

# Glioma

What is  
glioma?

Let us explain  
it to you.

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## **GLIOMA: A GUIDE FOR PATIENTS**

### **PATIENT INFORMATION BASED ON ESMO CLINICAL PRACTICE GUIDELINES**

This guide for patients has been prepared by the Anticancer Fund as a service to patients, to help patients and their relatives better understand the nature of glioma and appreciate the best treatment choices available according to the subtype of glioma. We recommend that patients ask their doctors about what tests or types of treatments are needed for their type of disease. The medical information described in this document is based on the clinical practice guidelines of the European Society for Medical Oncology (ESMO) for the management of glioma. This guide for patients has been produced in collaboration with ESMO and is disseminated with the permission of ESMO. It has been written by a medical doctor and reviewed by two oncologists from ESMO including the leading author of the clinical practice guidelines for professionals. It is also reviewed by two nurses of the European Oncology Nursing Society (EONS) and by patient representatives from ESMO's Cancer Patient Working Group.

More information about the Anticancer Fund: [www.anticancerfund.org](http://www.anticancerfund.org)

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*For words marked with an asterisk, a definition is provided at the end of the document.*

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## FACTSHEET ABOUT GLIOMA

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### Definition of glioma

- Gliomas\* are a group of tumours of the central nervous system which differ according to the cells of origin in the brain (astrocytes\* or oligodendrocytes\* or both) and the grade of aggressiveness (from the least to the most aggressive: low grade glioma\* → anaplastic glioma\* → glioblastoma\*).

### Diagnosis

- Glioma\* can be suspected when a number of symptoms are present, such as seizures\*, changes in personality and behaviour, various types of neurological problems (including sight problems, difficulty in speaking, understanding what is said, loss of strength or feeling in a part of the body or gait changes), as well as symptoms associated with increased pressure in the head (headache, nausea, vomiting, and drowsiness).
- Magnetic Resonance Imaging (MRI\*) of the brain is the gold standard radiological test for the detection of a glioma\*. It also helps define the extent of the disease and indicates whether the tumour can be surgically removed safely.
- A piece of the tumour (taken either by surgical resection or by stereotactic\*/open biopsy\* in case surgical removal is not possible) must be obtained for analysis in the lab to confirm the diagnosis and get more details about the molecular characteristics\* of the tumour. Molecular characterisation may help define the exact subtype of glioma\*, gain information on the likely outcome of the diagnosis (“prognosis”\*) and help guide treatment decisions.

### Treatment

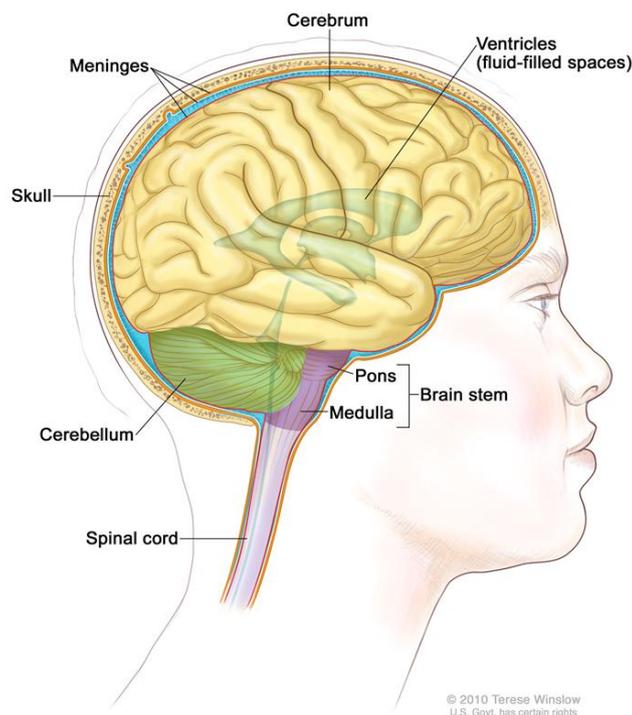
Surgery is the first treatment of choice for the majority of newly diagnosed gliomas\*; in fact, surgical removal as extensive as safely possible is associated with an improved outcome regardless of the subtype of glioma\*. After surgery, treatment differs according to the subtype of glioma\*.

- **Low grade glioma\* (Grades 1 and 2)**
  - Radiotherapy\* is the standard post-operative treatment in patients whose disease characteristics suggest a high likelihood of return of the disease (called recurrence\*).
  - Chemotherapy\* has a less defined role in low grade glioma\*. However, it can be used in patients who are not deemed eligible for surgery and/or radiotherapy\* or in tumours recurring after radiotherapy\*. Patients whose tumour shows a specific molecular characteristic\* (called ‘genetic loss on chromosomes 1p/19q’\*) appear to be particularly sensitive to chemotherapy\*, meaning there is more chance of chemotherapeutic benefit in these patients.
- **Anaplastic glioma\* (Grade 3)**
  - Radiotherapy\* followed by chemotherapy\* is a standard post-operative treatment in anaplastic glioma\*.
  - Radiotherapy\* alone may be used in anaplastic oligodendroglial tumours\* without genetic loss on chromosomes 1p/19q\*.

- Studies have shown that chemotherapy\* alone after surgery, and administering radiotherapy\* only at the time of disease progression, achieves the same results as radiotherapy\* applied after surgery and chemotherapy\* administered at the time of disease progression.
- **Glioblastoma\* (Grade 4)**
  - Use of chemotherapy\* and radiotherapy\* in combination ('concurrently' or 'concomittantly') is the standard treatment after surgery in glioblastoma\* patients younger than 70 years as well as in older fit patients whose tumour tests positive for a specific molecular characteristic\* (presence of MGMT gene methylation\*).
  - Radiotherapy\* alone is preferred in elderly (>70 years) patients who are not fit enough to receive concurrent chemo-radiotherapy\* and/or whose tumour is negative for the presence of MGMT gene methylation\*.
  - Chemotherapy\* alone is the preferred treatment option in elderly unfit patients whose tumour is positive for MGMT gene methylation\*.

## DEFINITION OF GLIOMA

Gliomas\* represent a group of malignancies\* that may arise anywhere in the central nervous system, ('CNS') meaning in the brain or, much less frequently, in the spinal cord\* (see illustration below). They are characterised by an infiltrative pattern\* of growth and/or a tendency for spreading locally within the CNS. Tumour spread to outside the brain usually does not occur.



Anatomy of the brain, showing the cerebrum\*, cerebellum\*, brain stem\*, and other parts of the brain. The upper part of the spinal cord\* is also represented.

Following histopathological\* examination, gliomas\* are usually named according to the type of nervous cells which they derive from (astrocytes\*, oligodendrocytes\* or ependymal cells). The classification of gliomas\* follows a scale from I to IV (1 to 4), which reflects the rate of tumour growth as well as its aggressiveness. Grade I tumours, which occur mainly in childhood, are associated with the best prognosis\*. Grade II (low grade gliomas\*) represent slowly growing and infiltrative tumours\* with intermediate prognosis\*. On the other hand, grade III (anaplastic) and grade IV (glioblastoma\*) tumours are both considered to be high grade gliomas\*, as they are aggressive and generally have the least favourable prognosis\*. The present guide will focus on the management of low grade gliomas\*, anaplastic gliomas\* and glioblastoma\*. The table below provides an overview of the main types of glioma\* brain tumours according to the cell they derive from and the grade to which they belong.

Cell of origin*	Name of tumour**	Grade	Comments
Astrocyte*	Astrocytoma*	I to IV	Grades I and II are called low grade astrocytomas* Grades III and IV are called high grade astrocytomas* Grade III are also called anaplastic astrocytomas* Grade IV are also called glioblastomas*
Oligodendrocytes*	Oligodendroglioma*	II or III	Grade II are called low grade oligodendrogliomas* Grade III are called high grade or anaplastic oligodendrogliomas*
Mixed (astrocyte* and oligodendrocyte)	Oligoastrocytoma*	II or III	Grade II are called low grade oligoastrocytomas* Grade III are called high grade or anaplastic oligoastrocytomas*

\* Ependymal cells are a third type of glial cells. Rare tumours called ependymomas\* (grade I to III) can arise from these cells. Information on the treatment on these tumours is not covered in the current guide.

