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Pediatric Neurosurgery After the COVID-19 Pandemic: Management Strategies from a Single Pediatric Hospital in Italy

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■ **BACKGROUND:** Coronavirus disease-2019 (COVID-19) pandemic had a great impact over all elective neurosurgical activity and important implications in management of neurosurgical urgencies. During the pandemic, some pediatric hospitals reported their experiences. After the emergency phase of the COVID-19 pandemic, the health care system needs to be reorganized to again manage all nonurgent activities, while ensuring safety of both patients and health care workers.

■ **METHODS:** We developed preventive measures to limit any possibility of COVID-19 spread, according to the principles of epidemiologic prevention and suggestions from recent literature. To evaluate the efficacy of these measures, we retrospectively reviewed the neurosurgical activity at our institution from May 4 to July 15, 2020.

■ **RESULTS:** One hundred nineteen patients were admitted to the neurosurgical ward, and 80 surgical procedures were performed. Furthermore, 130 outpatient clinics were scheduled. A total of 258 nasopharyngeal swabs and 249 specific interviews were performed. In our series, no cases of positivity for severe acute respiratory syndrome coronavirus-2 infection were found, and no surgical cases were postponed.

■ **DISCUSSION:** We present the management of the neurosurgical activity after the emergency phase at the Neurosurgical Department of Giannina Gaslini Children's Hospital in Genoa, Italy.

■ **CONCLUSIONS:** The Italian health care system is undertaking a process of reorganization of resources, in an attempt to restore all nonurgent activities while ensuring safety. After the emergency phase, we are learning to live together with COVID-19 and, although epidemiologic data are encouraging, we must be prepared for an eventual second peak.

INTRODUCTION

The coronavirus disease-2019 (COVID-19) pandemic produced a unique global crisis in the recent history, with critical economic, health, and social repercussions. No countries have been spared and many national health care systems experienced an important lack of health resources. To contain the infection, many governments put in place extensive and aggressive counter-measures, such as a national lockdown. Guidelines for optimization of resources were mostly limited to guidelines from national societies and single institutions. COVID-19 pandemic had a great impact over all elective neurosurgical activity but at the same time had important implications in management of neurosurgical urgencies.¹ During the pandemic, some authors²⁻⁴ reported their experience in pediatric hospitals regarding the management of the neurosurgical activity, such as elective and urgency surgery, outpatient visits, and visitors access for pediatric patients. Although clinical manifestations of COVID-19 in pediatric patients are generally less severe compared with the adult patients (>90% are asymptomatic, mild, or moderate cases), young children, particularly infants, are still vulnerable to

Key words

- COVID-19
- Neurosurgery
- Pandemic
- Pediatric neurosurgery

Abbreviations and Acronyms

COVID-19: Coronavirus disease-2019

HCW: Health care worker

PPE: Personal protective equipment

SARS-CoV-2: Severe acute respiratory syndrome coronavirus-2

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infection.⁵ Furthermore, visitors, nonmedical staff, and health care workers (HCWs) of pediatric hospitals are not free from risk of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection.

Four months after the World Health Organization declared COVID-19 a pandemic,⁶ the Italian epidemiologic data were encouraging, showing that the epidemic peak decreased. After the emergency phase of the COVID-19 pandemic, the health care system needs to be reorganized to again manage all nonurgent activities, while ensuring safety of both patients and HCWs. In this article, we present the management of the pediatric neurosurgical activity after the emergency phase at the Neurosurgical Department of Giannina Gaslini Children's Hospital in Genoa, Italy.

METHODS

A specific crisis unit commission for the management of COVID-19 infection has been created. For the neurosurgical activity, the expert panel was composed of the general manager, health director, and health management service director from our institution; consultant anesthesiologists; infectious disease specialists; hygiene and public health specialists; and neurosurgeons with direct experience in COVID-19 management. Specific guidelines were developed to maintain a high-quality health care and security for patients and HCWs. In addition, 2 levels of personal protective equipment (PPE) have been established: primary PPE (e.g., surgical mask, surgical cap, and gloves) and secondary PPE (filtering face piece 2 mask or powered air-purifying respirator, work uniform, disposable medical protective uniform, gloves, and surgical cap).

All the following measures have been developed according to the principles of epidemiologic prevention and suggestions from recent literature. To evaluate the efficacy of these preventive measures, we retrospectively reviewed the neurosurgical activity at our institution from May 4 to July 15, 2020, after the end of national lockdown in Italy, and we compared these data with data collected during national lockdown in Italy (from March 1 to April 30, 2020).

RESULTS

In the selected period, 119 patients were admitted in the neurosurgical ward and 80 surgical procedures (71 elective cases, 9 urgencies) were performed. Furthermore, 130 outpatient clinics were scheduled. All the patients admitted to the ward, one parent/caregiver for each patient, and the neurosurgery staff (physicians, nurses, and supplementary personnel) underwent nasopharyngeal swabs for SARS-CoV-2 for a total of 258 cases. A total of 249 specific interviews were performed. In our series, no cases of positivity for SARS-CoV-2 infection were found and no surgical cases were postponed.

