Brain Tumors

A **brain tumor** is any abnormal growth of cells found within the brain or near it. Typically, a brain tumor, which can be **benign** (noncancerous) or **malignant** (cancerous), results from unchecked cell division and abnormal tissue growth. Benign brain tumors generally grow slowly and rarely spread to remote parts of the body. Although benign tumors are not cancerous, they can be dangerous if they constrict or damage areas of the brain. Malignant brain tumors usually grow fast and spread, moving aggressively through the brain's tissue layers and possibly into the spinal column.

Given the brain's complex functions and delicate anatomy, diagnosis of brain tumors can be challenging. Brain tumors are classified based on their location, behavior, and cell type. Whereas **primary brain tumor**s originate within or near the brain itself, **metastatic brain tumor**s, also referred to as secondary tumors, originate elsewhere in the body—such as the lung, breast, or colon—and then spread into brain tissue.

Types of Brain Tumors

Brain tumors include several types of benign and malignant growths. **The benign tumors** include the following (American Association of Neurological Surgeons [AANS], n.d.):

- **meningioma—**the most common type of benign intracranial tumor. As their name suggests, meningiomas begin growing in the meninges around the brain and spinal cord.
- **schwannoma—**common type of benign brain tumor found in adults. Schwannomas are found near nerves and may displace a nerve rather than invading it. Although schwannomas are benign, they can be serious health threats, even causing death, if they exert too much pressure on nerves and/or the brain.
- **pituitary adenoma—**also common, this type of benign tumor begins in the pituitary gland. Typically, pituitary adenomas affect individuals in their 30s and 40s, although children may have them.
- **craniopharyngioma—**typically arises from the pituitary gland and becomes embedded deep in the brain near critical structures. Patients with craniopharyngiomas usually need hormone replacement therapy, even though these tumors are benign.
- **chordoma—**rare, slow-growing tumor that generally occurs in individuals between the ages of 50 and 60. Typically, chordomas are found at the base of the skull or in the lower spine.
- **gangliocytoma—**rare tumor that involves the neoplastic nerve cells, which are nervous system cells that have become cancerous, and typically occurs in young adults.
- **glomus tumor—**rare tumor that occurs in the head and neck, often near the jugular vein.

The more serious brain tumors are malignant. The most common type of malignant brain tumor is a **glioma**, produced from the brain's glial cells. A **glial cell** is a supporting cell that provides nourishment to neurons. The **different types of malignant brain tumors** include the following (AANS, n.d.):

- **astrocytoma—**common type of glioma that grows from astrocytes. An **astrocyte** is a star-shaped glial cell that forms part of the brain's supportive tissue. Typically, astrocytomas form in the brain's cerebrum and can occur in individuals of all ages.
- **glioblastoma multiforme (GBM)—**the most invasive of the glial tumors. GBMs tend to be comprised of multiple types of cells, including astrocytes and oligodendrocytes, and they tend to grow quickly, spreading to other tissues. GBMs typically affect individuals between ages 50 to 70 and tend to occur in men more than women. For individuals who have a GBM, the prognosis is usually poor.

- **medulloblastoma—**typically occurs in children, affecting the cerebellum, and tends to be high-grade. Medulloblastomas usually respond to chemotherapy and radiation, making them more treatable than some brain tumors.
- **ependymoma—**less common brain tumor that occurs when the ependymal cells that line the ventricular system experience a **neoplastic transformation**, which occurs when oncogenes are activated while tumor suppressor genes are inactivated.
- **oligodendroglioma—**occurs in the cells that produce the brain's myelin, which insulates the brain's wiring.

Clinical Manifestations

Brain tumor symptoms vary according to the tumor's location, size, and growth rate. Generally, all brain tumors cause headaches. Other common symptoms include vertigo, nausea, fatigue, and changes in appetite. Additional manifestations, depending on the part of the brain affected by the tumor, include the following (Mayo Clinic, 2023a):

- Frontal lobe tumors tend to cause personality changes, disinterest in normal activities, forgetfulness, balance issues, and difficulty walking.
- Parietal lobe tumors, in the upper middle section of the brain, typically cause issues with the senses, including hearing and vision problems.
- Occipital lobe tumors, in the back of the brain, may cause vision problems, including blindness.
- Temporal lobe tumors, on the lower sides of the brain, may cause memory loss as well as issues with the senses, such as tasting or smelling something that does not exist.

Assessment and Diagnostics

As with other medical issues, to assess a brain tumor, nurses and other health-care professionals should first obtain the patient's medical history. This history should identify whether patients could be at risk for a brain tumor because of factors such as obesity, age, family history, and certain radiation exposure. It should also determine whether patients are exhibiting symptoms of a brain tumor, such as frequent headaches and nausea. Patients should receive a physical examination to check their vision, hearing, speech patterns, coordination, and other physical behavior, including the patient's ability to walk. The examination should also include an assessment of the patient's deep tendon reflexes.

