Introduction

After the World Health Organization declared the coronavirus disease 2019 (COVID-19) pandemic on March 11, 2020, there were more than 8.5 million documented infections and nearly half a million deaths in the first wave (as of June 21, 2020). In Spain, a state of alarm was declared and during lockdown (March–June 2020) the containment measures imposed were unprecedented. Mobility restriction and overload of the health system forced the postponement or cancellation of many nonurgent health processes.

In the setting of pediatric neuro-oncology, continued patient care is essential, as delay in diagnosis or treatment of these patients can result in an increase in morbidity and mortality. Furthermore, oncology patients on active treatment were considered at greater risk for both acquisition of infection and development of complications from COVID-19. Accordingly, during the first wave of the pandemic, hospital processes were adapted to guarantee healthcare in optimal safety conditions.

In the Neuro-Oncology Unit at Hospital Niño Jesús, approximately 40–50 new patients are diagnosed every year. Once the state of alarm was declared, in order to reduce exposure to the virus, the following measures were enforced: restriction of one parent per patient, facial mask, social distancing, hand hygiene, and systematic polymerase chain reaction (PCR) testing for COVID-19 of patients who required admission. In-person visits were reduced to a minimum and replaced by telephone consultations when necessary. These measures have been advised in the literature.

Methods

We present a retrospective descriptive study analyzing the clinical records of patients booked in this unit during lockdown.
lockdown to describe its performance. This study has been approved by a research ethics committee. Patient epidemiologic and clinical variables were collected, including the type of visit and the presence of delays in diagnosis and treatment. Quantitative variables were expressed as median and range and qualitative variables as percentages. Statistical analyses were performed using SPSS version 21.0.

Results

During the study period, there were 438 consultations for 123 patients. The median age was 10.93 years (range, 1.58–22.24 years). Sixty-four patients (52%) had finished treatment by March 2020, with a median follow-up of 2.17 years (range, 0.15–13.9 years). The most frequent cancer type was low-grade glioma. Patient characteristics are shown in Table 1.

The unit also offered care to oncology patients from another hospital in Madrid that was fully dedicated to adult patients with COVID-19. There was a total of eight newly diagnosed brain tumors. One patient had delay in diagnosis.

From all consultations, 320 were on-site and 118 were by telephone. Patients selected for telephone consultation were those in complete remission or stable disease, patients diagnosed with low-grade gliomas, and those living out of province. Patients on active treatment (radiotherapy or chemotherapy) or with a recent diagnosis were preferably selected for on-site consultations and telephone calls were used as intermediate follow-up.

Telehealth was used to assess the clinical status of the child, screen patients for early signs of tumor progression, and communicate medical test results. It was also useful to answer questions about treatment and counsel patients about the need for on-site consultations. Those patients living out of province were followed up by phone and all procedures such as imaging tests or chemotherapy administration were arranged in their local hospitals.

Telehealth prevented 27% of on-site consultations, with no delays in diagnosis due to this kind of consultation.

Only one patient diagnosed with a craniopharyngioma was positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). PCR testing performed prior to hospital admission was negative in 100% of the 29 patients tested. Only one patient had contact with a confirmed case; this patient did not develop infection (Table 1).

Delay in treatment and imaging schedules is widely described during the pandemic. In our study, there was a delay in imaging tests in 15 patients, with a median time of 49 days (range, 5–215 days). In six patients, the delay was due to mobility restriction and the inability to travel to the hospital from other provinces. In the other cases, the reason for delay was the decrease of available magnetic resonance imaging (MRI) slots due to a shortage of radiology staff physicians. In one patient diagnosed with medulloblastoma, MRI was delayed by a month; that patient was diagnosed with a relapse at that time.

Of all patients receiving chemotherapy (47 patients), treatment administration was only delayed in one case. A patient included in a clinical trial could not receive treatment at our institution, but was referred to his local hospital for treatment administration on time. No delays were identified in patients treated with radiotherapy (9 patients).

Discussion

The COVID-19 pandemic has overwhelmed healthcare systems, leading to resource optimization, postponing nonurgent processes, relocating staff, and promoting telemedicine.

Pediatric oncology patients, including neuro-oncology patients, have been in a vulnerable situation during this period. It is well known that delays in diagnosis can result in more advanced disease stage, and delays or interruption in treatment can result in treatment failure or tumor relapse.3 This is in addition to a high risk of acquiring infection in hospitals and developing complications due to immunosuppression.

Although there have been publications about impact of COVID-19 in pediatric oncology patients, there are few available data about children with brain tumors. Most of them measure its impact by surveying centers about administration during the COVID-19 pandemic or describe small case series of delays in diagnostics. We share our experience in order to help other pediatric neuro-oncology units, especially in countries with limited resources.