\*\* There are many subtypes of these tumours. They are classified and named according to their specific features under the microscope and/or to their location in the brain. For instance, optic pathway gliomas\* are low-grade gliomas\* arising from astrocytes\* locating in the optic nerve or in the optic pathway.

## Important note regarding other types of brain tumours

### Secondary brain tumours, also called metastases\* to the brain

Cancers that initially developed in other organs of the body (e.g. in the lung or the breast), can spread to the brain. In this case, the 'secondary' tumour found in the brain is called metastasis\* as opposed to a primary brain tumour developing initially in the brain. The management of a brain metastasis\* is different from the management of a primary brain tumour.

### Other types of primary brain tumour

Other brain tumours also exist. The most frequent other brain tumours are meningiomas\* which develop from the meninges\* and adenomas\* of the pituitary gland\* which develop from cells making the pituitary gland\*. Other types include ependymoma\*, primitive neuroectodermal tumour and medulloblastoma\* which are rare tumours arising mainly in children. The management of all these tumours is different from the management of gliomas\* and is therefore not covered in this guide.

## IS GLIOMA FREQUENT?

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Glioma\* is considered a rare cancer because it affects less than 6 out of 100,000 persons every year. Nevertheless, gliomas\* represent 80% of all tumours of the central nervous system. Gliomas\* can affect people of all ages including children, teenagers and young adults but are more frequent in people in their 50s and 60s. Worldwide, 3 women and 4 men out of 100,000 are diagnosed with a tumour affecting the central nervous system every year. In Europe, 5 women and 6 men out of 100,000 are affected every year. Europe has the highest rates per year. Within Europe, the highest rates are reported for Sweden and Albania (10 per 100,000), and the lowest in Cyprus and Moldova (less than 4).

On average, about one in every 150 European men and one in every 200 European women will develop a tumour of the central nervous system (of which 80% will be malignant glioma\*), at some point in their life.

## WHAT CAUSES GLIOMA?

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Before addressing the risk factors that may predispose to the development of glioma\*, it is important to know that a risk factor increases the risk of cancer occurring, but is neither necessary nor sufficient on its own to cause cancer. A risk factor is not a cause in itself. **Therefore, some people with one or more risk factors will never develop glioma\* and some people without any of these risk factors may nonetheless develop glioma\*.**

Nevertheless, at the present time, it is not clear why glioma\* occurs, and very few risk factors have been identified. Generally speaking, gliomas\* are slightly more common in men than in women as well as in white rather than black populations. Recognised risk factors of gliomas\* are:

- **Ionising radiation\***

This is an established environmental risk factor, as documented by the observation that individuals exposed to atomic bombs and nuclear weapons testing have an increased risk of developing glioma\*. Individuals who have received cranial irradiation\* for cancer therapy during their childhood are also at increased risk of developing glioma\* years or even decades later.



- **Family history**

A family history of glioma\* (meaning one or more cases of glioma\* in the same family) is associated with a 2-fold increase in the risk of developing a glioma\*.

- **Genetic syndromes**

A number of rare hereditary syndromes are associated with a higher risk of development of cancers in general, mainly as a result of the presence of one or multiple genetic alterations. Importantly, some of these hereditary syndromes may also carry a higher risk of glioma\*, such as Cowden syndrome\*, Turcot syndrome\*, Lynch syndrome\*, Li-Fraumeni syndrome\*, and neurofibromatosis type I\*.

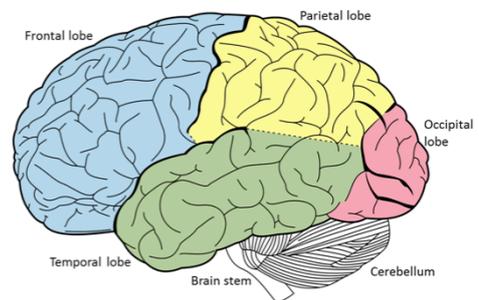


Other factors have been suspected to be associated with an increased risk of glioma\*, but the evidence is inconsistent. This is the case with cell phone exposure, for which epidemiological studies (research into the patterns, causes and effects of specific health and disease populations) have failed so far to conclusively demonstrate an association with an increase in the risk of glioma\*. Evidence is also inconsistent for other factors once suspected to increase the risk of glioma\* such as head injury, aspartame, or exposure to pesticides.

## HOW IS GLIOMA DIAGNOSED?

### Signs and symptoms

Glioma\* can be suspected in the presence of different symptoms. Nevertheless, it is important to know that these symptoms largely depend on the type of glioma\* as well as on its exact location in the central nervous system. The different lobes of the left hemisphere of the brain are represented in the illustration. The brain has two hemispheres and each lobe in each hemisphere is responsible for a multitude of functions. Therefore, the list of symptoms reported herein cannot be exhaustive. However, in an effort to generalize, the following signs and symptoms may be commonly present either alone or combined with each other both at first diagnosis or later on during the course of the disease:



- **Seizures\***  
These are among the most common, and often most distressing, symptoms of gliomas\*. Seizures\* are especially present in patients with slowly growing tumours such as low grade gliomas\*. A seizure can cause jerking or twitching of a hand, arm or leg. However, a seizure may also affect the whole body with quite violent and uncontrolled movements, possibly with losing consciousness. A seizure can be a very frightening event so it is important for carers or others witnessing a seizure not to panic. Knowing what to do when a person has a seizure can reduce fear and potential injury to the patient.
- **Neurological problems (known as 'deficits')**  
These largely depend on the lobe(s) of the brain that is (are) affected. Sight problems may be present if the occipital lobe\* (represented in blue) is involved. Difficulty in speaking or understanding what is said to you as well as loss of function (strength) or sensitivity (feeling) in a part of the body occurs when the frontal (in yellow) or parietal lobe (in red) is affected. Personality and behavioural changes such as apathy, loss of initiative, and loss of emotional control/loss of inhibition may occur if the frontal lobe\* (in yellow) is compromised. Finally, memory loss is often associated with involvement of the temporal (in green) lobe, while poor coordination or uncontrolled movement of the eyes can be present if the disease involves the 'little brain' (cerebellum\*). When glioma\* arises from the spinal cord\*, pain, numbness and/or weakness in the lower part of the body, and/or loss of control of the bladder or bowel may be present.
- **Symptoms that result from increased pressure in the brain**  
These symptoms are typical for high grade gliomas\*. They occur because the tumour grows rapidly in the brain which is contained inside the fixed space of the skull. This can result in headache, nausea, vomiting, double vision and drowsiness.

- **Thromboembolic events\***

Thromboembolic events\*, which are the formation of clots in the blood stream, are often present in glioma\* patients. There are several possible reasons for this. Glioma\* patients often carry risk factors commonly associated with the development of thrombosis such as motor deficits and/or immobility, and, after diagnosis, treatment with chemotherapy\*. Symptoms associated with thrombosis largely differ according to the involved site, and their list is beyond the scope of this guide for patients.

## **Clinical examination\***

Testing the central nervous system is the most important part of the clinical examination\* if a glioma\* is suspected or diagnosed. However, general physical examination (e.g. breast, abdomen, skin) is also important so that signs of a cancer somewhere else in the body can be excluded. With regard to neurological examination\*, the physician may ask a few questions, as well as perform some simple tests. Neurological examination\* usually includes:

- Testing your strength by asking you to squeeze the physician's hands or push against the physician's hand with your feet.
- Checking to see that you have normal sensation throughout the body
- Asking you to touch your nose with your finger while your eyes are shut
- Asking you to walk in a straight line
- Asking you to answer simple questions
- Asking you to follow a moving finger with your eyes
- Asking you about your hearing and sight

## **Radiological examination\***

Radiological tests are crucial examinations which detect a glioma\* and define its exact location and extent. As glioma\* does not metastasise to distant organs, diagnostic imaging is limited to the brain.

