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RESEARCH ARTICLE

Palliative care for children with central nervous system tumors: results of a Spanish multicenter study

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Abstract

Background Brain tumors represent the most common cause of cancer-related death in children. Few studies concerning the palliative phase in children with brain tumors are available.

Objectives (i) To describe the palliative phase in children with brain tumors; (ii) to determine whether the use of palliative sedation (PS) depends on the place of death, the age of the patient, or if they received specific palliative care (PC).

Methods Retrospective multicenter study between 2010 and 2021, including children from one month to 18 years, who had died of a brain tumor.

Results 228 patients (59.2% male) from 10 Spanish institutions were included. Median age at diagnosis was 5 years (IQR 2–9) and median age at death was 7 years (IQR 4–11). The most frequent tumors were medulloblastoma (25.4%) and diffuse intrinsic pontine glioma (DIPG) (24.1%). Median number of antineoplastic regimens were 2 (range 0–5 regimens). During palliative phase, 52.2% of the patients were attended by PC teams, while 47.8% were cared exclusively by pediatric oncology teams. Most common concerns included motor deficit (93.4%) and asthenia (87.5%) and communication disorders (89.8%). Most frequently prescribed supportive drugs were antiemetics (83.6%), opioids (81.6%), and dexamethasone (78.5%). PS was administered to 48.7% patients. Most of them died in the hospital (85.6%), while patients who died at home required PS less frequently (14.4%) ($p = .01$).

Conclusion Children dying from CNS tumors have specific needs during palliative phase. The optimal indication of PS depended on the center experience although, in our series, it was also influenced by the place of death.

Keywords End-of-life · Palliative · Brain tumor · CNS tumor · Neuro-oncology · Childhood cancer

Abbreviations

CNS	Central nervous system
PS	Palliative sedation
PC	Palliative care
SEHOP	Spanish Society of Pediatric Onco-Hematology
IQR	Interquartile range
DIPG	Diffuse intrinsic pontine glioma
VEGF	Vascular endothelial growth factor
ITCC	Innovative therapies for children with cancer
VPS	Ventriculo-peritoneal shunting
NICE	National Institute for Health and Care Excellence

Introduction

Central nervous system (CNS) tumors are the second most common pediatric cancer. In Europe, the incidence rate has been estimated to be 2.99 per 100,000 population [1]. Despite the use of multimodal therapies, the estimated 5-year mortality is 30%, making these tumors the leading cause of cancer-related death in children and adolescents [2].

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Extended author information available on the last page of the article

Typical end-of-life symptoms include dysphagia, paralysis, headache, seizures, and cognitive impairment. This generates stress and anxiety for both patients and families and has a major impact on quality of life [3]. A greater understanding of the needs of seriously ill children and their families would enhance the quality of care offered and avoid unnecessary hospital admissions and treatments near the end of life. It would also help pediatricians, palliative care (PC) specialists, and pediatric oncologists to anticipate symptoms management and establish care goals with families. Studies on PC in children with brain tumors, however, are scarce [4–8].

The main aim of this study was to describe the palliative phase in children diagnosed with an incurable CNS tumor in Spain. We analyzed the characteristics of patients and PC provision, the treatment of symptoms according to tumor location, and the use of palliative anticancer treatments and palliative sedation (PS). The secondary aim was to determine whether the use of PS varied according to place of death (hospital vs. home), patient age, or involvement of a dedicated PC team.

Materials and methods

Study population and design

Multicenter retrospective, observational study of patients aged between 1 month and 18 years who died of a primary CNS tumor between January 2010 and August 2021. All Spanish hospitals with a pediatric oncology unit were invited to participate through the Spanish Society of Pediatric Onco-Hematology (SEHOP).

We considered large units those with more than 600 annual admissions and/or 70 new cases per-year (Virgen del Rocío, Vall d'Hebrón, Niño Jesús and Sant Joan de Déu). Small units were those with less than 600 annual admissions and/or 70 new cases per-year (Gregorio Marañón Hospital, Universitario de Donostia, Álvaro Cunqueiro, Virgen de la Salud, Universitario de Burgos and Montepríncipe Hospitals). We checked again and we noticed Gregorio Marañon Hospital has less than 70 new cases per year.

Regarding pediatric PC organization in Spain: in Madrid, pediatric public hospitals share a common structure and all children who require PC are attended by Niño Jesus Hospital (NJH). The only exception is Montepríncipe Hospital (from where we included seven patients), because it is private. Also, six patients from Gregorio Marañon Hospital (GMH), were not cared for in NHJ during the palliative phase, mainly due to family preferences.

