SANUS.2022;7:e246
DOI: https://doi.org/10.36789/revsanus.vi1.246
www.sanus.unison.mx

RESEARCH

# Epidemiological overview of brain neoplasms with surgical treatment in a third level hospital

# Panorama epidemiológico de las neoplasias encefálicas con tratamiento quirúrgico en un hospital de tercer nivel en Guanajuato, México

# Panorama epidemiológico das neoplasias cerebrais com tratamento cirúrgico em um hospital de terceiro nível

Carlos Francisco Meza-García[1*]
https://orcid.org/0000-0002-1549-7190

Luxana Reynaga-Ornelas[2]
https://orcid.org/0000-0002-1206-199X

Rosa María Rodríguez-Medina[3]
https://orcid.org/0000-0003-4216-7987

Adriana Dávalos-Pérez[4]
https://orcid.org/0000-0002-8048-2446

Sara Patricia Pérez-Reyes[5]
https://orcid.org/0000-0002-6649-0327

1. PhD student in Nursing Sciences, Health Sciences and Engineering Division, Celaya Salvatierra Campus, Universidad de Guanajuato.
2. Departament of Nursing and Obstetrics, Health Sciences Division, Universidad de Guanajuato, León, Guanajuato Campus, Mexico.
3. Departament of Nursing and Obstetrics, Health Sciences Division, Universidad de Guanajuato, León, Guanajuato Campus, Mexico.
4. Departament of Nursing and Obstetrics, Health Sciences Division, Universidad de Guanajuato, León, Guanajuato Campus, Mexico.
5. Medical Subdirection, Hospital Regional de Alta Especialidad del Bajío, Mexico.

* Correspondence author: cf.meza@ugto.mx

**Received:** 17/11/2020
**Accepted:** 16/01/2022

ISSN: 2448-6094
Universidad de Sonora

## Abstract

**Introduction:** The overall incidence rate of primary tumors of the central nervous system is 10.8 per 100,000 people per year. **Objective:** To describe the epidemiological picture of patients with encephalic neoplasms who underwent surgery in the year 2017 to July 2018 in a tertiary care level hospital. **Methodology:** Descriptive, observational, cross-sectional and retrolective study. As inclusion criteria, the clinical records of the files of people over 18 years of age with a diagnosis of EN who received neurosurgical treatment during the aforementioned period were used. The elimination criteria were clinical records related to spinal surgery and duplicate records. The study adhered to the Code of Ethics of the World Medical Association and the Declaration of Helsinki. It was approved by the institution's ethics and research ethics committees. **Results:** The average age found in the records was 49.315 years, 89.8% of encephalic neoplasms were of primary origin in people aged 48.715.9 years. The most frequent with 42% were gliomas and 29.5% were meningiomas. Most of them were located in the brain with 39%. The most frequent surgical procedure performed was supratentorial craniotomy in 69.3%, the most common tumor was encephalic in 38.6% and almost 70% were malignant tumors. **Conclusion:** the epidemiological overview is the first step for the integration of proposals for nursing clinical practice guidelines and care plans, mainly at in-hospital and out-of-hospital discharge.


**Key words:** Brain neoplasms; Neurosurgery; Epidemiology; Nursing (DeCS).


## Resumen

**Introducción**: La tasa de incidencia global de los tumores primarios del sistema nervioso central es de 10.8 por cada 100,000 personas al año. Objetivo: Describir el panorama epidemiológico de pacientes con neoplasias encefálicas que fueron sometidos a cirugía en el año 2017 a julio 2018 en un hospital de tercer nivel. **Metodología**: Estudio descriptivo, observacional, transversal y retrolectivo. Como criterios de inclusión fueron los registros clínicos de los expedientes de las personas mayores de 18 años con diagnóstico de NE que recibieron tratamiento neuroquirúrgico durante el periodo mencionado. Los criterios de eliminación fueron registros clínicos relacionados con cirugía de columna y registros duplicados. El estudio se apegó al Código de Ética de la Asociación Médica Mundial y la Declaración de Helsinki. Fue aprobado por los comités de ética y de ética en la investigación de la institución**. Resultados**: La edad promedio encontrada en los registros fue 49.3▪ 15 años, un 89.8% de incidencias neoplasias encefálicas fueron de origen primario en personas de 48.7▪ 15.9 años. Los más frecuentes con 42% los gliomas y 29.5% los meningiomas. La mayoría se localizaron en el encéfalo con 39%. El procedimiento quirúrgico realizado con mayor frecuencia fue la craneotomía supratentorial en 69.3%, el tumor más común fue el encefálico en 38.6% y casi un 70% fueron tumores malignos. **Conclusión**: el panorama epidemiológico es el primer paso para la integración de propuestas de guías de práctica clínica de enfermería y planes de cuidado principalmente al alta intra y extrahospitalaria.