In comparison with these data, during national lockdown (from March 1 to April 30, 2020) neurosurgical activity decreased. Indeed, 55 patients were admitted to the neurosurgical ward and 48 surgical procedures (40 elective cases, 8 urgencies) were performed. Nasopharyngeal swabs for SARS-CoV-2 were performed only for hospitalized patients and neurosurgery staff with clinical signs/symptoms or suspicious of SARS-CoV-2 infection for a total

of 75 nasopharyngeal swabs for SARS-CoV-2. Only 1 case of SARS-CoV-2 infection was found among personnel. Outpatient visit were suspended.

DISCUSSION

Surgical Case Classification

As for other neurosurgical centers, during the pandemic all elective cases were suspended and surgical cases were classified to quantify the "surge level" of the disease.^{1,7,8} Surgical cases were classified into 5 classes: A++ (emergency: requiring immediate treatment), A+ (urgency: requiring treatment within a maximum of 7–10 days), A (requiring treatment within 1 month), B (requiring treatment within 6 months), and class C (requiring treatment without a specific timing). At our institution, surgical activity was maintained for all the first 4 classes (also for some surgical cases whose treatment could be delayed for >1 month) because the Neurosurgical Department of Giannina Gaslini Children's Hospital in Genoa is one of the few dedicated pediatric hospitals of the Italian health care system, with the duty of management of patients from all over the country. Those cases were selected after multidisciplinary clinical case discussion and crisis unit commission approval.

Following the earlier mentioned guidelines adopted during national lockdown, elective workload was also stratified according to the "surge level" of the disease. The priority of the elective surgical waiting list was based on this classification of surgical cases and stratification was done according to the clinical status.

Specifically, tumors were stratified as class A+ (urgency: requiring treatment within a maximum of 7–10 days) or A and treated with no delay during pandemic. Epilepsy disorders, vascular diseases, and malformative pathologies (such as craniosynostosis, Chiari malformations, and spinal dysraphism) were stratified as class A (requiring treatment within 1 month) or B (requiring treatment within 6 months). Minor surgery (such as dermoid cyst of the skull, cranioplasty, selective lumbar rhizotomy, or antalgic pump systems) were stratified as class B or class C (requiring treatment without a specific timing).

After the end of national lockdown, referrals at our unit returned to as before the pandemic; the overall waiting list has been delayed for about 2 months.

Emergency Admission/Surgery

After the emergency phase, patients who need urgent hospital admission or neurosurgical treatment are managed as suspected cases with proper preventive measures in the same way as in the emergency period. During triage, a specific interview and a nasopharyngeal swab for SARS-CoV-2 is performed. As in the emergency period, if the patient's conditions could allow to wait for the result, surgery is postponed, whereas cases that require immediate treatment are managed through a separate COVID-19 path, and surgery is performed in a dedicated COVID-19 operating room, and subsequent hospitalization in a dedicated COVID-19 department.

Elective Admission/Surgery

Since the end of national lockdown in Italy, all elective surgery for nonurgent cases has been scheduled again and performed at our

institution. A specific protocol for elective surgery has been developed:

- 4 days before the admission, to preventively assess clinical and epidemiologic conditions of patients and caregivers, a specific telephone interview is performed.
- A nasopharyngeal swab for SARS-CoV-2 is performed 48 hours before admission at an affiliated laboratory in the city of residence or at the outpatient clinic of Giannina Gaslini Hospital. If patient's clinical conditions require hospitalization to perform preoperative examinations before the admission to the neurosurgical ward, a nasopharyngeal swab for SARS-CoV-2 is performed after hospitalization at the dedicated COVID-19 department of Giannina Gaslini Hospital.
- If both telephone interview and nasopharyngeal swab are negative, patient is considered negative and therefore admitted to the neurosurgical ward. In case any positivity is found, considering the nonurgent nature of these cases, surgery is postponed until the negativity of a second nasal swab and after 15 days of patient isolation.

Ward's Activity/Visitors

The neurosurgical department was considered a COVID-19-free zone during the emergency. For this reason, all supplementary activities (e.g., internal teaching, volunteering, students training) were suspended. Residents' activity was reduced to help physicians for routine activity, on-call shifts, and cover shifts of sick staff. Furthermore, pediatric patients need the presence of parents/caregiver in their daily activity. To reduce the risk of infection, during the pandemic, access of visitors was limited to a single person that underwent specific interview for COVID-19 disease.