- **CT-scan\* of the brain**

This radiological test is often the first exam to be performed when a brain tumour is suspected. That is because a brain tumour usually shows up on this type of scan. The injection of contrast-medium, namely a dye that circulates in your bloodstream, before this test allows for a clearer picture of the brain. It is very important to tell your doctor if you have had previous allergic reactions to this contrast-medium.



- **MRI\* of the brain**

MRI\* is the gold standard examination for the radiological diagnosis\* of glioma\*. As compared to CT-scan\*, MRI\* gives a much clearer picture of the brain. Similarly to CT-scan\*, MRI\* is performed following the injection of contrast medium. It is very important to tell your doctor if you have metal inside your body as this may mean you cannot have an MRI\* scan.

### **Histopathological examination\***

This is the laboratory examination of the tumour cells. It can be performed either on the tumour(s) removed by surgery or on biopsies\* coming from stereotactic procedures\* (see treatment options) of surgically inoperable gliomas\*. Importantly, histopathological examination\* is the only method that can definitively confirm a diagnosis of glioma\*. In general, the more tumour tissue is available, the more accurate the diagnosis is. However, histopathological examination\* can yield more precise results when carried out at experienced centres where pathologists\* (the medical specialists who examine your tissue after it has been removed) have particular experience of analysing brain tumours. Therefore, careful review of tumour cells by an expert neuropathologist\* is crucial.



## WHAT IS IMPORTANT TO KNOW TO GET OPTIMAL TREATMENT?

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Doctors will need to consider many aspects about you as the patient and your type of brain tumour in order to decide on the best treatment.

### Relevant information about you

- **Your age**
- **Your performance status\***, namely a measurement scale of your general condition that is influenced by the presence and severity of tumour-related symptoms
- **Your personal and family medical history**, including type and number of other diseases
- **Results of your blood tests** (e.g. white blood cells\*, red blood cells\*, platelets\* count, liver and kidney function).

### Relevant information about your brain tumour

- **Histopathological examination\***

Histopathological examination\* of gliomas\* is the basis for guiding optimal treatment. In general, gliomas\* can be classified according to grade into low grade gliomas\*, anaplastic gliomas\* and glioblastoma\*. In addition, low grade and anaplastic gliomas\* can be further classified according to the type of cells they derive from, namely astrocytes\*, oligodendrocytes\*, or both. It should be noted that ependymomas\*, which are gliomas\* deriving from ependymal cells, also exist but treatment of ependymomas\* is not covered in the current guide.

This classification results in different treatment approaches as well as a different overall prognosis\*, normally based on statistics. Statistics are a tool used for comparing treatments and for describing what has happened in the past to groups of people with various tumour types. Statistics cannot predict exactly how long any individual person will live so patients should not necessarily consider statistics as a completely accurate indicator of their lifespan after diagnosis. Individual prognosis\* is best discussed, on a case by case basis, with brain tumour specialists. In order to provide a general idea on prognosis\*, we know from statistics that in general the lower the grade of the tumour, the better the prognosis\*. But there are exceptions to these statistics and there are even some very long term survivors of anaplastic astrocytoma\* and glioblastoma\*.

- **Grade II oligodendrogliomas\***
- **Anaplastic oligodendrogliomas\* (also called grade III)**
- **Grade II astrocytomas\***
- **Anaplastic astrocytomas\* (also called grade III)**
- **Glioblastomas\* (also called grade IV)**

In addition to grade and subtypes, other established prognostic factors include your age, your performance status\*, the possibility of resection of the tumour, your general condition and your cognitive function (a person's mental abilities and processes). The recent advances in discovery of tumour markers (as explained below) have made it possible to predict a potentially better outcome for malignant glioma\* with specific tumour characteristics.

- **Molecular markers\* of the tumour**

The following markers have to be taken into account for analysis by your physician because they can either provide information on the prognosis\* of the tumour or help guide treatment decisions.

- **Genetic loss on chromosomes 1p/19q\***

The detection of this marker is important in order to ascertain the diagnosis of glioma\* with an oligodendroglial component (either pure oligodendroglioma\* or mixed oligoastrocytoma\*). Also, it identifies a tumour entity with a slower course of disease, and which shows particular sensitivity both to radiotherapy\* and chemotherapy\*.

- **Mutation of the IDH\* gene 1 or 2**

A mutation in this gene is often present both in low grade and anaplastic gliomas\*, where it is associated with a better survival regardless of treatment. Its presence in high grade gliomas\* (anaplastic gliomas\* or glioblastoma\*) suggests that these tumours developed from a previously low grade glioma\*. Therefore, high grade tumours with a mutation in the IDH\* gene generally have a better prognosis\* compared with high grade gliomas\* without IDH\* mutation.

- **MGMT\* gene methylation**

The presence of this marker reflects the inability of the tumour to repair the damage on the DNA produced by certain chemotherapies called 'alkylating agents\*', particularly temozolomide\*. Therefore, when this alteration is found in glioblastoma\* it suggests the tumour is more sensitive to temozolomide\* (see treatment options).

## WHAT ARE THE TREATMENT OPTIONS?

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### Surgery

Regardless of the glioma\* subtype, surgery (either surgical resection or stereotactic\*/open biopsy\*) represents an essential component of treatment of all newly diagnosed gliomas\*.



- **Surgical resection**

Surgical resection of the tumour is the preferred initial treatment for the majority of gliomas\*. Surgery is aimed to be as complete as possible. The reason for this is that maximal tumour resection has been shown to result in longer survival and allow for more effective post-operative therapies to be given. But if such radical surgery\* is expected to impair neurological function, it should be aimed just at removing as much tumour as is safely possible, sparing healthy tissues.

In addition, surgical removal of the tumour provides a sufficient amount of tissue for both an accurate histopathological diagnosis\* and molecular characterisation of the tumour.

- **Stereotactic\*/open biopsy\***

If surgery is not safely feasible, mainly due to tumour location (e.g. surgically inaccessible region or a region that carries a high risk for significant impairment of neurological function) or due to a deteriorated clinical condition, a stereotactic\* or open biopsy\* may be considered to obtain tissue for a diagnosis. A biopsy is not a treatment for the tumour but analysis of the tissue removed by biopsy will allow for planning the best treatment. A stereotactic biopsy\* is a less invasive way to obtain the tissue sample, while an open biopsy\* is surgery that uses local or general anesthesia to remove the tissue needed for the diagnosis. In experienced hands, a stereotactic biopsy\* provides sufficient tissue for a correct histopathological diagnosis\* in more than 95% of cases. However, in order to provide as much tumour tissue as possible for both diagnosis and molecular characterisation, open biopsy\*, may be preferred.

### Radiotherapy\* and/or chemotherapy\*

Post-operative treatments mainly consist of chemotherapy\* and/or radiotherapy\*. However, their use differs according to the subtype of glioma\*.



- **Low grade glioma\* (WHO grade I and grade II)**

Low grade gliomas\* comprise the histological types of astrocytoma\*, oligodendroglioma\* and oligoastrocytoma\*<sup>1</sup>.

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<sup>1</sup> Low grade ependymomas\* are also low grade gliomas\*. However, treatment of ependymomas\* differs from treatment of other gliomas\* and is therefore not covered in the current guide.

- **Radiotherapy\***

Post-operative radiotherapy\* is the standard treatment for low grade gliomas\*. It is usually administered in 28 sessions over 6 weeks. Nevertheless, not all patients who undergo resection of a low grade glioma\* should be treated with radiotherapy\*. That is because these patients may have a longer/slower natural history of disease even in the absence of post-operative treatment.

However, post-operative radiotherapy\* should always be considered in the presence of three or more of the following factors which suggest a higher likelihood of tumour recurrence\*:

- tumours greater than 5 cm in diameter,
- age > 40 years,
- absence of an oligodendroglial component at histopathological examination\*,
- tumours extending from one brain hemisphere to the other,
- presence of neurological deficits before surgery.