**Palabras clave:** Neoplasias encefálicas; Neurocirugía; Epidemiología; Enfermería (DeCS).

**Abstrato**

**Introdução:** A taxa de incidência global de tumores primários do sistema nervoso central é de 10,8 por 100.000 pessoas por ano. **Objetivo:** Descrever o quadro epidemiológico dos pacientes com neoplasias encefálicas submetidos à cirurgia no ano de 2017 a julho de 2018 em um hospital de nível terciário. **Metodologia:** Estudo descritivo, observacional, transversal e retroletivo. Como critérios de inclusão foram utilizados os prontuários dos prontuários de pessoas maiores de 18 anos com diagnóstico de NE que receberam tratamento neurocirúrgico no período supracitado. Os critérios de eliminação foram registros clínicos relacionados à cirurgia de coluna e registros duplicados. O estudo aderiu ao Código de Ética da Associação Médica Mundial e à Declaração de Helsinque. Foi aprovado pelos comitês de ética e ética em pesquisa da instituição. **Resultados:** A média de idade encontrada nos prontuários foi de 49.315 anos, 89,8% das neoplasias encefálicas foram de origem primária em pessoas com idade de 48.715,9 anos. Os mais frequentes com 42% foram gliomas e 29,5% foram meningiomas. A maioria deles estava localizada no cérebro com 39%. O procedimento cirúrgico mais realizado foi a craniotomia supratentorial em 69,3%, o tumor mais comum foi o encefálico em 38,6% e quase 70% eram tumores malignos. Conclusão: o panorama epidemiológico é o primeiro passo para a integração das propostas de diretrizes da prática clínica de enfermagem e planos de cuidados, principalmente na alta hospitalar e extra-hospitalar.

**Palavras-chave:** Neoplasias cerebrais; Neurocirurgia; Epidemiologia; Engermagem (DeCS).

## Introduction

Encephalic neoplasms (EN) are neurological disorders considered within the group of diseases of the central and peripheral nervous system [(1)]. Hundreds of millions of people worldwide suffer from neurological disorders. Among them, ENs are one of the main causes of death, both primary lesions originating in the cells of the central nervous system (CNS) and secondary lesions originating in other tissues and subsequently reaching the brain (secondary tumors) [(2-3)].

The World Health Organization (WHO) classifies ENs into four groups, which allows establishing a prognosis in terms of mortality according to the grade. Grade I tumors have low proliferative potential, and have the possibility of cure when surgically resected. Grade II tumors are infiltrative tumors with low proliferative activity. Grade III tumors are lesions with histological evidence of malignancy, predisposition to necrosis, with rapid and fatal evolution. Therefore, grade III and IV tumors are taken as high grade or malignant. In some cases gliomas tend to develop to grade III and IV [(3-4)]. The WHO classifies tumors according to their origin as astrocytic, oligodendroglial, ependymal, neuronal, pineal, embryonal, cranial nerve and

meningeal[3]. ENs are usually differentiated and relatively benign lesions, e.g., hemangiomas. However, they can also present as invasive and differentiated lesions, e.g., glioblastoma multiforme. Overall, ENs account for 2% of neoplasms [4-5].

Although the data are heterogeneous, in general an overall incidence rate of primary CNS tumors of 23.0 cases per 100,000 population is reported [5], and other authors report 10.8 per 100,000 persons per year [6]. As for malignant brain tumors, an age-adjusted incidence of 4.3 cases per 100,000 persons was reported; although it varies by region, from 6.8 in Europe, 5.3 in Latin America and up to 2.8 in Africa [7]. Survival of patients with CNS tumors is more than 10 years, in 14% of the cases of people with CNS tumors in developed countries, 1% being preventable [8]. More recent studies indicate that neoplasms occupy the 20th place in incidence and mortality globally, with a total of 308,102 new cases and 251,329 deaths in 2020 [9]. In the United States, secondary neoplasms have an incidence of 10 per 10,000 inhabitants [10].