Definitions

For standardization purposes, the PC phase was considered to begin when the tumor was deemed incurable (normally by the attending oncologist) and the decision made to discontinue treatment with curative intent [4, 5]. At that point, patients at hospitals with a PC unit were transferred to this unit, with the possibility of continued support from the oncology department. In other cases, PC was only provided by the oncologists. Other definitions [9–20] used in this study are given in Annex 1.

Data sources

A survey (Annex 2) was sent to all participants centers to be completed between November 2020 and January 2022 by a pediatric oncologist and/or PC professional. Anonymized clinical data were collected from electronic databases at the participating hospitals. The study was approved by the ethics committee at Virgen del Rocio Hospital, which waived the need for informed consent.

Statistical analysis

Statistical analysis was performed to analyze if: (1) there was any difference between symptom management according to tumor location (Table 4, Annex 3), (2) palliative phase duration differed between DIPG vs non-DIPG tumors, (3) model of care during palliative phase changed according to era (2009–2013 vs 2014–2021) (Fig. 1), (4) the use of palliative sedation varied according to place of death (hospital vs. home), patient age, or involvement of a dedicated PC team vs pediatric oncology team (Annex 3).

Statistical analyses were performed in SPSS (version 28.0). Significance was set at a p level of 0.05 (two-tailed). Normally and non-normally distributed variables were compared using T test and Mann–Whitney U or Kruskal–Wallis tests, respectively. Chi-square test was used for qualitative variables. Qualitative results were expressed as absolute and relative frequencies and quantitative variables as median and interquartile range (IQR).

Results

Patient characteristics

Ten out of 36 Spanish Pediatric Oncology Units agreed to participate.

We studied 228 children, 135 male (59.2%). Their characteristics are summarized in Table 1. Fourty three patients

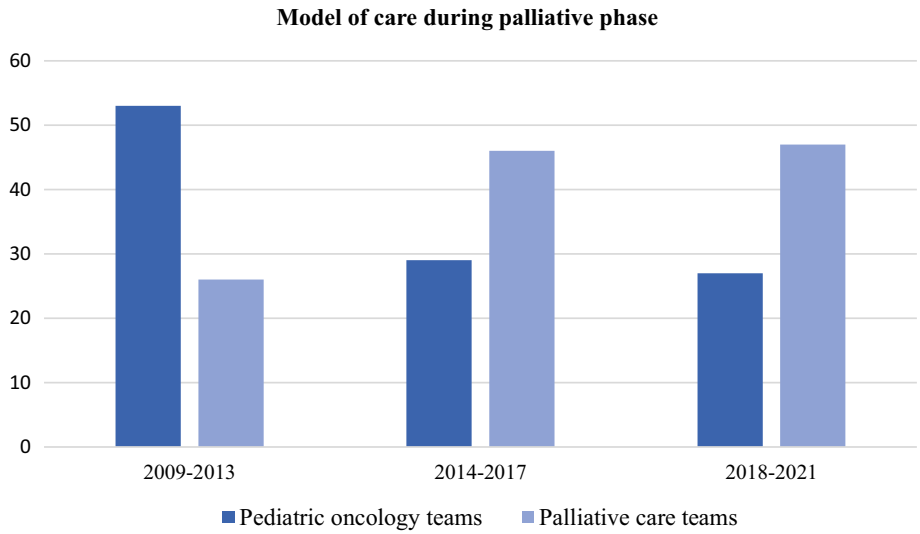

Fig. 1 Model of care during palliative phase. From 2014, the number of patients attended by palliative care teams grew, reaching statistical significance ($p=0.03$) when compared to the previous period (< 2014)

Table 1 Patient characteristics

Spanish regions represented in the study *N* (%)	
Andalusia (Seville)	80 (35)
Madrid	74 (32.4)
Catalonia (Barcelona)	44 (19.3)
Basque Country (S. Sebastian)	16 (7)
Galicia (Vigo)	6 (2.6)
Castilla La Mancha (Toledo)	5 (2.3)
Castilla y Leon (Burgos)	3 (1.3)
Sex *N* (%)	
Male	135 (59.2)
Female	93 (40.8)
Age at diagnosis (years) Me (IQR)	5 (2–9)
Age of death (years) Me (IQR)	7 (4–11)
Diagnosis *N* (%)	
Medulloblastoma	58 (25.4)
DIPG	55 (24.1)
High grade glioma	48 (21.1)
Ependymoma	21 (9.2)
ATRT	16 (7)
Other[a]	13 (5.7)
Low grade glioma	10 (4.4)
Germ cell tumor	7 (3.1)
Primary tumor location *N* (%)	
Infratentorial	81 (35.5)
Supratentorial	70 (30.7)
Brainstem	64 (28.1)
Spinal cord	13 (5.7)
Lines of antineoplastic therapies Me (IQR)	2 (1–3)