- **Chemotherapy\***

Temozolomide\* chemotherapy\* given orally is the preferred treatment option for patients who are not deemed eligible for surgical resection and/or radiotherapy\* because of tumour location and tumour dimension/appearance at MRI\*, respectively. Also, temozolomide\* can be used if/when disease recurs following radiotherapy\*. There is some evidence suggesting that tumours with genetic loss on chromosomes 1p/19q\* might be more sensitive to chemotherapy\* as compared to low grade gliomas\* without this alteration.



- **Anaplastic glioma\* (WHO grade III)**

Similarly to low grade gliomas\*, anaplastic gliomas\* comprise the histological types of astrocytoma\*, oligodendroglioma\* and oligoastrocytoma\*. However, they differ from low grade glioma\* because of some histological and/or radiological characteristics which suggest a more aggressive behaviour of the tumour.

- **Radiotherapy\***

Post-operative radiotherapy\* is the standard treatment for anaplastic astrocytoma\*. It is usually administered in 33 sessions over 6.5 weeks. Radiotherapy\* alone may also be considered for anaplastic oligodendroglioma\* and oligoastrocytoma\* without genetic loss on chromosomes 1p/19q\*. On the other hand, radiotherapy\* given either before or after chemotherapy\* should be considered for anaplastic oligodendroglioma\* and oligoastrocytoma\* with genetic loss on chromosomes 1p/19q\*.



- **Chemotherapy\***  
 Post-operative chemotherapy\* of the orally administered chemotherapeutic agent temozolomide\* or the three-drug chemotherapy\* regimen called PCV\* (procarbazine\*, lomustine\* and vincristine\*) should be considered as an alternative to radiotherapy\* for anaplastic gliomas\*. Between the two regimens, temozolomide\* is usually preferred because of its greater tolerability and ease of administration. Genetic loss on chromosomes 1p/19q\* identifies the anaplastic tumours with an oligodendroglial component\* which are more sensitive to chemotherapy\* with or without radiotherapy\*.
- **Glioblastoma\* (WHO grade IV)**  
 Post-operative treatment of glioblastoma\* may differ according to some of your characteristics (i.e. age, performance status\*) and histopathological/molecular features of your tumour (i.e. MGMT\* status of the tumour)
  - **Concurrent chemo-radiotherapy\***  
 The concurrent administration of chemotherapy\* during radiotherapy\* and then chemotherapy\* on its own for a period of time after radiotherapy\* is the standard post-operative treatment of patients with glioblastoma\* up to 70 years of age; it is also the preferred treatment approach for fit elderly patients older than 70 years whose tumour has tested positive for the presence of MGMT gene methylation\*.
    - Chemotherapy\* consists of the orally administered drug called temozolomide\*, which acts by interfering with the mechanism of DNA replication of cancer cells. Temozolomide\* is administered daily from the first day of radiotherapy\* and for the whole duration of it. At the end of radiation, after a short treatment break (approximately 4 weeks), temozolomide\* is resumed at a higher dosage for at least 6 cycles (six months) of therapy. Although the addition of temozolomide\* to radiotherapy\* is beneficial for most of patients with glioblastoma, it is important to know that the greatest benefit is observed in patients whose tumour is detected positive for MGMT gene methylation\* testing.
    - Radiotherapy\* is administered concurrently with temozolomide\* for 5 days a week for a total of 6 weeks, i.e. in 30 separate sessions.
  - **Radiotherapy\***  
 Elderly patients older than 70 years who are not deemed eligible for concurrent chemo-radiotherapy\* because of deteriorated performance status\* and/or because their tumour has tested negative for the presence of MGMT gene methylation\*, are adequately treated with radiotherapy\* alone using a hypo-fractionated schedule. A hypo-fractionated schedule\* consists of administering higher daily doses of radiotherapy\* over a shorter period of time. Hypo-fractionated radiotherapy\* alone is also appropriate for elderly patients in whom no information is available on the MGMT\* status.
  - **Chemotherapy\* alone**  
 Elderly patients older than 70 years who are not deemed eligible for concurrent chemo-radiotherapy\*, may be adequately treated with temozolomide\* chemotherapy\*, provided their tumour has tested positive for the presence of MGMT gene methylation\*.

## Medications to relieve symptoms of a glioma\*

The symptoms and signs mentioned in the section about diagnosis can improve or even disappear if effective therapies are used to treat glioma\* successfully (see aforementioned treatment options). However, the following medications are used in order to effectively control, at least in part, tumour symptoms:

- **Anti-epileptic drugs**

Anti-epileptic drugs are very effective medications for patients who have seizures\*. However, these drugs should not be used for the prevention of seizures\* in patients who have never experienced one. There are several types of anti-epileptic drugs. Nevertheless, only a few anti-epileptic drugs (lamotrigine\*, levetiracetam\*, pregabalin\*, or topiramate\*) offer the advantage of lack of interference with the commonly prescribed chemotherapeutic agents\*. Notwithstanding, clinical studies have demonstrated that temozolomide\* can be safely administered with any type of anti-epileptic drug.

- **Corticosteroids\***

Corticosteroids\* alleviate patients' symptoms by reducing tumour-associated inflammation (called 'oedema\*'), which usually forms around the tumour and contributes to symptoms by increasing intracranial pressure. Therefore, corticosteroids\* are indicated if oedema\* is detected at radiological tests, or if the responsible physician decides on starting corticosteroid\* treatment based on signs and symptoms of increased intracranial pressure. Unfortunately, the downside of corticosteroids\* is that their long-term use can be associated with some side effects (e.g. Cushingoid or moon face, condition in which fat accumulates to the sides of the face, giving it a rounded appearance, also increase in blood glucose levels\* which therefore should be monitored at each visit, increased risk of infection, osteoporosis, muscle weakness, impaired wound healing). For this reason, upon improvement of symptoms, the dose of corticosteroids\* should be gradually reduced in order to find the lowest effective dose or eventually be discontinued if symptoms resolve and/or oedema\* disappears as a result of effective treatment of the tumour.

- **Anticoagulation\***

Anticoagulation\* using coumadin derivatives\* (i.e. warfarin\*) is feasible in glioma\* patients experiencing thromboembolic events\*; however, low-molecular-weight heparin\* is often preferred due to a favourable safety profile.

## WHAT ARE THE POSSIBLE SIDE EFFECTS OF THE TREATMENTS?

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In this section you can find the most common side effects of surgery, radiotherapy\* and chemotherapy\*. However, the following list is not exhaustive. Therefore, you should carefully discuss with your doctor the side effects potentially related to the proposed treatment(s).

### Surgery

- **Epilepsy**

Some people will have seizures\* within the first week of surgery, but this doesn't mean that surgery has not been successful. Seizures\* after surgery can happen because of the direct stress the brain experiences during the surgical procedure. On the other hand, if seizures\* were one of the symptoms of disease presentation, after surgery they will likely improve or even disappear over time. However, it may take time to fully measure how successful your surgery has been in terms of seizure improvement.
- **Bleeding**

There is a possibility of post-operative intracranial bleeding in cases when surgical removal of a glioma\* has been carried out. This bleeding causes an increase in intracranial pressure. However, only rarely this increase in pressure either within or on the brain as well as the surrounding structures has the potential to reach alarmingly high levels, thus leading to either unconsciousness or other serious complications.
- **Neurological deficits**

If present at diagnosis, neurological deficits usually improve following surgery. However, surgical removal of tumour tissue in the brain sometimes leads to removal of healthy unaffected brain tissue as well, thus potentially causing neurological deficits. They may vary in type and severity, and can be either temporary or permanent. Symptoms gradually disappear in temporary cases within months, but where permanent damage of tissue has occurred rehabilitation may be required. In some cases, brain tissue damage can also alter personality or cause changes in mood.
- **Infections**

To gain access to the brain tumour, a piece of the skull is temporarily removed from its place, under sterile conditions. Nevertheless, bacteria may gain access to the brain during the operating procedure, and then the chances of brain infection are high. To prevent this type of infection, an intravenously\* administered antibiotic is given to the patient during the operating procedure. As a cut is made on the skin and a hole is made in the skull, there is always the possibility of an acquired skin or skull infection. A proper antibiotic regimen is started immediately in such cases to treat the infection.
- **Cerebrospinal fluid leak\* (also known as a 'CSF leak')**

Surgery of the brain can cause a leak of the cerebrospinal fluid, a fluid produced by the brain. Headache, a salty taste in the throat or a watery drainage from the nose (usually from one nostril) or from the wound site are the most common symptoms. However, a cerebrospinal fluid leak\* may also give no symptom. A cerebrospinal fluid leak\* needs to be rapidly repaired since it increases the risk of bacterial infection in the brain (meningitis\* or abscess).