Additionally, 79,718 deaths attributable to primary brain and CNS neoplasms have been registered from 2012 to 2016, which represents an average annual mortality rate of 4.4%. The incidence of both benign and malignant EN and CNS is 23.4 per 100,000 population, being higher in women, white race, and non-Hispanics [11]. Another study reports that adjusting for age, this incidence is 22.6 between 2010 and 2014 and prevalence of 47.6 per 100,000 population [12]. Meningiomas are the most common primary brain tumors (36.4%) followed by gliomas (27%) [11]. Among malignant tumors, glioblastoma is the tumor with the highest incidence (14.6%) and among benign tumors, meningioma (37.6%). Glioblastoma is more common in men and meningioma is more common in women. The relative survival rate 5 years after diagnosis of a malignant brain and CNS tumor is 35.8% and 91.5% for benign brain and CNS tumors [12].

In Mexico, a study was published in which the records of CNS neoplasms treated at the National Institute of Neurology and Neurosurgery from 1965 to 2014 were analyzed. Neuroepithelial neoplasms had the highest frequency (33%) and of these, the main ones were astrocytic (67%), meningeal (26%), and pituitary (20%), presenting between the third and fourth decade of age. Meningeal neoplasms had a frequency of 26% and

pituitary neoplasms 20% in ages around the second decade. In terms of sex, meningeal neoplasms predominated in women and neuroepithelial neoplasms in men [13]. In another study, it was reported that from 1993 to 2013 at the Manuel Velasco Suarez National Hospital of Neurology and Neurosurgery, the prevalence of CNS tumors and histopathology was 511 patients with EN, with the highest prevalence being meningeal (n=171) and neuroepithelial (n=121) [14]. Likewise, according to the National Institute of Statistics and Geography (INEGI), of the total of the main tumors in the population aged 18 to 29 years in 2011 to 2017, morbidity due to malignant brain and CNS tumors represented 0.5 per 100,000 inhabitants [15].

For nursing professionals involved in the care of people with EN who undergo surgery in a high-specialty hospital, it is important to know the epidemiological panorama, which lays the foundation for the development of comprehensive in-hospital and out-of-hospital post-surgical care programs and plans. Therefore, our objective is to describe the epidemiological picture of patients with EN who underwent surgery from January 2017 to July 2018 in a tertiary care hospital.

## Methodology

Descriptive observational, cross-sectional and retrolective study. The clinical records of the files of people over 18 years of age with a diagnosis of EN who received neurosurgical treatment in a high specialty hospital during the period from January 2017 to July 2018 were included. A total of 152 cases were registered, eliminating 64 corresponding to spinal surgeries and duplicate records, leaving a sample of 88, sociodemographic variables such as age, sex, marital status, schooling, occupational status, place of residence were collected. The clinical variables were tumor origin, tumor type (primary/secondary), tumor location, type of surgical procedure, complications of surgical treatment, other treatments, chronic diseases and follow-up. Descriptive statistical treatment was carried out for quantitative variables such as mean and standard deviation, and for qualitative variables, frequencies and percentages. The statistical software IBM Statistical Package for Social Sciences (SPSS) version 21 was used, creating a database for the statistical tabulation, presentation and data analysis.

Regarding the protection of humans and animals, this study adheres to the World Medical Association Code of Ethics for the Protection of Human Subjects and the Declaration of Helsinki [27]. The protocol was approved by the research ethics committee and the research committee by the institution (IRB/30/18 and CI/HRAEB/047/2018). Regarding confidentiality, it is stated that the protocols for data protection were followed. Likewise, the authors declare that no personal data of patients appear in this article. According to the Regulations of the General Health Law on Health Research of the United Mexican States [16] article 17, it is considered a category 1 research, with no risk or probability that the subject will suffer any harm as an immediate or delayed consequence of the study, since it is a documentary research.