Me median, *DIPG* diffuse intrinsic pontine glioma, *ATRT* atypical teratoid rhabdoid tumors

[a]Other: pinealoblastoma ($n=4$), ependymoblastoma ($n=1$), choroid plexus carcinoma ($n=2$) and not otherwise specified embryonal tumor ($n=6$)

(18.85%) were treated in small hospitals and 185 (81.14%) in large hospitals. The median age was 5 years (IQR 2–9 years) at diagnosis and 7 years (IQR 4–11 years) at the time of death.

The most common tumors were medulloblastoma ($n=58$, 25.4%) and diffuse intrinsic pontine glioma (DIPG) ($n=55$, 24.1%). The most common location was the infratentorial region ($n=81$, 35.5%). Patients received a median of two treatment lines (IQR 1–3, range 0–5).

Palliative care characteristics

The characteristics of PC provision are summarized in Table 2. Median duration of palliative phase was 2 months (IQR 0–7 months), and it was significantly longer in patients with DIPG (median 7 months [IQR 1–12 months], $p=0.01$), compared to patients with non-DIPG tumors (median 1 month [IQR 0–5 months]).

Of the 228 children studied, 119 (52.2%) were managed by a PC team. Of these, 104 patients (87.4%) were managed by dedicated pediatric PC teams. Just under half of the patients ($n=109$, 47.8%) were cared exclusively by pediatric oncology teams during palliative phase. Specialist PC provision was more common in large hospitals (105/190 patients [55.2%] vs. 14/38 patients [36.8%] at small hospitals).

Care model varied over time (Table 1, Fig. 1), with a greater proportion of patients receiving specialist PC from 2014 onwards: 26/79 (32.9%) between 2009 and 2013, 46/75 (61.3%) between 2014 and 2017, and 47/74 (63.5%) between 2018 and 2021. Differences between 2009–2013 and 2014–2021 periods were analyzed, reaching statistical significance ($p=0.03$).

Overall, 157 patients (69%) died at the hospital, and 71 (31%) died at home. The main cause of death was disease progression ($n=215$, 94.3%).

Table 2 Palliative care characteristics

Place of death *N* (%)	
Home	71 (31)
Hospitalization ward	149 (65.5)
Intensive care unit	8 (3.5)
Cause of death *N* (%)	
Tumor progression	215 (94.3)
Infection	9 (3.9)
Surgical complication	1 (0.4)
VPS dysfunction	1 (0.4)
Tumor-associated hemorrhage	2 (0.9)
Palliative care team according to era *N* (%)	119 (52.2)
2009–2013 *n*/*N* (%)	26/79 (32.9)
2014–2017 *n*/*N* (%)	46/75 (61.3)
2018–2021[a] *n*/*N* (%)	47/74 (63.5)
Palliative care team *N* (%)	
Pediatric	104 (87.3)
Adult	15 (12.6)
Time from diagnosis to palliative phase (months) Me (IQR)	8.5 (1–23)
Time from diagnosis to exitus (months) Me (IQR)	14 (8–28)
Palliative phase duration (months) Me (IQR)	2 (0–7)

Me median, *VPS* ventriculo-peritoneal shunting

[a]3 missing values for start date of palliative phase

Table 3 Clinical issues during the palliative care phase

Problems	*n*/*N* (%)
Motor deficit	211/226 (93.4)
Communication disorders[a]	185/206 (89.8)
Asthenia	154/176 (87.5)
Headache	167/201 (83.1)
Cranial nerve deficit	169/206 (82)
Dysfagia	170/214 (79.4)
Nausea and vomiting	175/221 (79.2)
Nutritional problems	164/211 (77.7)
Constipation	160/213 (75.1)
Urinary incontinence	89/120 (74.2)
Anxiety	120/166 (72.3)
Seizures	136/224 (60.7)
Vision deficit	66/117 (56.4)
Bedridden > 30 days	114/218 (52.3)
Dysnea	74/150 (49.3)
Depression	60/137 (43.8)
Spasticity	87/203 (42.9)
Infections	91/217 (41.9)
Pure neuropathic pain	66/174 (37.9)
Mixed neuropathic pain	60/166 (36.1)
Behavioural disorders	60/176 (34.1)
Fecal incontinence	43/173 (24.9)
Central fever	34/217 (15.7)
Hearing impairment	13/174 (7.5)