## Radiotherapy\*

- **Side effects with an early onset**

Side effects usually occur during or within 6 months after completion of radiotherapy\*. They often include nausea/vomiting, headache, a worsening of the existing neurological deficits (due to radiotherapy\* induced swelling, which is called 'oedema'\*) and hair loss in the irradiated area as well as on the opposite side of the head where the radiotherapy\* beams pass through. In glioma\* patients, radiotherapy\* can also cause an increase in the risk of seizures\* as one of the brain's reactions to this treatment.

- **Side effects with a late onset**

These side effects typically occur 6 months or more from completion of radiotherapy\*. The most common ones include radio-necrosis\* (meaning death of healthy brain tissue in the previously irradiated area) which, in some instances, may lead to symptoms associated with increased pressure in the head (i.e. headache, nausea, and drowsiness), and/or neurological deficits. Late side effects may also include partial loss of short-term memory, whose occurrence strictly depends on the area of the brain which has been irradiated (i.e. temporal lobe\*).

## Chemotherapy\*

The side effects of chemotherapy\* vary in frequency and severity based on the type of agent and/or combination regimens employed. Therefore, you are encouraged to thoroughly discuss the main side effects associated with the proposed chemotherapy\* regimen with your doctor.

However, in general, common side effects of chemotherapy\* may include: loss of appetite, fatigue, hair loss, nausea and/or vomiting, increased susceptibility to infections and bleeding. Nevertheless, it is important to note that not everyone will have side effects, or experience them to the same extent. Here, you can find some specific side effects of the most commonly administered chemotherapeutic agents\* for the treatment of gliomas\*.

- **Temozolomide\***

This orally administered chemotherapeutic agent may cause a reduction in the number of platelets\* as one of its most common side effects. Platelets\* are cellular elements of the blood whose function is to help stop bleeding. As a consequence, the risk of bleeding may be increased during chemotherapy\* with temozolomide\*. This is the reason why the levels of platelets\* should be monitored and evaluated carefully at the beginning and during therapy with temozolomide\*.

Nausea and/or vomiting are other common side effects of temozolomide\*. However, they can be largely prevented with the use of anti-emetic (anti-nausea/anti-vomiting) drugs to be administered before taking temozolomide\*.

Finally, pneumonia due to opportunistic pathogens\* is a rare side effect of temozolomide. Temozolomide\* can weaken the immune system by lowering the level of lymphocytes, a subtype of white blood cells\*. This may result in a life-threatening pneumonia caused by microbes\* that only affect immuno-compromised patients.

- **Procarbazine\*, lomustine\* and vincristine\* ('PCV'\*)**

These drugs are usually administered in combination (oral administration for procarbazine\* and lomustine\*, and intravenous administration for vincristine\*).

Procarbazine\* and lomustine\* can often lead to a reduction in the number of white blood cells\*, which are elements of the blood involved in protecting the body from infections. The number of platelets\* might also decrease. This is why the blood counts should be monitored and evaluated carefully at the beginning and during therapy with procarbazine\*, lomustine\* and vincristine\*.

Vincristine\* can cause peripheral neuropathy\*, which is a progressive and often irreversible tingling, numbness and pain in the hands and feet. These side effects may have an impact on the activities of daily living and must immediately be reported to the responsible physician. It may lead to a dose reduction or interruption of vincristine\*, as the best interests of the patient are foremost in any treatment plan.

Nausea and/or vomiting are another common side effect of lomustine\*. However, they can be largely prevented with the use of anti-emetic drugs taken right before lomustine\*.

### **Should you consider clinical trials?**

The prognosis\* for patients diagnosed with gliomas\* is very different from one tumour to another. In all cases, but especially when the prognosis\* is less favourable, clinical trials\* should be considered. In many countries, clinical trials may be available for newly diagnosed patients as well as for patients who already received standard, first-line treatment and who may be dealing with a recurrence\* of their disease. As there is still unmet need for improving the effectiveness of treatments for gliomas\*, doctors and scientists are exploring new therapies. For instance, immunotherapies, new neurosurgical techniques, new methods of irradiation\*, new devices and targeted therapies have shown promise and are all being tested in clinical trials in some countries.

Promising therapies have to first be tested stringently in clinical trials before they are approved (licensed for a specific use) by regulatory bodies and then made available to patients. These clinical trials may provide an opportunity to receive a new therapy before it is generally available. On the other hand, such new therapies which are used in research studies also have some risks as, at the clinical trial stage, all of the side effects are not yet known. Because of these positive and negative aspects of clinical trials, it is very important that you thoroughly discuss the suitability of a clinical trial with your doctor.

Most of the clinical trials for gliomas\* are listed on the following websites:

- <https://www.clinicaltrials.gov/ct2/results?cond=%22Glioma%22>
- <https://www.clinicaltrialsregister.eu/ctr-search/search?query=glioma>

More information on what clinical trials are and what it takes to participate can be found on the following website: <http://www.anticancerfund.org/what-is-a-clinical-trial-0>

## WHAT HAPPENS AFTER THE TREATMENT?

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### Evaluating your response to treatment

MRI\* is the preferred imaging method for assessing treatment(s). Your first MRI\* should be carried out within 24-48 hours after surgery. It is in order to verify the true extent of tumour resection, to detect the presence of any residual disease\* and to look for any bleeding. The intervals of subsequent MRI\* assessments may vary depending on the type of glioma\*, on how it is being treated, and on the symptoms you report.

Generally speaking, the results of the MRI\* scan should always be viewed in relation to the neurological status\* of the patient and the use of corticosteroid\* therapy.

As for glioblastoma\* treated with concurrent chemo-radiotherapy\* a first MRI\* will preferably be performed 3 to 4 months after the end of radiotherapy\*, after 2 or 3 adjuvant temozolomide\* cycles. An MRI\* performed within 4-12 weeks after the end of treatment, may be difficult to interpret due to reactive changes in the tumour, and a possible false MRI\* reading of disease progression (this phenomenon is called 'pseudoprogression\*'). A repeated MRI\* after 6-8 weeks, will help evaluate this phenomenon and disclose whether there is true progression or not. It is important to discuss MRI\* findings and neurological condition\* of the patient in a multidisciplinary tumour board, to decide on continuation of the treatment.

### Follow-up with your doctors

Regular follow-up with your doctors is important in order to evaluate neurological function, seizure(s) and corticosteroid\* use. Corticosteroids\* should be tapered off as soon as possible in view of their long-term use side effects. Laboratory tests may help find out complications of symptomatic medication(s)\*, as corticosteroids\* may increase blood glucose levels\*, and anti-epileptic drugs may alter blood cell count and liver function tests. During follow-up, MRI\* should be performed every 3-4 months, unless earlier or more frequent monitoring is clinically indicated.



### Returning to normal life

Returning to normal life can be difficult for glioma\* patients, as different degrees of neurological impairment may be present. Patients become increasingly less independent as a result of direct injury of brain structures responsible for motor, sensory, cognitive, and speech functions. Also, the indirect effects of radiotherapy\* and chemotherapy\* may add to the functional deficit which patients experience. For these reasons, rehabilitation is of crucial importance for glioma\* patients, and emphasis should be placed on restoring or maximising independence with activities of daily living, mobility, cognition\* and communication.

However, though rehabilitation interventions can be applied in all stages of the disease, its goals change as the stage of illness advances. When tumour progression causes a decline in functional skills, rehabilitation assumes a supportive role, with goals adjusted to accommodate persistent physical and functional limitations. During advanced stages of illness, palliative rehabilitation can improve and maintain comfort and quality of life.