## Results

The sociodemographic data presented an age range between 18 and 82 years (49,315), with a predominance of female sex (52.3%), marital status married (65.9%), level of basic education (63.6%), residents mostly in the State of Guanajuato in Mexico (70.5%), (Table 1).

The prevalence of chronic diseases were arterial hypertension with 18.2%, type II diabetes 7.9%, and presence of both with 7.9%. The clinical variables related to the type of EN showed that most were malignant (70.5%). EN of primary origin had a higher incidence (89.8%) and occurred in younger age (48.7±15.9) as opposed to EN of secondary origin (54.9±9.3). Primary tumors, gliomas occurred most frequently (42%), followed by meningiomas (29.5%). Most of them were located in the brain (39%), (Table 2).

Table 1. Sociodemographic variables of people with a diagnosis of EN who received neurosurgical treatment in a high specialty hospital during the period from January 2017 to July 2018(n=88)

| Variable | f | % |
|---|---|---|
| Sex | | |
| Female | 46 | 52.3 |
| Male | 42 | 47.7 |
| Marital Status | | |
| Married | 58 | 65.9 |
| Single | 19 | 21.6 |
| Widower | 5 | 5.7 |
| Common marriage | 4 | 4.5 |
| Divorced | 2 | 2.3 |
| Schooling | | |
| Elementary School | 39 | 44.3 |
| Middle school | 17 | 19.3 |
| High School | 11 | 12.5 |
| Uneducated | 10 | 11.4 |
| University | 5 | 5.7 |
| Other | 6 | 6.8 |
| Place of residence | | |
| Guanajuato | 52 | 59.1 |
| León | 10 | 11.4 |
| Other state | 26 | 29.5 |
| Occupation | | |
| Housewife | 39 | 44.3 |
| Employee | 12 | 13.6 |
| Student | 1 | 1.1 |
| Other | 36 | 40.9 |

Source: Own Development

Table 2. Clinical variables of persons with a diagnosis of EN who received neurosurgical treatment in a high specialty hospital during the period from January 2017 to July 2018(n=88).

| Variable | f | % |
|---|---|---|
| Origin of EN | | |
| Primary Tumor | 79 | 89.8 |
| Secondary Tumor | 9 | 10.2 |
| Type of EN | | |
| Malignant | 62 | 70.5 |
| Benign | 26 | 29.5 |
| Primary tumor | | |
| Meningiomas | 26 | 29.5 |
| Gliomas | | |
| Glioblastomas | 22 | 25.0 |
| Astrocytoma | 12 | 13.6 |
| Ependinomas | 3 | 3.4 |
| Pituitary | 5 | 5.7 |

| | | |
|---|---|---|
| Schwannoma | 3 | 3.4 |
| Medulloblastoma | 2 | 2.3 |
| Not reported | 15 | 17.0 |
| Localized | | |
| Brain | 34 | 39.0 |
| Brain except lobes and ventricles | 26 | 29.9 |
| Meninges | 19 | 21.6 |
| Pituitary | 4 | 4.6 |
| Cranial nerves | 2 | 2.3 |
| Ventricles | 1 | 1.1 |
| Cerebellum | 1 | 1.1 |
| Frontal lobe | 1 | 1.1 |
| Secondary tumor | | |
| Pulmonary | 1 | 11.1 |
| Breast | 1 | 11.1 |
| Not reported | 7 | 77.8 |

Source: Own Development

Of the two most frequent types of ENs, gliomas occurred at a younger age than meningiomas, with an average of 44.7 vs. 57.3 years, respectively. On the other hand, of the 42% of glioma cases, ependymomas and glioblastomas were more frequent in males (66.7% and 59.1%) and astrocytomas in females (66.7%). Meningeal ENs predominated in females (53.8%). Medulloblastoma was the EN that occurred at the youngest age (31±7 years). Supratentorial craniotomy was the most commonly used surgical procedure (48.9%) and the complications reported were: fistula (11.4%), infection (9.1%) and bleeding (4.5%). The 35.2% of the patients required between 8 to 15 days and 16 to 30 days of hospitalization (17.0%), (Table 3). The EN with the highest percentage of cases requiring more than 30 days of hospitalization was meningioma (50%).