Diagnostics and Laboratory Values

Diagnostic procedures for brain tumors typically include imaging studies such as MRI or CT scans, tissue biopsies, and magnetic resonance spectroscopy (MRS) testing. MRI and/or CT scans will show whether a tumor exists. A tissue biopsy can determine the type and grade of the brain tumor. MRS testing can provide further analysis of the tumor by examining its chemical profile and providing more details about lesions found on MRIs. To gauge their severity, tumors are graded on a four-point scale, with one being the least aggressive tumors and four being the most aggressive. The characteristics associated with each grade of tumor include the following (AANS, n.d.; Johns Hopkins Medicine, n.d.):

- Grade I—slow-growing, benign tumors that may appear as normal cells, are noninfiltrating, and typically pose no life threats
- Grade II—reasonably slow-growing tumors that are usually benign, appear as slightly abnormal cells, may be infiltrative, and may recur if removed
- Grade III—malignant tumors that grow reasonably fast, appear as abnormal cells, infiltrate into neighboring tissues, and tend to recur as a grade 4 tumor

- Grade IV—malignant, aggressive tumors that grow rapidly, appear as very abnormal cells, infiltrate easily into other parts of the brain, and rapidly recur if removed

Nursing Care of the Patient with Brain Tumors

Brain tumors, whether benign or malignant, are critical conditions requiring nursing care tailored to address the patient's needs based on the grade of their tumor. By recognizing the cues of brain tumors, nurses can help to identify patients with a brain tumor. Nurses also need to understand how to provide effective nursing care to patients with a brain tumor.

Nursing Care	**Rationale**
Complete focused neurological assessments.	Changes in LOC, pupillary response and shape, motor function, speech, and vital signs indicate health issues.
Provide after-surgery care.	Patients may need assistance as the effects of anesthesia wear off, which may include suturing incisions, emptying drains, changing dressings and bandages, and applying heat/cold packs to assist with any swelling.
Provide care associated with radiation therapy.	Patients may need help to understand what to expect with radiation, and they may experience side effects such as nausea.
Administer chemotherapy as ordered.	The patient may need help to understand the treatment and chemotherapy drugs that may need to be administered. Patients should be monitored because they may experience side effects, such as nausea and fatigue.
Manage pain.	Patients may experience pain, including headaches. They may need pain medications, such as analgesics.
Avoid Valsalva maneuvers.	Avoiding or minimizing bowel straining, coughing, or bearing down will reduce the risk of increases in ICP.
Implement seizure precautions	Because brain tumors can cause seizures, keep the bed in a low position with the side rails up and provide bedside padding if needed. Ensure basic suction equipment is set up and ready for use.

Evaluation of Nursing Care for Patients with Brain Tumors

The desired outcomes for patients with brain tumors include the successful removal of brain tumors if possible. For patients who must learn to live with their brain tumors, the desired outcome is to relieve symptoms and restore as much quality of life as possible. For patients whose brain tumors are terminal, the desired outcome is to help patients navigate end-of-life challenges. Examples of successful outcomes for patients with brain tumors include pain that is satisfactorily controlled, physical therapy that results in a decreased risk for falls, and range of motion exercises that restore or sustain the patient's mobility.

Medical Therapies and Related Care

Treatment strategies for brain tumors depend on whether the tumor is benign or malignant, the grade of the tumor, its location and size, and the patient's health. Common treatments for tumors may include the following:

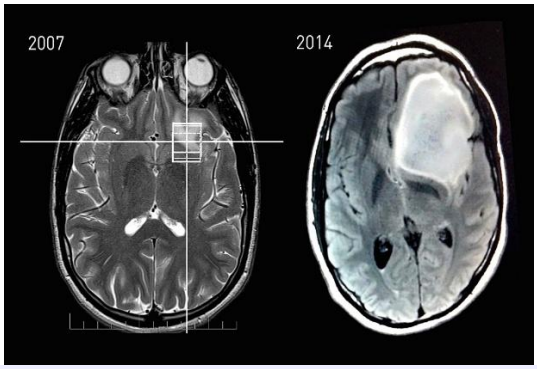
- Surgical procedures
    - craniotomy—involves removing a bone flap from the skull to access a tumor

Astrocytoma

Astrocytoma is a type of brain tumour originating from astrocytes, star-shaped glial cells in the cerebrum. These tumours typically remain confined to the brain and spinal cord, rarely affecting other organs.
Astrocytomas are the second most common type of glioma after glioblastomas and can occur in various parts of the central nervous system.