## Psychological, social and peer support

Psychological stress and the social effects of the disease on patients and their families and caregivers should not be underestimated. Psychiatric difficulties should be recognised and treated with both psychotherapy and pharmacotherapy. Recognition of the social effects of having a brain tumour and adequate counselling in such circumstances are vital aspects of care for patients and their caregivers. A dedicated nurse in a neuro-oncology centre can be responsible for guiding and supporting the patient as well as the caregiver during the disease journey. Referral to other health care professionals such as psychologists, social workers, physiotherapists and speech pathologists\* may help the patient and caregiver alleviate the experienced burden and meet their needs.

Patient advocacy groups\* can help you get in touch with other patients who have brain tumours, assist you in learning more about your disease, provide helpful information, find an experienced doctor for a second opinion, identify clinical centers of expertise that run clinical trials\* and provide other services to help you and your family deal with the diagnosis of a brain tumour so you do not feel alone. To see whether a brain tumour patient organisation exists in your country, you can visit the website of the International Brain Tumour Alliance at <http://theibta.org/brain-tumour-support-advocacy-and-information-organisations/>



Credit: Brain Tumour Support, United Kingdom

## What if my glioma comes back?

The treatment at disease recurrence\* differs according to the type of initial histopathological diagnosis\* and clinical scenario, type and number of previous therapies. Treatment options include:

- Chemotherapy\* in patients with good performance status\* who have not received prior adjuvant chemotherapy\*,
- second surgery (in particular if a period of time has elapsed since first surgical resection, or when recurrent tumour causes symptoms due to its mass effects),
- (re)-irradiation\* (in case of smaller tumours).

For patients progressing after prior chemotherapy\*, there is, as yet, no specific protocol established for a second chemotherapy\* regimen or targeted agents\* and therefore, patients should be encouraged to participate in clinical trials\*, if they are available (see paragraph “*Should you consider clinical trials?*” in the section “*What are the treatment options?*”). Chemotherapy\* with a PCV regimen\* or a single agent nitrosourea\* may achieve similar tumour control rates compared with temozolomide\*.

However, it should be noted that there is no agreed standard therapy when disease recurs, and clinical decision making should ideally be based on recommendations from a multidisciplinary tumour board who will review your case.

## **Supportive and palliative care**

Medications to relieve symptoms experienced by patients with glioma\* are a very important part of care as already explained. However, during and after the course of active anticancer treatment, some side effects can occur and adequate supportive measures should be applied (such as anti-emetic therapy, corticosteroids\*, antibiotic therapy, blood transfusion, etc. depending on the type and severity of underlying side effects). This is known as supportive and palliative care. It is important for patients and carers to remember that the term 'palliative care' does not only apply to end-of-life care but it applies to relieving symptoms at any stage of disease, including when you are newly diagnosed. So you should not be frightened when you hear the words 'palliative care'.

In summary, and importantly, being informed about the available therapies for a brain tumour will help you to be more actively involved in the decisions regarding your treatment. Not only that, but it can also open up the possibility of more in-depth discussions with your medical team as many questions may arise.

Do not hesitate to ask questions and to give your opinion. You, as the patient, are the primary concern and everybody is there to help you.

## DEFINITIONS OF DIFFICULT WORDS

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### **Adenoma**

Benign tumour of glandular origin. Over time this benign growth may become malignant, and even while benign it can have health consequences by compressing other structures or by producing large amounts of hormones.

### **Alkalyting agent**

A type of drug that is used in the treatment of cancer. It interferes with DNA and inhibits cell growth.

### **Anaplastic glioma**

Brain tumour characterised by cells that divide rapidly and have little or no resemblance to normal cell.

### **Anaplastic oligodendroglial tumours**

Type of brain tumour or glioma characterised by cells that divide rapidly and have little or no resemblance to normal cells.

### **Anticoagulation**

Prevention of blood clotting by means of anticoagulant drugs. Anticoagulant drugs are also called blood thinners.

### **Astrocyte**

A large, star-shaped cell that holds nerve cells in place and helps them develop and work the way they should. An astrocyte is a type of glial cells.

### **Astrocytoma**

A tumour that begins in the brain or spinal cord\* in small, star-shaped cells called astrocytes\*.

### **Blood glucose levels**

Glucose (a type of sugar) found in the blood. Also called glycaemia.

### **Brain stem**

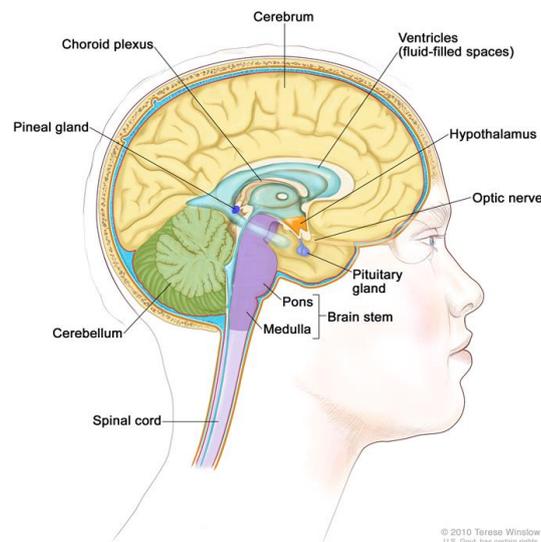
The part of the brain that is connected to the spinal cord\*.

### **Cerebellum**

The portion of the brain in the back of the head between the cerebrum\* and the brain stem\*. The cerebellum controls balance for walking and standing, and other complex motor functions. (See picture in page 24).

### **Cerebrospinal fluid leak**

Escape of the fluid that surrounds and bathes the spinal cord\* and brain. The main function of this fluid is to protect the brain and the spinal cord\*.



Anatomy of the inside of the brain, showing the pineal and pituitary glands\*, optic nerve, ventricles (with cerebrospinal fluid shown in blue), and other parts of the brain.

### **Cerebrum**

The largest part of the brain. It is divided into two hemispheres, or halves, called the cerebral hemispheres. Areas within the cerebrum control muscle functions and also control speech, thought, emotions, reading, writing, and learning (See picture in page 24).

### **Chemo-radiotherapy**

Treatment that combines chemotherapy\* with radiotherapy\*. Also called chemoradiation.

### **Chemotherapy/Chemotherapeutic agents**

A type of cancer treatment using drugs that kill cancer cells and/or limit their growth. These drugs are usually administered to the patient by slow infusion into a vein but can also be administered orally via a tablet or capsule.

### **Clinical examination**

The examination of the body to search for signs of disease.

### **Cognition**

The scientific term for the process of thought.

### **Corticosteroid (therapy)**

Corticosteroids are steroid hormones made in the outer part of the adrenal glands. They can also be synthetically produced in the laboratory, as they are used for therapeutic purposes. They may be used as hormone replacement, to suppress the immune system, and to treat some side effects of cancer and its treatment. Corticosteroids are also used to treat certain lymphomas and lymphoid leukaemias. In brain tumours they are used to relieve the brain's swelling (oedema\*) caused by the presence of the tumour.

### **Coumadin derivatives**

Coumadin, also called warfarin\*, is a drug that prevents blood from clotting. It belongs to the family of drugs called anticoagulants.

### **Cowden syndrome**

An inherited disorder marked by the formation of many noncancerous growths called hamartomas. These growths occur in the skin, breast, thyroid, colon, intestines, and inside of the mouth. Patients with Cowden syndrome are at increased risk of certain types of cancer, including breast and thyroid. Also called Cowden disease and multiple hamartoma syndrome.

### **CT-scan**

A form of radiography in which body organs are scanned with X-rays and the results are synthesized by a computer to generate images of parts of the body.

### **Ependymoma**

A type of brain tumour that begins in cells lining the spinal cord\* central canal (fluid-filled space down the centre) or the ventricles (fluid-filled spaces of the brain). Ependymomas may also form in the choroid plexus (tissue in the ventricles that makes cerebrospinal fluid). Also called ependymal tumour.