[a]Communication disorders: impairments of language, speech, and verbal and non-verbal communication

Clinical issues during the palliative care phase

The main symptoms reported during the palliative phase (Table 3) were motor deficits ($n = 211$, 93.4%) and communication disorders ($n = 185$, 89.8%), asthenia ($n = 154$, 87.5%), headache ($n = 167$, 83.1%), and cranial nerve impairments ($n = 169$, 82%).

Symptom management and use of medical devices during palliative phase

Details on the management of symptoms and use of medical devices during end-of-life care are summarized in Tables 4 and 5.

Dexamethasone was administered to 179 patients (78.5%) at a median dosage of 0.4 mg/kg/d (IQR 0.3–0.6 mg/kg/day). Median days of prescription until death was 30 days (IQR 14–68 days). Nineteen patients (8.3%) were treated with antiangiogenics (vascular endothelial growth factor [VEGF] inhibitors). In total, 186 patients (81.6%) required opioids for pain control (morphine was used in 88% of the cases). Eighty-one patients (37.3%) were treated for neuropathic pain. Of these, 69% received gabapentin. Out of the 126 patients that reported pure or mixed neuropathic pain, 45 patients (35.7%) did not receive any specific treatment for this pain.

Laxatives and anti-emetics were used in 145 (64.2%) and 189 (83.6%) patients, respectively.

The most widely used medical devices were wheelchairs ($n = 113$, 51%) and nasogastric tubes ($n = 107$, 47%), particularly in the subgroup of 63 patients with a brainstem tumor (Annex 3), with respective percentages of 65% ($n = 41$) and 51.6% ($n = 33$).

Twenty-one patients (9.2%) underwent ventriculoperitoneal shunting (VPS) during the palliative phase. Median time from shunt placement to death was 2.3 months (IQR 1.4–6 months). The oncologists rated the procedure provided clinical beneficial in 59% of them (13/ 21).

When comparing symptomatic treatments between tumor locations (Annex 3), it was observed that: the use of anticonvulsants was more common in supratentorial tumors (56%, $p = 0.01$) and patients with medullary tumors required neuropathic pain treatment more often (75%, $p = 0.012$). Other differences between tumor locations were not observed.

Table 4 Symptom management and use of medical devices during palliative care

	All
Dexamethasone *N* (%)	179/228 (78.5)
Dxm maximal dose (mg/kg/day) Me (IQR)[a]	0.4(0.3–0.6)
Days of dxm until exitus Me (IQR)[a]	30 (13.7–68)
Anti-angiogenics *N* (%)	19/22 (8.3%)
Opioids *N* (%)	186/228 (81.6)
Type of opyoid[a] *N* (%)	178 (100)
Morphine	157 (88.2)
Fentanyl	20 (11.2)
Tramadol	1 (0.6)
Neuropathic pain treatment[a] *N* (%)	81/217 (37.3)
Neuropathic pain drugs[a] *N* (%)	58 (100)
Gabapentin	40 (69)
Pregabalin	6 (10.3)
Pregabalin + TAD	1 (1.7)
Gabapentin + TAD	3 (5.2)
Gabapentin + Pregabalin	1 (1.7)
Ketamine	2 (3.4)
Gabapentin + Ketamine	5 (8.6)
Antiemetics[a] *N* (%)	189/226 (83.6)
Anxiolytics[a] *N* (%)	102/227 (45)
Antidepressants[a] *N* (%)	19/219 (8.7)
Antipsychotics[a] *N* (%)	26/227 (11.5)
Anti-epilectic drugs[a] *N* (%)	127/227 (56)
Laxatives[a] *N* (%)	145/226 (64.2)
Wheel-chair[a] *N* (%)	113/222 (51)
Nasogastric tube *N* (%)	107/228 (47)
Gastrostomy tube *N* (%)	26/215 (12)
NIMV *N* (%)	19/228 (8.3)