The vulnerability and impact of COVID-19 in children with cancer has concerned oncology units, which have adopted several preventive measures to keep patients safe.2,4,5 One important measure has been the use of telemedicine, in order to keep in touch with patients who could not attend the hospital.

In our experience, many parents preferred in-person visits, even when a telephone consultation was offered instead. Despite having more on-site visits than strictly necessary, following all the preventive measures, this did not result in an increase in COVID-19 infection among our clinic cohort.

The incidence of COVID-19 during the first wave of the pandemic in our unit has been low (0.8%) compared with the literature.4 Only one patient had SARS-CoV-2 confirmed infection. This patient was tested while in the intensive care unit and did not have any symptoms of COVID-19 or known positive contact. We had only one patient with a confirmed contact (0.8%); this patient did not develop infection. In our perception, most of the parents were conscious and aware of risk of COVID-19.

Delayed referral of pediatric brain tumors has been well documented during the first wave of the pandemic.6 In our...
Table 1. Patient and consultation characteristics.

| Variable                           | % or n (%) |
|------------------------------------|------------|
| Consultations                      |            |
| On-site                            | 73         |
| Telephone                          | 27         |
| Province of Madrid residence       |            |
| Yes                                | 60         |
| No                                 | 40         |
| Telephone visits                   |            |
| Madrid                             | 52         |
| Out of Madrid                      | 48         |
| In treatment                       | 55         |
| Out of treatment                   | 45         |
| Diagnosis                          |            |
| LGG                                | 50         |
| Medulloblastoma                    | 20         |
| HGG                                | 8          |
| Germ cell tumor                    | 8          |
| Ependymoma                         | 6          |
| Craniopharyngioma                  | 2          |
| ATRT                               | 2          |
| ETMR                               | 1          |
| Choroid plexus tumor               | 1          |
| CNS neuroblastoma                  | 1          |
| Pinealoblastoma                    | 1          |
| Contact with confirmed COVID-19 case|            |
| Yes                                | 1 (0.8)    |
| No                                 | 122 (99.2) |
| Positive test for COVID-19         |            |
| Yes                                | 1 (0.8)    |
| No                                 | 122 (99.2) |
| Imaging test delay                 |            |
| Yes                                | 15 (12)    |
| No                                 | 108 (88)   |
| Patients out of treatment          | 13 (86)    |
| Delay time for imaging test, days  |            |
| Median                             | 49         |
| Range                              | 5–215      |
| Chemotherapy delay                 |            |
| Yes                                | 1 (2)      |
| No                                 | 46 (98)    |
| Radiotherapy delay                 |            |
| Yes                                | 0 (0)      |
| No                                 | 9 (100)    |

ATRT: atypical teratoid rhabdoid tumor; CNS: central nervous system; COVID-19: coronavirus disease 2019; ETMR: embryonal tumor with multilayered rosettes; HGG: high-grade glioma; LGG: low-grade glioma.

cohort, only one patient was diagnosed later due to a several months gap between symptom onset and medical consultation due to home lockdown measures.

The unprecedented situation of shortage of beds; lack of ventilators, medication, blood products, and staff; delays in treatments such as chemotherapy and radiotherapy; and delays in imaging and surgery has been described worldwide. International societies recommend that planned diagnosis and treatment of children with cancer should continue with as few modifications as necessary. In our unit, it was more frequent to postpone imaging than radiotherapy or chemotherapy. Surgery has not been analyzed; nor has shortage of medication or blood products. In the Pediatric Oncology East and Mediterranean (POEM) group survey including 34 centers, there were delays in chemotherapy in 10 centers (29%) and in radiotherapy in 16 centers (47%). In Latin America, in a survey of 553 patients corresponding to 20 centers, there was a delay or modification in chemotherapy in 36% of cases and in 33% of radiotherapy treatments. There are fewer data about imaging tests, which is important, especially MRI, in patients with brain tumors, both in diagnosis and follow-up.

Comparisons are difficult due to differences between countries and socioeconomic situations. Our unit is also located in a pediatric hospital, which has not attended adults, without shortage of critical care beds.

Conclusion

The measures implemented in the Pediatric Neuro-Oncology Unit during the lockdown in Spain were effective in minimizing the risk of COVID-19 infection. These measures allowed for continuity in the diagnosis and treatment of children and adolescents with brain tumors, avoiding delays that could impact their survival, as recommended by pediatric oncology societies, and without a significant exposure to COVID-19 infection.

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