Table 3. Type of procedure, surgical complications and hospitalization days (n=88)

| Variable | f | % |
|---|---|---|
| Surgical procedure type | | |
| Supratentorial craniotomy | 43 | 48.9 |
| Craniotomy and VPS* | 16 | 18.2 |
| Infratentorial craniotomy | 9 | 10.2 |
| Transfenoidal | 5 | 5.7 |
| Biopsy and craniotomy | 4 | 4.5 |
| Craniotomy and resection | 4 | 4.5 |
| Craniotomy and laminectomy | 1 | 1.1 |
| Biopsy, laminectomy, VPS | 1 | 1.1 |
| Craniotomy and surgical cleaning | 1 | 1.1 |
| Transphenoidal approach and VPS | 1 | 1.1 |
| Endoscopic ventriculostomy | 1 | 1.1 |
| Tumor resection | 1 | 1.1 |
| Laminectomy | 1 | 1.1 |
| Surgical complications | | |
| Fistula | 10 | 11.4 |
| Infection | 8 | 9.1 |
| Bleeding | 4 | 4.5 |
| Infection and Fistula | 3 | 3.4 |
| None | 63 | 71.6 |
| Hospitalization days | | |
| 1 to 7 days | 15 | 17.0 |
| 8 to 15 days | 35 | 35.2 |
| 16 to 30 days | 31 | 17.0 |
| 30 or more days | 7 | 8.0 |

Source: Own Development
*Ventriculoperitoneal shunt (VPS)

After neurological surgery, the treatment indicated was rehabilitation, radiotherapy, and radiotherapy with chemotherapy. The reason for discharge in most cases was improvement (89.7%), with follow-up in the outpatient clinic (48.9%) (Table 4).

A total of 2.3% were discharged due to maximum benefit and 8% due to death. NE of secondary origin had a proportionally higher number of deaths (22%).

Table 4 . Non-neurological treatment, reason for discharge and type of follow-up (n=88).

| Variable | f | % |
|---|---|---|
| Non-neurological treatment | | |
| Rehabilitation | 21 | 23.9 |
| Radiotherapy | 15 | 17.0 |
| Chemo and Radiotherapy | 11 | 12.5 |
| Radiotherapy and Rehabilitation | 5 | 5.7 |
| Chemotherapy, Radiotherapy and Rehabilitation | 3 | 3.4 |
| Chemotherapy | 2 | 2.3 |
| Psychology | 2 | 2.3 |
| Palliative Care | 1 | 1.1 |
| Rehabilitation and Palliative Care | 1 | 1.1 |
| Endocrinology | 1 | 1.1 |
| Other | 8 | 9.1 |
| None | 18 | 20.5 |
| Discharge reason | | |
| Improvement | 79 | 89.7 |
| Death | 7 | 8.0 |
| Maximum benefit | 2 | 2.3 |
| Type of follow-up | | |
| *Outpatient Consultation* | 43 | 48.9 |
| *Outpatient and Rehabilitation* | 19 | 21.6 |
| *Final discharge* | 9 | 10.2 |
| *Referral to hospital of origin* | 6 | 6.8 |
| *Outpatient and Endocrinology* | 5 | 5.7 |
| *Outpatient and Psychiatry/Psychology* | 5 | 5.7 |
| *Under treatment* | 1 | 1.1 |

Source: Own Development

## Discussion

The results of the epidemiological overview of EN in 2017-2018 agree with most references from studies reported in other countries in that the highest incidence of tumors are those of the glioma and meningioma type [3,6,10,11,14]. Likewise, the higher frequency in general in women than in men [13-14]. Other studies report results that differ in the characteristics of the population and the treatment offered to the patients. In the case of Carter et al [17], glioblastoma survivors had an average age of 64 years and were mostly men; in our study with a younger average age but also present in men. One difference is that in the American study they reported that patients were treated with radiotherapy and in this one they received radio and chemotherapy

. Regarding age, the results of this study coincide with Anaya [14] with an average of 49.3 years, and a predominance of women. However, their results revealed a higher prevalence in meningiomas and in our study it was gliomas.