Me median, *Dxm* dexamethasone, *TAD* tricyclic antidepressant, *NGT* nasogastric tube, *NIMV* non-invasive mechanical ventilation

[a]Missing values exist

Anticancer treatment with palliative intent

Anticancer treatment with palliative intent was used in 144 patients (63%), 69 of whom (48%) received more than 1 line of treatment. The median time from last treatment to death was 43 days (IQR 15–122 days). The most common treatments were radiotherapy ($n=78$, 54.26%), metronomic chemotherapy ($n=57$, 39.5%), and conventional chemotherapy ($n=54$, 37.5%) (Fig. 2). Targeted therapies ($n=12$, 8.3%) and immunotherapy were used in 12 cases (8.3%).

Palliative sedation

In total, 111 patients (48.7%) received PS. The details are summarized in Table 5. The indication in all cases was alleviation of refractory symptoms, mainly dyspnea ($n=48$, 44.6%), seizures ($n=21$, 19.4%), and pain ($n=16$, 14.4%).

Table 5 Palliative sedation (indications and drugs)

Palliative sedation *N* (%)	228 (100)
Yes	111 (48.7)
Refractory symptoms that triggered the start of PS N(%)	107 (100)[a]
Dyspnea	48 (44.6)
Seizures	21 (19.4)
Pain	16 (14.4)
Other	7 (6.5)
Existential suffering	6 (5.8)
Hemorrhage	5 (5)
Psychomotor agitation	4 (4.3)
Drugs in palliative sedation *N* (%)	111 (100)
Midazolam	61 (55)
Midazolam and morphine	39 (35.1)
Propofol	3 (2.7)
Midazolam, propofol and morphine	5 (4.5)
Midazolam and propofol	3 (2.7)

[a]4 missing values

The most widely used drug was midazolam ($n=108$, 97.2%). Forty-four patients (39.6%) received morphine as an adjuvant in PS, to treat pain or dyspnea.

Most patients who received PS died in hospital (85.6%) vs. 14.4% at home ($p=0.012$). No differences were observed in PS use according to patient age ($p=0.49$) or care model (management by palliative care specialists vs. oncologists) (44.4% vs. 55.6%, $p=0.07$).

Discussion

We studied the palliative phase in a series of 228 children from ten Spanish institutions who died of a brain tumor.

Patients experienced progressive neurologic deterioration with characteristic symptoms during the PC phase. In line with previous reports [4, 6, 7, 21–23], motor deficits, cranial nerve alterations, and headaches were particularly common. The percentage of patients with dyspnea, 49.3%, was similar to in other studies [7, 22].

Asthenia was also particularly prevalent (87.5%). Although asthenia is not described in other studies of pediatric brain tumors [4, 6, 7, 22], many authors believe it is one of the most common symptoms of advanced cancer in both children and adults and has the greatest impact on quality of life [22–26].

Dexamethasone, anti-emetics, opioids, and laxatives were the main drugs used to manage symptoms. Corticosteroids are one of the mainstays of supportive therapy in PC and neuro-oncology. Over three-quarters of patients in

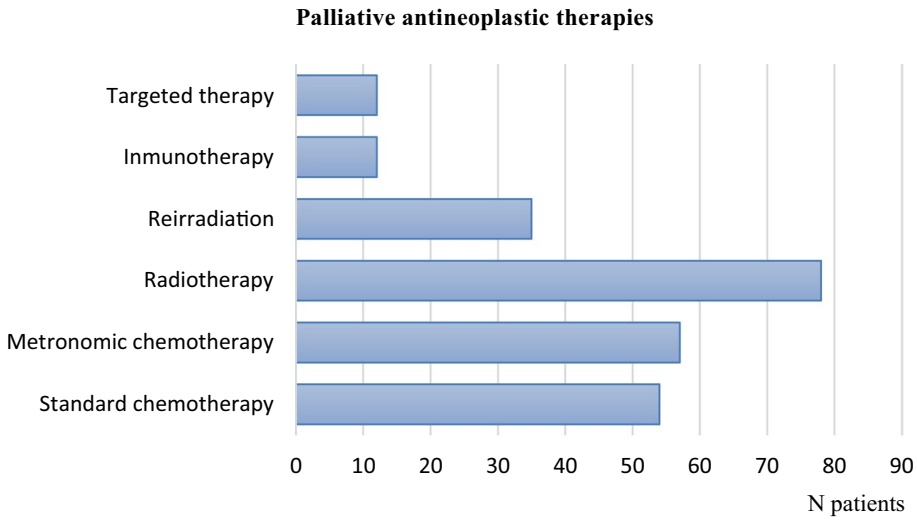

Fig. 2 Antineoplastic treatments during palliative phase. This figure shows the number of patients per treatment type received. 144 patients (63%) received palliative antineoplastic therapy. 69 patients (48%) received more than one line of palliative treatment