Diagnosis

Diagnosis begins with a history of symptoms and a basic neurological exam, including vision, balance, coordination, and mental status tests. CT and MRI scans are essential for characterizing tumour size, location, and consistency. Histologic analysis through biopsy is required for grading. The MRI or CT scans might be enhanced with a contrast dye for better tumour visualization.



MRI scans of an astrocytoma patient, showing tumour progression over the course of seven years

Grading

The World Health Organization (WHO) grading system categorizes astrocytomas from grade I to IV based on characteristics like atypia, mitosis, endothelial proliferation, and necrosis.

- **Grade I**: Includes pilocytic astrocytoma, subependymal giant cell astrocytoma, and subependymoma. These are slow-growing, benign tumours often associated with long-term survival.
- **Grade II**: Includes low-grade (fibrillary) astrocytoma, pleomorphic xanthoastrocytoma, and mixed oligoastrocytoma. These are relatively slow-growing but can evolve into higher-grade tumours.
- **Grade III**: Anaplastic astrocytomas, often linked to seizures and neurologic deficits. Standard treatment involves surgical removal followed by radiation.
- **Grade IV**: High-grade astrocytomas, typically glioblastomas, are extremely infiltrative and have poor prognosis despite aggressive treatment.

Prevention

There are no precise guidelines for preventing astrocytoma as the exact cause is unknown.

Treatment

For low-grade astrocytomas, surgical removal often leads to long-term functional survival. High-grade astrocytomas, however, cannot be completely resected due to their diffuse infiltration, leading to inevitable recurrence. Treatment focuses on palliative care, with radiation and chemotherapy providing limited extensions in survival.

Self-assessment MCQs (single best answer)

1. **What type of glial cell do astrocytomas originate from?**
a. Oligodendrocytes
b. Microglia
c. Ependymal cells
d. Astrocytes
e. Schwann cells

2. **Which imaging technique is essential for characterizing the size, location, and consistency of an astrocytoma?**
a. PET scan
b. X-ray
c. Ultrasound
d. CT and MRI scans
e. EEG

3. **What is the typical effect of high-grade astrocytomas on CDKN2A/B?**
a. Duplication
b. Homozygous deletion
c. Point mutation
d. Translocation
e. No effect

4. **Which World Health Organization (WHO) grade of astrocytoma is characterized by being slow-growing and often associated with long-term survival?**
a. Grade I
b. Grade II
c. Grade III
d. Grade IV
e. Grade V

5. **Which diagnostic procedure is essential for grading an astrocytoma?**
a. Blood test
b. Biopsy
c. Lumbar puncture
d. Electrocardiogram (ECG)
e. Genetic screening

6. **What is a common treatment approach for low-grade astrocytomas to achieve long-term functional survival?**
a. Radiotherapy
b. Chemotherapy
c. Surgical removal
d. Immunotherapy
e. Stem cell transplant

7. **What is a characteristic feature of grade IV astrocytomas?**
a. Slow growth and long-term survival
b. Benign nature and no recurrence
c. Extremely infiltrative and poor prognosis
d. Limited to spinal cord
e. Always localized and non-invasive

8. What is a common symptom linked to anaplastic astrocytomas (Grade III)?
a. Weight gain
b. Seizures and neurologic deficits
c. Skin rashes
d. Digestive issues
e. Respiratory problems

9. What is a significant challenge in treating high-grade astrocytomas?
a. Lack of diagnostic tools
b. Inability to completely resect due to diffuse infiltration
c. Poor response to antibiotics
d. Complete absence of symptoms
e. Limited availability of contrast dyes

Glioblastoma

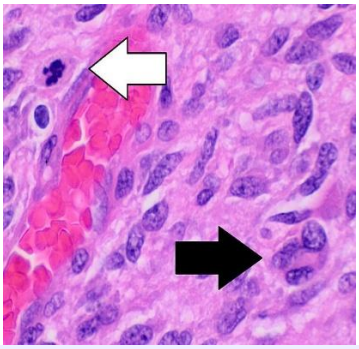
Glioblastoma, previously known as glioblastoma multiforme (GBM), is an aggressive and common type of brain cancer with a very poor prognosis. It typically arises in the brain's astrocytes and represents 15% of all brain tumours. Despite maximum treatment efforts, the median survival rate is approximately 15 months, with a five-year survival rate of less than 10%.

Signs and Symptoms
Initial signs and symptoms of glioblastoma are nonspecific and may include headaches, personality changes, nausea, and symptoms similar to those of a stroke. Common symptoms include seizures, headaches, nausea and vomiting, memory loss, changes to personality, mood or concentration, and localized neurological problems. The symptoms depend more on the tumour location than its pathological properties, and the tumour can sometimes remain asymptomatic until it reaches a significant size.

