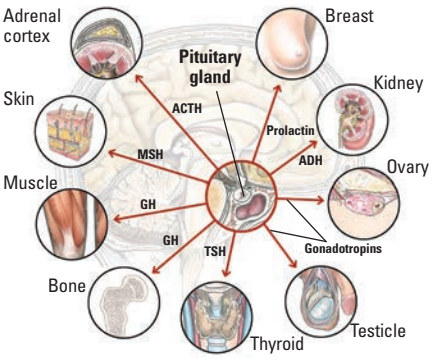
PITUITARY TUMORS

The pituitary is a small gland located inside the brain. It sits above the nasal passages, which are above the fleshy back part of the roof of the mouth (known as the soft palate). The pituitary gland is responsible for releasing multiple types of hormones that affect many bodily functions. Sometimes referred to as the "master endocrine gland," it produces hormones for the thyroid, adrenal gland, testicles, ovaries and breasts as well as melanin, oxytocin and growth hormones.

Two types of tumors start in the pituitary gland.

- Pituitary adenomas are divided into benign pituitary adenomas and invasive pituitary adenomas. Benign pituitary adenomas grow very slowly and do not spread outside of the pituitary gland. However, invasive pituitary adenomas may spread to the skull or the sinus cavity below the pituitary gland.
- Pituitary carcinomas, also known as pituitary cancer, are malignant (cancerous) and are very rare. They can grow into other areas of the brain and spinal cord or outside of the CNS.

FIGURE 3
POSSIBLE AREAS AFFECTED BY A PITUITARY TUMOR



Almost all pituitary tumors are pituitary adenomas, which are benign. However, they still can cause problems if they grow large enough to press on nearby structures or if they make too much of any kind of hormone (see Figure 3). For example, optic nerves that send visual information from the eyes to the brain are near the pituitary gland and may be affected by a tumor in this region.

Pituitary tumors can occur at any age, but they are most often found in older adults. The majority of pituitary adenomas develop in the front two-thirds of the pituitary gland.

Along with being considered benign or malignant, the tumors may be classified as "functioning" or "non-functioning" because the pituitary gland connects the brain with the endocrine system, which is responsible for directing the body to make hormones. Most pituitary tumors are the "functioning" type, producing larger than normal amounts of one or more hormones.

When pituitary tumors grow outside of the gland, they have very little room to grow in this part of the skull. Therefore, if they become larger than about 1 cm (about half an inch) across, they may grow upward where they can compress and damage nearby parts of the brain and the nerves that arise from it, especially vision.

SCHWANNOMAS

Schwannomas are tumors that form in Schwann cells, which primarily cover and protect cranial nerves, but can include other nerves as well. Although they can form on any cranial nerve, they typically develop on the vestibulocochlear nerve, which is near the cerebellum and controls hearing and balance. In this case, they are called vestibular schwannomas or acoustic neuromas. Schwannomas can also begin on spinal nerves where they extend from the spinal cord. When they press on the spinal cord, they can cause weakness, sensory loss, and bowel and bladder problems.

Schwannomas are almost always benign and usually very slow growing. They are considered Grade I tumors. The vast majority of them occur spontaneously and as a single tumor. Multiple schwannomas may develop in a small percentage of people and may be due to an inherited condition that was passed from parent to child. ■

OTHER TYPES OF BRAIN TUMORS IN CHILDREN & ADULTS*

Diffuse astrocytic and oligodendroglial tumors
- Gemistocytic astrocytoma
- Giant cell glioblastoma
- Gliosarcoma
- Epithelioid glioblastoma
- Diffuse midline glioma

Other astrocytic tumors
- Pilomyxoid astrocytoma
- Pleomorphic xanthoastrocytoma
- Anaplastic pleomorphic xanthoastrocytoma

Ependymal tumors
- Papillary ependymoma
- Clear cell ependymoma
- Tanycytic ependymoma