Moreover, in our results the majority of ENs glioma-type neoplasms were glioblastomas, while in another study in Mexico [14] they found that astrocytoma was the most frequent. Regarding sex, the results coincide in those meningeal neoplasms predominated in women and neuroepithelial neoplasms in men. The high incidence of gliomas was also reported by Drewes and collaborators who studied 136 patients operated on for low glioma and high glioma, without obtaining significant differences when comparing the quality of life in the first six months (p=.518) [18]. In addition, in Croatia, a study conducted from 2001 to 2014 describes a higher incidence of malignant EN in the male sex as well as mortality, contrary to this study; the highest incidence was in the female sex [19]. Regarding complications, it has been reported in a study in India [20] that 12.1% of patients undergoing neurological surgeries present chronic obstructive pulmonary disease. This situation was not present in the institution since the hospital stay is not prolonged, 75% is less than or equal to 30 days. Regarding surgeries for meningioma, in this study supratentorial craniotomy is the most used surgical procedure, while in a French study it was reported that the most common procedures were through the cranial convexity and the middle base of the skull [21]. It should be considered that, although it has been possible to compare the results, there are considerable methodological differences in the studies, which were carried out in different periods of time and with diverse populations in number and characteristics, making it difficult to draw conclusions. On the other hand, the records consulted in the hospital files are not uniform and do not use the classification of brain tumors recommended by the WHO in 2007 [4], which uses molecular biology markers, and they do not mention the grade, which has limited the possibility of contrasting the results with other publications. There are really few epidemiological studies that have been published on this subject so, in agreement with other authors, it is recommended to encourage and promote the reports of registries that provide more information on the behavior of ENs in the CNS that give rise to

better treatment and care strategies, and have an impact on survival and potential sequelae [14]. Post-surgical follow-up is important to address the disorders that may occur such as changes in memory, changes in concentration and ability to multitask, etc. As well as changes in sleep, balance, sensations and senses [22]. Other studies mention categories found as a terminal prognosis of negative experiences, positive experiences, coping with the tumor, surgery, the role of the family [23]. It is important to address in all aspects in the brain tumor patient, after surgery are: interrupted life, navigating the new reality of life, and social survival versus separation [24], other patients found depression, cognitive deficits, decreased role function, neurological deficit, neurological disability, and wheelchair use, post-surgery [25, 26].

## Conclusions

For the nursing professional, it is important to take a holistic and individualized approach to the care of patients with EN, taking into account the spiritual, psychological, social, physiological and emotional needs of the patient in order to plan actions with better health outcomes. The epidemiological overview of ENs is the first necessary step to promote the integration of proposals for nursing clinical practice guidelines and care plans during hospitalization and at discharge. It is recommended that studies be carried out to learn about the experiences of the people who undergo surgery, as well as phenomenological approaches that contribute to the establishment of new nursing care models to improve the quality of life in the reincorporation of the person to his or her daily life.

## Conflicts of interests

The authors declare that there is no conflict of interest.

## Financing

The authors declare that there was no funding of any kind.