### **Frontal lobe**

Part of the brain located in the frontal upper part of the brain. It is responsible for mental processes such as thinking, decision making, and planning. The frontal lobe also plays an important part in retaining longer term memories which are not task-based.

### **Genetic loss on chromosome 1p/19q**

Genetic mutation that is associated with a type of brain tumour called oligodendroglioma\*. This mutation is used as a predictor of response to chemotherapy\* and survival.

### **Glioblastoma**

A fast-growing type of central nervous system tumour that forms from glial (supportive) tissue of the brain and spinal cord\* and has cells that look very different from normal cells. Glioblastoma usually occurs in adults and affects the brain more often than the spinal cord\*. Also called grade IV astrocytoma\*.

### **Glioma**

A cancer of the brain that begins in glial cells (cells that surround and support nerve cells)

### **High grade glioma**

They are tumours that originate in the brain. As opposed to low grade tumours high grade gliomas grow fast and have the tendency to infiltrate adjacent structures and cause symptoms. They often grow back after removal.

### **Histopathological diagnosis**

Analysis in laboratory of a tissue specimen with the purpose of finding signs of disease.

### **Histopathological (examination)**

The study of diseased cells and tissues using a microscope and other tools and methods.

### **Hypo-fractioned (schedule) radiotherapy**

Radiation treatment in which the total dose of radiation is divided into large doses and treatments are given once a day or less often. Hypofractionated radiotherapy is given over a shorter period of time (fewer days or weeks) than standard radiotherapy\*.

### **IDH gene 1 or 2/Mutation of the IDH gene 1 or 2**

Genes that are mutated in the majority of low grade gliomas\* and some secondary high risk gliomas\*. In healthy cells they produce enzymes that are important for our bodies' normal functioning, however when the genes are mutated the function of the enzymes they produce changes, ultimately producing substances that create the milieu for cancer initiation. Nevertheless the role of these mutations in cancer needs further investigation.

### **Infiltrative pattern**

The growth pattern that some cancerous tissues have, when they invade nearby organs.

### **Infiltrative tumours/infiltrating cancer**

Cancer that has spread beyond the layer of tissue in which it developed and is growing into surrounding, healthy tissues. Also called invasive cancer.

### **Intermediate prognosis**

The potential outcome of the disease is not considered good or bad, it is placed in between.

### **Intravenously**

Into or within a vein. Intravenous usually refers to a way of giving a drug or other substance through a needle or tube inserted into a vein. Also called IV.

### **Ionising radiation**

A type of radiation made (or given off) by X-ray procedures, radioactive substances, rays that enter the Earth's atmosphere from outer space, and other sources. At high doses, ionizing radiation increases chemical activity inside cells and can lead to health risks, including cancer.

### **Irradiation**

The use of high-energy radiation from X-rays, gamma rays, neutrons, protons, and other sources to kill cancer cells and shrink tumours. Radiation may come from a machine outside the body (external-beam radiotherapy\*), or it may come from radioactive material placed in the body near cancer cells (internal radiotherapy\*). Systemic irradiation uses a radioactive substance, such as a radiolabelled monoclonal antibody, that travels in the blood to tissues throughout the body. Also called radiation therapy and radiotherapy\*.

### **Lamotrigine**

A drug that is used to treat partial seizures\* in the case of epilepsy and also to treat bipolar disorder as a mood stabilizer. It is being studied in the prevention of peripheral neuropathy\* caused by some chemotherapy\* drugs. It belongs to the family of drugs called anticonvulsants.

### **Levetiracetam**

A drug used to treat seizures\* (involuntary muscle movements) caused by epilepsy (a group of brain disorders). Levetiracetam is being studied in the treatment of seizures\* in patients with cancer that has spread to the brain. It is a type of anticonvulsant.

### **Li-Fraumeni syndrome**

A rare, inherited predisposition to multiple cancers, caused by an alteration in the p53 tumour suppressor gene.

### **Lomustine**

A drug used to treat brain tumours that have already been treated with surgery or radiotherapy\*. It is also used to treat Hodgkin lymphoma that has not gotten better with other types of treatment or has come back. It is being studied in the treatment of other types of cancer. Lomustine damages the cell's DNA and may kill cancer cells. It is a type of alkylating agent\*.

### **Low-molecular-weight heparin**

A class of anticoagulant medication. Its particular molecular structure makes its effects more predictable than naturally occurring heparin.

### **Lynch syndrome**

An inherited disorder in which affected individuals have a higher-than-normal chance of developing colorectal cancer and certain other types of cancer, e.g. endometrial cancer, gastric cancer, ovarian cancer, pancreatic cancer, bladder cancer, kidney cancer, or brain tumour amongst others. Also called hereditary nonpolyposis colon cancer and HNPCC.

### **Magnetic Resonance Imaging (MRI)**

An imaging technique that is used in medicine. It uses magnetic resonance. Sometimes, a fluid is injected that enhances the contrast between different tissues to make structures more clearly visible.

### **Malignancies/malignant glioma**

Malignant is used to describe a severe and progressively worsening disease. A malignant tumour grows fast invading surrounding tissues and spreading to other parts of the body. A malignant tumour is a synonym for cancer.

### **Medulloblastoma**

A malignant brain tumour that begins in the lower part of the brain and that can spread to the spine or to other parts of the body. They are the most common type of malignant brain tumours in children. Medulloblastomas are a type of primitive neuroectodermal tumour (PNET).

### **Meninges**

The three thin layers of tissue that cover and protect the brain and spinal cord\*.

### **Meningioma(s)**

A type of slow-growing tumour that forms in the meninges (thin layers of tissue that cover and protect the brain and spinal cord\*). Meningiomas usually occur in adults.

### **Meningitis**

Inflammation of the meninges\* (three thin layers of tissue that cover and protect the brain and spinal cord\*). Meningitis is usually caused by a bacterial or viral infection, but sometimes is caused by cancer, drug allergies, or inflammatory diseases.

### **Metastasis**

The spread of cancer from one part of the body to another. A tumour formed by cells that have spread is called a metastatic tumour or a metastasis. The metastatic tumour contains cells that are like those in the original tumour.

### **MGMT gene methylation**

Methylation is a chemical reaction by which a gene called MGMT is inactivated. When this gene is active it helps cells to repair DNA damage, but when it is inactive cells are not capable of repairing their DNA.

### **Molecular characteristics**

In glioma\*, it refers to the presence of MGMT gene methylation\*.

### **Molecular markers**

A biological molecule found in blood, other body fluids, or tissues that is a sign of a normal or abnormal process, or of a condition or disease. A molecular marker may be used to see how well the body responds to a treatment for a disease or condition. Also called biomarker and signature molecule.

### **Neurofibromatosis type I**

A rare genetic condition that causes brown spots and tumours on the skin, freckling in skin areas not exposed to the sun, tumours on the nerves, and developmental changes in the nervous system, muscles, bone, and skin. Also called NF1.

### **Neurological examination**

A series of questions and tests to check brain, spinal cord\*, and nerve function. The exam checks a person's mental status, coordination, ability to walk, and how well the muscles, sensory systems, and deep tendon reflexes work.

### **Neurological status/condition**

The extent to which the nervous system reacts to external stimuli. A systematic examination during the physical examination allows doctors to have information on the functioning of the nerves.

### **Neuropathologist**

A pathologist who specializes in diseases of the nervous system. A pathologist\* identifies disease by studying cells and tissues under a microscope.

### **Nitrosourea**

An anticancer drug that can cross the blood-brain barrier. Carmustine and lomustine\* are nitrosoureas.

### **Occipital lobe**

The smallest of four paired lobes in the human cerebral cortex. It is located in the rearmost portion of the skull and its functions are related to sight, as it contains the visual processing center.

### **Oedema**

An abnormal collection of fluid beneath the skin or in a body cavity which causes swelling. Oedema in the brain causes symptoms such as nausea, vomiting, blurred vision, faintness; and sometimes seizures\* and coma.

### **Oligoastrocytoma**

A brain tumour that forms from both oligodendrocytes\* and astrocytes\*, which are types of glial cells (cells that cover and protect nerve cells in the brain and spinal cord\* and help them work the way they should). An oligoastrocytoma is a type of mixed glioma\*.