Other gliomas
- Astroblastoma

Neuronal and mixed neuronal-glial tumors
- Anaplastic ganglioglioma

Embryonal tumors
- Embryonal tumor with multilayered rosettes
- CNS embryonal tumor
- Atypical teratoid/rhabdoid tumor
- CNS embryonal tumor with rhabdoid features

Tumors of the cranial and paraspinal nerves
- Malignant peripheral nerve sheath tumor (MPNST)
- Epithelioid MPNST
- MPNST with perineural differentiation

Meningiomas
- Papillary meningioma
- Rhabdoid meningioma
- Anaplastic (malignant) meningioma

Mesenchymal, nonmeningothelial tumors
- Solitary fibrous tumor/hemangiopericytoma
- Epithelioid hemangioendothelioma
- Angiosarcoma
- Kaposi sarcoma
- Ewing sarcoma/peripheral primitive neuroectodermal tumor
- Liposarcoma
- Fibrosarcoma
- Undifferentiated pleomorphic sarcoma/malignant fibrous histiocytoma
- Leiomyosarcoma
- Rhabdomyosarcoma
- Chondrosarcoma
- Osteosarcoma

Melanocytic lesions
- Meningeal melanoma
- Meningeal melanomatosis

Lymphomas
- Diffuse large B-cell lymphoma of the CNS
- Anaplastic large cell lymphoma
- Intravascular large B-cell lymphoma
- MALT lymphoma of the dura

Histiocytic tumors
- Langerhans cell histiocytosis
- Erdheim-Chester disease
- Histiocytic sarcoma

**Source: American Joint Committee on Cancer (AJCC), Eighth Edition (2017)*

ADDITIONAL RESOURCES

- **American Association of Neurological Surgeons:** www.aans.org
  Classification of Brain Tumors
- **American Brain Tumor Association:** www.abta.org
  About Brain tumors

Support and financial resources available for you

BRAIN TUMORS

Accelerate Brain Cancer Cure www.abc2.org
Acoustic Neuroma Association ..... www.anausa.org
American Brain Tumor Association ..... www.abta.org
Brains for the Cure ..... www.brainsforthecure.org
Brain Tumor Foundation ..... www.braintumorfoundation.org
Brain Tumor Network ..... www.braintumornetwork.org
CERN Foundation (Collaborative Ependymoma Research Network) ..... www.cern-foundation.org
Chordoma Foundation ..... www.chordomafoundation.org
Glioblastoma Foundation ..... www.glioblastomafoundation.org
IGN Foundation ..... www.ignfoundation.org/oligo
Keep Punching ..... www.keeppunching.org
Meningioma Mommas ..... www.meningiomamommas.com
The Musella Foundation for Brain Tumor Research & Information Inc. ..... www.virtualtrials.com/musella.cfm
National Brain Tumor Society ..... www.braintumor.org
Pituitary Network Association ..... www.pituitary.org
Tug McGraw Foundation ..... www.tugmcgraw.org

CAREGIVERS & SUPPORT

4th Angel Patient & Caregiver Mentoring Program www.4thangel.org
CanCare ..... www.cancare.org
CANCER101 ..... www.cancer101.org
Cancer*Care* ..... www.cancercare.org
Cancer Hope Network ..... www.cancerhopenetwork.org
Cancer Information and Counseling Line 800-525-3777
Cancer Support Community ..... www.cancersupportcommunity.org
Cancer Support Helpline 888-793-9355
Cancer Survivors Network ..... www.csn.cancer.org
Caregiver Action Network ..... www.caregiveraction.org
CaringBridge ..... www.caringbridge.org
Family Caregiver Alliance ..... www.caregiver.org
Fighting Chance ..... www.fightingchance.org
Friend for Life Cancer Support Network www.friend4life.org, 866-374-3634
The Hope Light Foundation ..... www.hopelightproject.com
Imerman Angels ..... www.imermanangels.org
Lacuna Loft ..... www.lacunaloft.org
LIVESTRONG Foundation ..... www.livestrong.org
MyLifeLine.org ..... www.mylifeline.org
Patient Empowerment Network ..... www.powerfulpatients.org
Patient Power ..... www.patientpower.info
SHARE Caregiver Circle ..... www.sharecancersupport.org/caregivers-support
Stronghold Ministry ..... www.mystronghold.org
Support Groups ..... www.supportgroups.com
Triage Cancer ..... www.triagecancer.org
weSPARK Cancer Support Center ..... www.wespark.org