our series (78.5%) received dexamethasone, a rate similar to those reported elsewhere [4, 6, 7]. High doses were used (median 0.4 mg/kg/day), and median duration of treatment prior to death (30 days) was also similar to previous findings [4, 6, 7]. Some authors have claimed that low doses of dexamethasone may be as effective as high doses in certain situations [27]. Consensus, however, is lacking on optimal doses or treatment duration. The goal in all cases should be to administer the minimum effective dose in order to minimize adverse effects, which can negatively impact patient quality of life and as observed in some studies, survival [27, 28].

Antiangiogenics can be used as corticosteroid-sparing agents in children with CNS tumors. Recent studies have shown that bevacizumab in particular has significant corticosteroid-sparing effects, and it is additionally effective and well tolerated in pediatric settings, particularly in the treatment of radiation necrosis or pseudoprogression [29–33]. In our series, 8.3% of patients were treated with bevacizumab to alleviate edema or reduce corticosteroid dose. Certainly, 45.2% patients in our study had DIPG or HGG, which develop radionecrosis and/or pseudoprogression more frequently, and 15.3% patients received reirradiation during palliative phase (Fig. 2), which increases the risk of radionecrosis. Additionally, most of these patients were treated in large hospitals with better drug availability and less cost-related issues. Since angiogenics can improve disease/treatment-related complications of brain tumors, international guidelines are necessary to standardize indications and recommended doses, especially in pediatric PC.

The proportion of patients who received opioids for pain, 81.6%, was higher than that reported in smaller series (around 55%) [4, 6]. However, just 37.3% of patients in our series received treatment for neuropathic pain. Most of them had spinal cord tumors (Appendix 3), and pain was probably caused by direct nerve root compression [34, 35]. It is noteworthy that 45 patients (35.7%) with neuropathic pain did not receive any specific treatment for this kind of pain. While widely recognized in adults, as seen in our series, neuropathic pain tends to be underdiagnosed and undertreated in pediatric settings. A high index of suspicion, together with the use of pain scales is necessary, as it can severely impact quality of life when not properly treated [35, 36].

Anticancer treatments with palliative intent were used in more than 60% of patients, in accordance with other authors [4, 6, 7]. The median time from completion of the last treatment to death (43 days) was similar to others reported elsewhere [6, 7].

Again, supporting previous reports [4, 6, 7], chemotherapy (metronomic in 39.5% of cases and conventional in 37.5%) and radiotherapy (54.26%) were the main anticancer treatments used with palliative intent.

Only10.6% of the patients were treated with an experimental drug (targeted therapy or immunotherapy) within a clinical trial setting or under compassionate programs (this distinction was not analyzed). The difficulties associated with conducting clinical trials in pediatric patients, together with variable access to these trials across Spain's regions [37–40], might explain why so few patients in our series were treated with novel drugs.

Of note, according to Levine et al. ($n = 380$), enrollment on phase I trial does not affect end-of-life care characteristics. As long as an individualized approach is used and both patients and families are involved in treatment decision-making, quality PC can be delivered regardless of clinical trial participation and should not preclude early contact with PC specialists [41, 42].

VPS was performed during the palliative phase in 9.2% patients. Risks and benefits of any invasive end-of-life procedure should be carefully weighed up and discussed with patients and families. VPS placement was perceived as

beneficial by the oncologists involved in 59.1% of cases. This rate was similar to that reported in similar series that have found VPS to improve both survival and quality of life [43–45]. Although our observations were limited by the retrospective design of the study, the heterogeneous nature of the sample, and the lack of objective criteria for evaluating the true benefits of VPS during palliative care, this procedure could be a valid option for treating hydrocephalus in given patients, providing therapeutic relentlessness is avoided.