### **Oligodendrocytes/Oligodendroglioma**

A rare, slow-growing tumour that begins in oligodendrocytes (cells that cover and protect nerve cells in the brain and spinal cord\*). Also called oligodendroglial tumour.

### **Open biopsy**

A procedure in which a surgical incision (cut) is made through the skin to expose and remove tissues. The biopsy tissue is examined under a microscope by a pathologist\*. An open biopsy may be done in the doctor's office or in the hospital, and may use local anaesthesia or general anaesthesia. In the case of brain tumour, it is an actual surgery, so general anaesthesia is required.

### **Pathogens**

A microorganism, such as virus or bacteria, that causes disease.

### **Pathologist**

A doctor specialized in histopathology which is the study of diseased cells and tissues using a microscope.

### **PCV regimen**

An abbreviation for a chemotherapy\* combination used to treat certain types of brain tumours. It is often used with radiotherapy\*. It includes the drugs procarbazine hydrochloride\*, lomustine\* (CCNU), and vincristine sulfate\*.

### **Performance status**

The performance status evaluates the patient's physical abilities by giving a score from 0, for a fully active patient, to 4 for a patient who is completely disabled due to his/her disease.

### **Peripheral neuropathy**

A nerve problem that causes pain, numbness, tingling, swelling, or muscle weakness in different parts of the body. It usually begins in the hands or feet and gets worse over time. Peripheral neuropathy may be caused by physical injury, infection, toxic substances, disease (such as cancer, diabetes, kidney failure, or malnutrition), or drugs, including anticancer drugs. Also called neuropathy.

### **Pituitary gland**

The main endocrine gland in the brain. It produces hormones that control other glands and many other functions including growth. (See picture in page 23)

### **Platelets**

Small cell fragments that play a fundamental role in the formation of blood clots. Patients with a low platelet count are at risk of severe bleeding. Patients with a high count are at risk of thrombosis, the formation of blood clots that can block blood vessels and result in stroke or other severe conditions, and can also be at risk of severe bleeding because of platelet dysfunction.

### **Pregabalin**

A drug used to treat nerve pain caused by diabetes or herpes zoster infection and certain types of seizures\*. It is being studied in the prevention and treatment of nerve pain in the hands and feet of cancer patients given chemotherapy\*. Pregabalin is a type of anticonvulsant.

### **Procarbazine**

The active ingredient in a drug that is used to treat advanced Hodgkin *lymphoma* and is being used and studied in the treatment of other types of cancer. Procarbazine blocks cells from making proteins and damages DNA. It may kill cancer cells. It is a type of antineoplastic agent and a type of alkylating agent\*.

### **Prognosis**

The likely outcome or course of a disease; the chance of recovery or recurrence\*.

### **Pseudoprogression**

As a reaction to chemoradiotherapy\* a brain tumour might look bigger than previous to the treatment in imaging tests. This could happen if the imaging is taken just some weeks after the treatment is finished. It might not be progression but a reaction of tumoural tissues to damage caused by the treatment. That is why it is necessary to repeat initial imaging some more weeks later to confirm whether a tumour is actually progressing or that the apparent progression was just tissue reaction to damage but the tumour might actually be regressing.

### **Radical resection/surgery**

Surgery that is extensive and aims to remove as much tumour tissue as possible, as well as surrounding tissue.

### **Radiological diagnosis**

Visualization of a tumour or lesion in imaging tests.

### **Radiological examination**

Test that uses imaging technology (such as radiography, ultrasound, computed tomography and nuclear medicine) to visualize organs, structures and tissues within the body to both diagnose and treat diseases.

### **Radiotherapy**

A therapy in which radiation (high-energy X-rays) is used in the treatment of cancer that is always oriented to the specific location of the cancer. Radiotherapy can be administered internally or externally. When it is internal, a source of radiation (radioactive material) is inserted inside the body cavity or near the tumour, the radioactive energy of that source at some point will decrease; when radiotherapy is administered externally a machine generates the radioactive energy that is targeted to the tumour in the form of beams.

### **Recurrence**

Cancer or disease that has come back, usually after a period of time during which the cancer or disease was not present or could not be detected. Also called recurrent cancer or disease.

### **Red blood cell**

The most common type of blood cell. It is the substance that makes the blood appear red. Their main function is the transport of oxygen.

### **Residual disease**

Cancer cells that remain after attempts to remove the cancer have been made.

### **Seizures**

Sudden, uncontrolled body movements and changes in behaviour that occur because of abnormal electrical activity in the brain. Symptoms include loss of awareness, changes in emotion, loss of muscle control, and shaking. Seizures may be caused by drugs, high fevers, head injuries, certain diseases, such as epilepsy and brain tumours.

### **Spinal cord**

A column of nerve tissue that runs from the base of the skull down the centre of the back. It is covered by three thin layers of protective tissue called membranes. The spinal cord and membranes are surrounded by the vertebrae (back bones). The spinal cord and the brain make up the central nervous system (CNS). Spinal cord nerves carry messages between the brain and the rest of the body.

### **Stereotactic biopsy/procedures**

A biopsy procedure that uses a computer and a 3-dimensional scanning device to find a tumour site and guide the removal of tissue for examination under a microscope.

### **Symptomatic medication(s)**

Drugs that are used to treat symptoms and signs of a disease without fighting the cause in itself.

### **Targeted agents/therapy**

A type of treatment that uses drugs or other substances to identify and attack specific types of cancer cells with less harm to normal cells. Some targeted therapies block the action of certain enzymes, proteins, or other molecules involved in the growth and spread of cancer cells. Other types of targeted therapies help the immune system kill cancer cells or deliver toxic substances directly to cancer cells and kill them. Targeted therapy may have fewer side effects than other types of cancer treatment. Most targeted therapies are either small molecule drugs or monoclonal antibodies.

### **Temozolomide**

Temozolomide belongs to a group of anticancer medicines called alkylating agents\*. In the body, temozolomide is converted to another compound called MTIC. MTIC binds to the DNA of cells while they are reproducing, which stops cell division. As a result, the cancer cells cannot divide, slowing down the growth of tumours.

### **Temporal lobe**

Each of two lobes of the brain, localised at the bottom middle part of cortex, right behind the temples. The temporal lobe is involved in processing sensory input into derived meanings for the appropriate retention of visual memories, language comprehension, and emotion association.

### **Thromboembolic (events)**

Formation of blood clot(s) in blood vessels, which detach and are carried away by the blood stream to plug another vessel. It could be a vessel in the lungs, brain, gastrointestinal tract, kidneys, or extremities.

### **Topiramate**

Drug that is used to treat seizures and migraines.

### **Turcot syndrome**

Condition in which cells in the colon become abnormal and form masses called polyps. It is also characterised by nervous system tumours.

### **Vincristine**

The active ingredient in a drug used to treat acute leukaemia. It is used in combination with other drugs to treat Hodgkin disease, non-Hodgkin lymphoma, rhabdomyosarcoma, neuroblastoma, and Wilms tumour. Vincristine is also used and studied in the treatment of other types of cancer. It blocks cell growth by stopping cell division. It is a type of vinca alkaloid and a type of antimitotic agent.

### **Warfarin**

A drug that prevents blood from clotting. It belongs to the family of drugs called anticoagulants.

### **White blood cells**

Cells of the immune system that are involved in the body's defence against infections.

The ESMO / Anticancer Fund Guides for Patients are designed to assist patients, their relatives and caregivers to understand the nature of different types of cancer and evaluate the best available treatment choices. The medical information described in the Guides for Patients is based on the ESMO Clinical Practice Guidelines, which are designed to guide medical oncologists in the diagnosis, follow-up and treatment in different cancer types. These guides are produced by the Anticancer Fund in close collaboration with the ESMO Guidelines Working Group and the ESMO Cancer Patient Working Group.

For more information please visit [www.esmo.org](http://www.esmo.org) and [www.anticancerfund.org](http://www.anticancerfund.org)