CHILDHOOD CANCER

Alliance for Childhood Cancer ..... www.allianceforchildhoodcancer.org
American Childhood Cancer Organization ..... www.acco.org
Cancer*Care* for Kids ..... www.cancercareforkids.org
Children's Brain Tumor Foundation ..... www.cbtf.org
Children's Hospice International ..... www.chionline.org
Jessie Rees Foundation ..... www.negu.org
Kids Kicking Cancer ..... www.kidskickingcancer.org
Kids Konnected ..... www.kidskonnected.org
Make-A-Wish Foundation ..... www.wish.org
The National Children's Cancer Society ..... www.thenccs.org
National Pediatric Cancer Foundation ..... www.nationalpcf.org
Ronald McDonald House Charities ..... www.rmhc.org
Special Love for Children with Cancer ..... www.specialove.org
Starlight Children's Foundation ..... www.starlight.org
The Sunshine Kids Foundation ..... www.sunshinekids.org
The Ulman Cancer Fund for Young Adults ..... www.ulmanfund.org
Wipe Out Kids' Cancer ..... www.wokc.org

CLINICAL TRIALS

AccrualNet ..... www.accrualnet.cancer.gov
ACT (About Clinical Trials) ..... www.learnaboutclinicaltrials.org
Center for Information & Study on Clinical Research Participation ..... www.searchclinicaltrials.org
CenterWatch ..... www.centerwatch.com
ClinicalTrials.gov ..... www.clinicaltrials.gov
Lazarex Cancer Foundation ..... www.lazarex.org
LIVESTRONG Foundation ..... www.livestrong.org
My Clinical Trial Locator ..... myclinicaltriallocator.com
National Cancer Institute ..... www.cancer.gov/clinicaltrials
NCI Contact Center (cancer information service) 800-422-6237

FINANCIAL ASSISTANCE

BenefitsCheckUp ..... www.benefitscheckup.org
Bringing Hope Home ..... www.bringinghopehome.org
Cancer*Care* ..... www.cancercare.org/financial
Hope Lodge ..... www.cancer.org/treatment/supportprogramsservices/hopelodge
Medicare.gov ..... www.medicare.gov
Partnership for Prescription Assistance ..... www.pparx.org
Patient Access Network Foundation ..... www.panfoundation.org
Patient Advocate Foundation ..... www.patientadvocate.org
Social Security Administration ..... www.ssa.gov
Social Security Disability Resource Center ..... www.ssdrc.com
State Health Insurance Assistance Programs ..... www.shiptacenter.org