## Bibliographic References

1. Organización Mundial de la Salud (OMS). ¿Qué son los trastornos neurológicos?. OMS [Internet]. 2016 [cited Jan 18, 2021]. Available at: https://www.who.int/features/qa/55/es/
2. American Brain Tumor Asociation. Sobre tumores cerebrales. Manual para pacientes y cuidadores. American Brain Tumor Asociation [Internet]. 2012 [cited Jan 18, 2021]. Available at: https://www.abta.org/wp-content/uploads/2018/03/sobre-tumores-cerebrales.pdf
3. Contreras L. Epidemiología de tumores cerebrales. Rev. Med. Clin. Condes [Internet]. 2017 [cited Jan 19, 2021];28(3):332-338. Available at: https://www.sciencedirect.com/science/article/pii/S0716864017300585.
4. Louis DN, Ohgaki H, Wiestler OD, Cavenee WK, Burger PC, Jouvet A. The 2007 WHO classification of tumours of the central nervous system. Acta Neuropathol [Internet]. 2007 [cited Jan 19, 2021];114(5):547. Available at: https://pubmed.ncbi.nlm.nih.gov/17618441/
5. Central Brain Tumor Registry of the United States (CBTRUS). Fact sheet CBTRUS [Internet]. 2018 [cited Jan 19, 2021]. Available at: https://www.cbtrus.org/www.cbtrus.org/factsheet/factsheet.html
6. De Robles P, Fiest KM, Frolkis AD, Pringsheim T, Atta C, St Germaine-Smith C, et al. The worldwide incidence and prevalence of primary brain tumors: a systematic review and meta-analysis. Neuro Oncol [Internet]. 2015 [cited Jan 19, 2021];17(6):776-83. Available at: https://pubmed.ncbi.nlm.nih.gov/25313193/.
7. Bell JS, Koffie RM, Rattani A, Dewan MC, Baticulon RE, Qureshi MM, et al. Global incidence of brain and spinal tumors by geographic region and income level based on cancer registry data. J Clin Neurosci [Internet]. 2019 [cited Jan 20, 2021];66:121-127. Available at: https://pubmed.ncbi.nlm.nih.gov/31133367/
8. Ostrom QT, Gittleman H, De Blank PM, Finlay JL, Gurney JG, McKean- Cowdin R, et al. American Brain Tumor Association adolescent and young adult primary brain and central nervous system tumors diagnosed in the United States in 2008-2012. Neuro Oncol [Internet]. 2016 [cited Jan 20, 2021];18(1):1-50. Available at: https://pubmed.ncbi.nlm.nih.gov/26705298/.
9. Global Cancer Observatory. Worl source: Globocan 2020. International Agency for Research on Cancer [Internet]. 2020 [cited Jan 20, 2021]. Available at: https://gco.iarc.fr/today/data/factsheets/populations/900-world-fact-sheets.pdf
10. Stelzer KJ. Epidemiology and prognosis of brain metastases. Surg Neurol Int [Internet]. 2013 [cited Jan 20, 2021];4(4):192-202. Available at: https://surgicalneurologyint.com/surgicalint-articles/epidemiology-and-prognosis-of-brain-metastases/
11. Ostrom QT, Cioffi G, Gittleman H, Patil N, Waite K, Kruchko C, et al. CBTRUS Statistical report: primary brain and other central nervous system tumors diagnosed in the United States in 2012-2016. Neuro Oncol [Internet]. 2019 [cited Jan 19, 2021];21(5):1-100. Available at: https://pubmed.ncbi.nlm.nih.gov/31675094/
12. Barnholtz-Sloan JS, Ostrom QT, Cote D. Epidemiology of brain tumors. Neurol Clin [Internet]. 2018 [cited Jan 18, 2021];36(3):395-419. Available at: https://pubmed.ncbi.nlm.nih.gov/30072062/
13. Aguirre-Cruz L, Rangel-López E, Cruz-Aguilera DL, Rodríguez-Pérez CE, Ruano L, Velásquez-Pérez L, et al . Historical distribution of central nervous system tumors in the Mexican National Institute of Neurology and Neurosurgery. Salud pública Méx [Internet]. 2016 [cited Jan 18, 2021];58(2):171-178. Available at: http://www.scielo.org.mx/scielo.php?pid=S0036-36342016000200171&script=sci_abstract&tlng=en
14. Anaya G, Juanbelz P, Fernandez B, Pazos F, Velasco A, Revuelta R. Prevalencia de tumores del sistema nervioso y su identificación histológica en pacientes operados: 20 años de experiencia. Cirugía y cirujanos