Risk Factors
The cause of most glioblastoma cases is unclear. Known risk factors include exposure to ionizing radiation and certain genetic disorders such as neurofibromatosis and Li–Fraumeni syndrome. Environmental factors like exposure to smoking, pesticides, and working in petroleum refining or rubber manufacturing have also been associated. Viruses such as SV40, HHV-6, and cytomegalovirus may play a role in the development of glioblastoma.

Pathogenesis
Glioblastomas usually form in the cerebral white matter, grow quickly, and can become very large before producing symptoms. They may extend into the meninges or ventricular wall, and malignant cells carried in the cerebrospinal fluid (CSF) could rarely spread to the spinal cord. About 50% of glioblastomas occupy more than one lobe of a hemisphere or are bilateral.

Diagnosis
Diagnosis typically involves a combination of CT and MRI scans, followed by a tissue biopsy. Glioblastomas often appear as ring-enhancing lesions on MRI, but this is not specific. Definitive diagnosis requires a stereotactic biopsy or craniotomy with tumour resection and pathologic confirmation.
Histopathology helps distinguish glioblastoma from high-grade astrocytomas, often relying on molecular markers like IDH1 and IDH2 mutations, as these are not present in glioblastomas.



Histopathology of glioblastoma, showing high grade astrocytoma features of marked nuclear pleomorphism, multiple mitoses (one at white arrow) and multinucleated cells (one at black arrow), with cells having a patternless arrangement in a pink fibrillary background on H&E stain.

Treatment
Treatment of glioblastoma is challenging due to the tumour's resistance to conventional therapies and the brain's susceptibility to damage. Standard treatment involves surgery, radiation, and chemotherapy.

Surgery
Surgery is the first line of treatment aimed at pathological diagnosis, symptom alleviation, and tumour removal. Complete resection is rarely possible due to the infiltrative nature of glioblastoma.

Radiotherapy
Radiotherapy is a mainstay post-surgery, typically administered with temozolomide. Standard doses range between 60-65 Gy, aimed at maximizing tumour control while minimizing damage to healthy tissue.

Chemotherapy
Temozolomide is the most common chemotherapeutic agent used, often combined with radiation to improve survival. Treatment efficacy is higher in tumours with MGMT promoter methylation.

Other Treatments
Alternating electric field therapy has shown some promise, with initial trials indicating improved survival. However, its efficacy remains debated. Immunotherapy and oncolytic virotherapy are under investigation but have not yet shown significant success in clinical trials.

Prognosis
Prognosis remains poor, with a median survival of 10-13 months post-diagnosis. Factors such as age, Karnofsky performance score (KPS), and MGMT methylation status influence survival outcomes.

Self-assessment MCQs (single best answer)

1. **What percentage of all brain tumours does glioblastoma represent?**
a. 10%
b. 15%
c. 20%
d. 25%
e. 30%

2. Which of the following is NOT a common symptom of glioblastoma?
a. Seizures
b. Headaches
c. Shortness of breath
d. Nausea and vomiting
e. Memory loss

3. Which genetic disorder is known to be a risk factor for glioblastoma?
a. Cystic fibrosis
b. Down syndrome
c. Neurofibromatosis
d. Huntington's disease
e. Marfan syndrome

4. What is the median survival rate for glioblastoma patients following maximum treatment efforts?
a. 6 months
b. 10 months
c. 15 months
d. 20 months
e. 25 months

5. In which part of the brain do glioblastomas typically form?
a. Cerebral white matter
b. Cerebellum
c. Brainstem
d. Thalamus
e. Hypothalamus

6. What imaging technique is commonly used to diagnose glioblastoma?
a. X-ray
b. Ultrasound
c. MRI
d. PET scan
e. Bone scan

7. Which chemotherapeutic agent is most commonly used in the treatment of glioblastoma?
a. Cisplatin
b. Doxorubicin
c. Temozolomide
d. Methotrexate
e. Cyclophosphamide

8. What is the primary goal of surgery in glioblastoma treatment?
a. Complete tumour removal
b. Pathological diagnosis and symptom alleviation
c. Immunotherapy initiation
d. Radiation therapy planning
e. Chemotherapy administration

9. What is the typical dose range for radiotherapy in glioblastoma treatment?
a. 20-25 Gy
b. 30-35 Gy
c. 40-45 Gy
d. 50-55 Gy

e. 60-65 Gy

10. Which factor does NOT influence the survival outcome for glioblastoma patients?

a. Age
b. Karnofsky performance score (KPS)
c. MGMT methylation status
d. Blood type
e. Tumour location