PRESCRIPTION EXPENSES

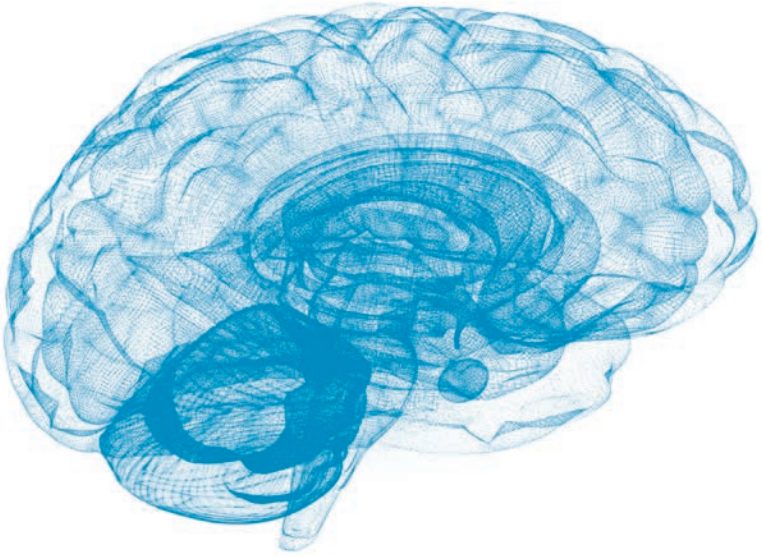
Cancer*Care* Co-Payment Assistance Foundation ..... www.cancercarecopay.org, 866-552-6729
Cancer Financial Assistance Coalition ..... www.cancerfac.org
Foundation for Health Coverage Education ..... www.coverageforall.org
GoodDays ..... www.mygooddays.org, 972-608-7141
HealthWell Foundation ..... www.healthwellfoundation.org, 800-675-8416
Mission4Maureen www.mission4maureen.org, 440-840-6497
NeedyMeds ..... www.needymeds.org, 800-503-6897
Partnership for Prescription Assistance ..... www.pparx.org
Patient Access Network Foundation ..... www.panfoundation.org, 866-316-7263
Patient Advocate Foundation Co-Pay Relief ..... www.copays.org, 866-512-3861
Patient Services, Inc ..... www.patientservicesinc.org, 800-366-7741
RxAssist ..... www.rxassist.org
RxHope ..... www.rxhope.com
RxOutreach ..... www.rxoutreach.com, 888-796-1234
Singlecare ..... www.singlecare.com, 844-234-3057
Stupid Cancer ..... www.stupidcancer.org, 877-735-4673
Together Rx Access ..... www.togetherrxaccess.com, 800-444-4106

REIMBURSEMENT & PATIENT ASSISTANCE PROGRAMS

AbbVie Patient Assistance ..... www.abbviepaf.org, 800-222-6885
Afinitor Patient Support ..... www.us.afinitor.com/sega-tuberous-sclerosis, 888-669-6682
Amgen Assist 360 ..... www.amgenassist360.com/patient, 888-427-7478
AstraZeneca Access 360 ..... www.myaccess360.com, 844-275-2360
AstraZeneca Prescription Savings Program (AZ&ME) ..... www.azandmeapp.com, 800-292-6363
Avastin Access Solutions ..... www.avastin.com/patient/support/financial-resources, 866-422-2377
Bayer US Patient Assistance Foundation ..... www.patientassistance.bayer.us, 866-228-7723
Genentech Access Solutions ..... www.genentech-access.com/patient, 866-422-2377
Genentech BioOncology Co-pay Assistance Program ..... www.copayassistancenow.com, 855-692-6729
Gliadel Wafer Arbor Assistance Program ..... gliadel.com/patient/reimbursement.php, 866-516-4950
Helsinn Cares ..... helsinnreimbursement.com/patient-access-resources, 844-357-4668
Janssen CarePath ..... www.janssencarepath.com, 877-227-3728
Janssen Prescription Assistance ..... www.janssenprescriptionassistance.com
Merck Access Program ..... www.merckaccessprogram.com/hcc, 855-257-3932
Merck Helps ..... www.merckhelps.com, 800-727-5400
Merck Patient Assistance Program ..... www.pparx.org/prescription_assistance_programs/merck_patient_assistance_program
NextSource Cares ..... www.nextsourcepharmaceuticals.com/patient-assistance-program.aspx, 855-672-2468
Novartis Financial Assistance ..... www.patient.novartisoncology.com/financial-assistance, 800-282-7630
Novartis Patient Assistance NOW ..... www.patientassistancenow.com, 800-245-5356
Optune nCompass ..... www.optune.com/resources/ncompass-support, 855-281-9301
Patient Rx Solutions ..... www.patientrxsolutions.com, 800-676-5884
Pfizer Oncology Together ..... www.pfizeroncologytogether.com/patient, 877-744-5675
Pfizer RxPathways ..... www.pfizerrxpathways.com, 844-989-7284
Sancuso Patient Assistance ..... sancuso.com/patient/patient-assistance, 800-676-5884
Teva Cares Foundation Patient Assistance Programs ..... www.tevacares.org, 877-237-4881
Teva Oncology CORE Reimbursement Assistance & Support .... www.tevacore.com, 888-587-3263
Vitrakvi TRAK Assist ..... www.vitrakvi-us.com/patient-support/, 844-634-8725
Zarxio Sandoz One Source ..... www.zarxio.com/patient/support, 844-726-3691