[Internet]. 2016 [cited Jan 19, 2021];84(6):447-453. Available at: https://www.sciencedirect.com/science/article/pii/S0009741116000116
15. Instituto Nacional de Estadística y Geografía. Estadísticas a propósito del día mundial contra el cáncer. INEGI [Internet]. 2018 [cited Feb 01, 2018]. Available at: https://www.inegi.org.mx/contenidos/saladeprensa/aproposito/2018/cancer2018_nal.pdf
16. Reglamento de la Ley General de Salud en materia de investigación para la salud. Secretaría de Salud [Internet]. 2014 [cited Aug 20, 2020]. Available at: http://www.salud.gob.mx/unidades/cdi/nom/compi/rlgsmis.html
17. Carter T, Medina R, Lawler B. Glioblastoma treatment with temozolomide and bevacizumab and overall survival in a rural tertiary healthcare practice. Biomed. Res. Int [Internet]. 2018 [cited Jan 18, 2021];6204676. Available at: https://www.hindawi.com/journals/bmri/2018/6204676/
18. Drewes C, Sagberg L, Jakola A, Solheim O. Perioperative and postoperative quality of life in patients with glioma a longitudinal cohort study. World Neurosurg [Internet]. 2018 [cited Jan 20, 2021];117:465-474. Available at: https://pubmed.ncbi.nlm.nih.gov/29920391/
19. Mrak G, Korent V, Krpan A, Bitunjac A, Štenger M, Kordić A, et al. Malignant brain neoplasms incidence and mortality trends in Croatia from 2001 to 2014. Croat Med J [Internet]. 2019 [cited Jan 18, 2021];60:33-41. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6406061/
20. Hooda B, Chouhan RS, Rath GP, Lamsal R, Bithal PK. Incidence and predictors of postoperative pulmonary complications in patients undergoing craniotomy and excision of posterior fossa tumor. J Anaesthesiol Clin Pharmacol [Internet]. 2019 [cited Jan 21, 2021];35(2):254-260. Available at: https://journals.lww.com/joacp/Fulltext/2019/35020/Incidence_and_predictors_of_postoperative.21.aspx
21. Champeaux C, Weller J, Katsahian S. Epidemiology of meningiomas. A nationwide study of surgically treated tumours on French medico-administrative data. Cancer Epidemiol [Internet]. 2019 [cited Jan 20, 2020];58:63-70. Available at: https://pubmed.ncbi.nlm.nih.gov/30481723/

22. Walter FM, Penfold C, Joannides A, Saji S, Johnson M, Watts C, et al. Missed opportunities for diagnosing brain tumors in primary care: a qualitative study of patient experiences. British Journal of General Practice [Internet]. 2019 [cited Jan 17, 2021];69(681):224-235. Available at: https://bjgp.org/content/69/681/e224

23. Sutton K. Perceptions and experiences of the subjective wellbeing of people with a diagnosis of high-grade glioma a longitudinal phenomenological study [Dissertation]. London; King´s College [Internet] 2020. [cited May 20, 2021]. Available at https://kclpure.kcl.ac.uk/portal/en/theses/perceptions-and-experiences-of-the-subjective-wellbeing-of-people-with-a-diagnosis-of-high-grade-glioma(ca04b977-77ed-44e2-9941-b06f03f622af).html
24. Cubis L, Ownsworth T, Pinkham MB, Chambers S. The social trajectory of brain tumor: a qualitative metasynthesis. Disabil Rehabil [Internet]. 2018 [cited Jan 20, 2020];40(16):1857-1869. Available at: https://www.tandfonline.com/doi/abs/10.1080/09638288.2017.1315183?journalCode=idre20
25. Gately L, McLachlan S, Dowling A, Philip j. Life beyond a diagnosis of glioblastoma: a systematic review of the literatura. Journal of cáncer Survivorship [Internet]. 2017 [cited Jan 20, 2020];11(4):447-452. Available at: https://pubmed.ncbi.nlm.nih.gov/28194640/
26. Shia C, Lambaa N, Zhengc l, Cotea D, Regesteine Q, Liuf C, Tranf Q, et al. Depression and survival of glioma patients: A systematic review and meta-analysis. Clin Neurol Neurosurg [Internet]. 2018 [cited Jan 20, 2020];172:8-19. Available at: https://pubmed.ncbi.nlm.nih.gov/29957299/

27. Declaración de Helsinki de la Asociación Médica Mundial. Principios éticos para las investigaciones médicas en seres humanos [Internet]. 2014 [cited Jan 20, 2021]. Available at http://www.ctomedicina.com/impugnaciones2014/bibliografiaP202MIR.pdf

**How to cite this article:** Meza-García C, Reynaga-Ornelas L, Rodríguez-Medina R, Dávalos-Pérez A, Pérez-Reyes S. Panorama epidemiológico de las neoplasias encefálicas con tratamiento quirúrgico en un hospital de tercer nivel en Guanajuato, México. SANUS [Internet]. 2022. [citado dd mm aa];7:e246. Available at: URL/DOI