After resuming elective surgery, supplementary activities have been gradually reintegrated. All asymptomatic staff is screened for SARS-CoV-2 infection with nasopharyngeal swab. This screening was performed sporadically in the first period after the end of the emergency phase. With the increasing number of nasopharyngeal swabs that can be performed and the use of the rapid antigenic test, health care personnel is screened weekly. If the screening revealed a positivity for SARS-CoV-2 infection, the HCW was discharged from work and quarantined for 14 days. At the end of this period, the HCW returned to work after 2 negative nasopharyngeal swab for SARS-CoV-2 infection, performed 24 hours from each other. In case of HCW still positive after 14 days of quarantine, 2 more nasopharyngeal swab for SARS-CoV-2 infection were performed 21 days after infection. HCWs with persistent positivity underwent to specific visit by the Occupational Health Service. Visitors are currently limited to 1 parent/caregiver for each patient. Given the increase of SARS-CoV-2 swabs that can be performed at our hospital, the selected visitor is now subjected to nasopharyngeal swab at patient admission and receive a written authorization from the neurosurgical department after negative result. The visitor must wear primary PPE. In case the hospitalization lasts >7 days, another visitor is allowed to access the neurosurgical ward, always after negative nasopharyngeal swab and written authorization as mentioned before.

Diagnostic Instrumental Examinations

Pediatric patients often require anesthesiologic support and mild sedation while performing radiologic and instrumental examinations (such as brain or spine MRI, CT scan and x-ray, endovascular treatments, lumbar puncture, valve check and regulation, etc.). During the pandemic, nonurgent examinations were not performed. For urgent examinations, specific areas, with a dedicated path for entrance and exit were created. HCW, radiologic, and diagnostic instrumentation were dedicated for patients with COVID-19 disease or suspected cases. A sanitization procedure of the areas and machines was performed after every examination.

With the end of the lockdown, routine examinations were gradually re-established but 2 different paths have been maintained:

- Patients with negative nasopharyngeal swab for SARS-CoV-2 (performed at least 48 hours before the examination) hospitalized in the neurosurgical ward or admitted in a day hospital regimen, follow the clean path and are subjected to radiologic/instrumental examinations with primary PPE for patients and HCWs.
- Patients without nasopharyngeal swab are outpatients who will follow a dedicated path and are subjected to radiologic/instrumental examinations with primary PPE for patients and secondary PPE for HCWs.

To ensure an adequate separation among patients/caregivers and to limit the time spent in waiting rooms, corridors, et cetera, every examination/procedure is scheduled considering the required time for each procedure. Sanitization procedure of the areas and machines are performed after every examination.

Outpatient Clinics

During the emergency period, nonurgent outpatient clinics were suspended, whereas urgent consultations were performed, whenever feasible, with a telemedicine service. If clinical examination was required, outpatient visit was performed with secondary PPE and after specific telephone interview to assess sign or symptoms of COVID-19 disease.

After the emergency phase, outpatient activity has been restored with an effort on ensuring safety of both patients and HCWs. The patient and a single parent/caregiver must wear primary PPE and are screened (specific interview and temperature check) before entering into the hospital. Outpatient clinics are scheduled considering the time required for each visit (mean 30–45 minutes) and for sanitization of medical office (up to 30 minutes). To reduce overcrowding into waiting rooms, patients and caregivers are allowed to access the hospital only from 15 minutes before the appointment until 15 minutes after. In case of delay, according to the priority of the outpatient visit, it was rescheduled and the patients were telephonically informed. In addition, the maximum capacity for every clinic is established with respect to social distancing (1.5 square meters). Because of the increased time needed for each visit, the outpatient clinics are scheduled from 08:00 AM to 08:00 PM, 5 days per week. The use of absorbable stitches made it possible to avoid further access to the hospital for their removal. Telemedicine service was restored as it was before

the pandemic for small peripheral hospitals requiring pediatric neurosurgical consultation.

CONCLUSIONS

The Italian health care system is undertaking a process of reorganization of resources in an attempt to restore all nonurgent activities while ensuring safety. After the emergency phase, we are learning to live together with COVID-19 and, although epidemiologic data are encouraging, we must be prepared for an eventual second peak. For this reason we must limit any possibility of COVID-19 spread. The aim of our article was to provide information and suggest management strategies beyond the emergency phase. It is clear that we cannot resign to treating all other pathologies, even if nonurgent, beside SARS-CoV-2 infection. All the measures and strategies proposed in the article have been developed specifically for our hospital, but part of these guidelines are similar to the measures adopted in other Italian centers and this is an expression of the efforts made to reorganize the Italian health care system. Furthermore, the development of these guidelines

follows the principles of epidemiologic prevention and suggestions from recent literature, considering the strategies also adopted from other health care systems. We hope that our experience could be helpful for other centers around the world.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Marco Ceraudo: Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Alberto Balestrino:** Visualization, Investigation, Writing - review & editing. **Armando Cama:** Supervision. **Gianni Macrina:** Writing - review & editing. **Gianluca Piatelli:** Supervision. **Alessandro Consales:** Data curation, Writing - original draft, Supervision.

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