A Study for Management of Eye Side Effects in Patients with EGFR-Amplified Glioblastoma Receiving Depatuxizumab Mafodotin (ABT-414)

Glioblastoma (GBM) Research Study



Do you or someone you know have a glioblastoma?

This study evaluates the effect of several eye treatments for the management of eye side effects in patients treated with depatuxizumab mafodotin (Depatux-M). All participants will receive Depatux-M along with 1 of 3 eye treatments.

Patients must meet the following criteria:

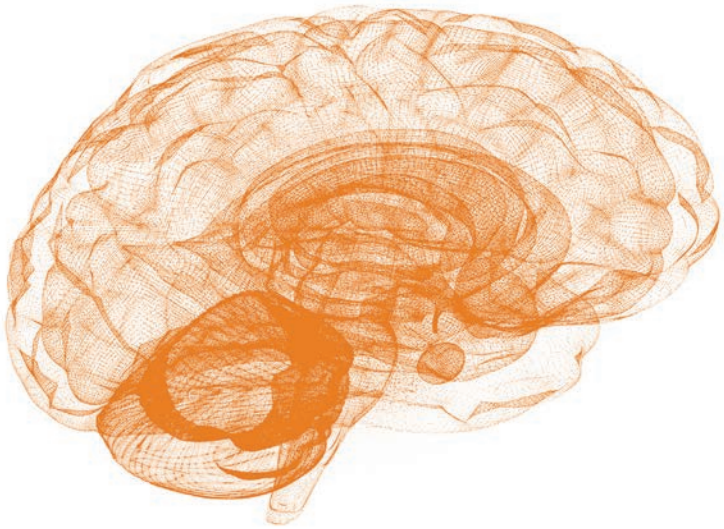
- Be ages 18 or older
- Newly diagnosed GBM and have not already started treatment
- GBM tumor tested positive for EGFR amplification (about half of people with GBM tumors have EGFR amplification)
- Not pregnant or breastfeeding
- Other criteria must also be met

For more information, ask your doctor about the Ocular Side Effect Study or visit **www.clinicaltrials.gov** (NCT03419403) to see if you qualify.

Depatuxizumab Mafodotin is an investigational medicine that is not approved by the FDA. Safety and efficacy have not been established.

INTELLANCE2 SUB-STUDY
Study in Pediatric Patients with High Grade Gliomas (HGG) with Epidermal Growth Factor Receptor (EGFR) Amplification

Pediatric High Grade Gliomas (HGG) Research Study



Do you or someone you know have a child with a high grade glioma that is EGFR Amplified?

The INTELLANCE2 sub-study is a research study evaluating the pharmacokinetics, safety and tolerability of a novel therapy for children with a high grade glioma that is EGFR amplified.

Patients must meet the following criteria:

- Less than 18 years of age
- Newly diagnosed or recurrent high grade glioma (grade III glioma, grade IV glioma or diffuse intrinsic pontine glioma (DIPG))
- Sufficiently recovered from previous therapy
- No current or recent treatment with another investigational drug
- Other criteria apply

For more information, ask your doctor about the INTELLANCE2 Pediatric Sub-Study or visit **www.clinicaltrials.gov** (NCT02343406) to see if you qualify.