Median duration of palliative phase was close to 2 months, which is similar to that reported in a Dutch series of children with incurable brain tumors [7]. Of note, it was significantly longer in patients with DIPG (7 months, $p = 0.01$), in comparison with non-DIPG tumors. Considering the definition of palliative phase used in the present study (it was set as the point at which the patient's illness was deemed incurable) [4, 5], patients with DIPG entered the palliative phase from the time of diagnosis, as there are no curative treatments for DIPG. However, considering that PC starts at diagnosis and continues throughout the patient's illness [8, 9], other patients with high-risk brain tumors and poor prognostic factors in our series may have benefited from earlier initiation of this care.

Sixty-nine percent of patients in our series died in hospitals (a higher rate than that reported by other series) [4, 7, 8], indicating perhaps room for improvement in terms of accommodating patients and families wishes. The proportion of pediatric patients with life-limiting conditions who die at home varies widely according to country, type of hospital, and availability of PC resources [46–48]. In a multicenter study by Cantero et al. [49], only 40% of children under palliative care died at home. Noriega et al. [8], in turn, reported a rate of 64.4% in a study of 71 pediatric patients with CNS tumors at Hospital Niño Jesús in Madrid, Spain.

International guidelines, such as the NICE guideline [50], recommend that patients with advanced disease be cared for at home wherever possible due to the emotional benefits for both patients and families. PS at home is also considered safe, although it requires close monitoring by PC teams and cooperation from the family [51–53].

Regarding PS, 48.7% patients in our series received PS. The rates in the literature vary considerably from 65% in some series [4, 54] to 5% in others [7, 8]. Of note, not all patients with CNS tumors require PS near the end of life, as many will already be in a coma [7]. In our series, patients managed by a dedicated PC team seemed to be less likely to receive PS (44.4% vs. 55.6%, $p = 0.07$). Hospitalized patients were significantly more likely to receive PS than those being cared for at home (85.6% vs.14.4%). Probably, this group of patients had more complex care requirements and we did not perform a multivariate analysis to control for confounding factors. Despite this, hospitalized patients with life-limiting conditions may be more likely to receive more heavily medicalized treatment as they approach the end of life, possibly due to pressure from the family or even the medical team [48, 49]. Certainly, there is a lack of standardized protocols for pediatric PS procedures and possibly, in the present study, the optimal and time-appropriate indication of PS was mainly influenced by the team experience. A clinical guideline that can be adapted and individualized based on institutional experience and resource availability has recently been published by Cuviello et al. [54] from St. Jude Children's Research Hospital. Nonetheless, increased research and education on PS in pediatric neuro-oncology and standardization of clinical practice is necessary.

Strengths and limitations

This is the largest and first Spanish multicenter study that describe the palliative phase in pediatric CNS tumors. We documented all areas of PC, which provides a comprehensive view of the palliative phase in children with brain tumors and shows possible areas for improvement in their care (e.g. facilitate earlier access to PC).

Some limitations to our study need to be acknowledged. First, the criterion used to define palliative phase—judgement of incurability by the oncology team—is prone to subjectivity. Other limitations were: sample heterogeneity, use of medical records to collect data (certain symptoms may have been over-/underestimated), lack of homogeneous criteria in classifying a symptom as "irreversible" and retrospective nature of the study. We also acknowledge the study may not have country wide coverage, since most patients were treated in large centers from Seville, Madrid and Barcelona. The inequality of resources among PC teams in Spain, as well as the different dynamics in their development (some teams were probably formed during the retrospective phase of the study) were also part of the study limitations.

Certainly, there was significant heterogeneity between PC teams and possibly, many medical decisions during the palliative phase were influenced by team experience. For this reason, guidelines for good clinical practice (GPC) are necessary to standardize and improve care for children with brain tumors. With this purpose, in the near future, we plan to develop within the SEHOP group a recommendation guideline that includes algorithms for the pharmacological therapy and PC referral criteria, among others.

Conclusions

Children dying from CNS tumors face key challenges during palliative phase that require specific management. Early involvement of PC specialists should be encouraged. In our series, the use of PS was influenced by the place of death

(hospital vs home), but not patient´s age or care model. GPC guidelines are necessary to improve care for children with brain tumors.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12094-023-03301-7.

Author contributions All authors contributed to the study conception and design. The first draft of the manuscript was written by MP-TL and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability The data that support the findings of this study are available from the corresponding author, [L.M], upon reasonable request.

Declarations

Conflict of interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Ethics approval This retrospective chart review study involving human participants was performed in line with the principles of the Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed consent Informed consent was not required since the study is retrospective, it doesn't use identifiable private information or identifiable biospecimens and the research doesn't involves any risk to the subjects.

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