

# BMJ Open Patients awaiting surgery for neurosurgical diseases during the first wave of the COVID-19 pandemic in Spain: a multicentre cohort study

Ana M Castaño-Leon <sup>1,2</sup>, Igor Paredes <sup>1,2,3</sup>, Alfonso Lagares,<sup>1,2,3</sup> Pedro A Gomez,<sup>1,2</sup> Pedro González-Leon,<sup>1</sup> Angel Perez-Nuñez,<sup>1,2,3</sup> Luis Jiménez-Roldán,<sup>1,2,3</sup> Juan Delgado-Fernández <sup>1</sup>, Carla Eiriz Fernández,<sup>1</sup> Daniel García-Pérez,<sup>1</sup> Luis M Moreno-Gómez,<sup>1</sup> Olga Esteban-Sinovas,<sup>1</sup> Pedro D Delgado-López <sup>4</sup>, Javier Martín-Alonso,<sup>4</sup> Ariel Kaen,<sup>5</sup> Jorge Tirado-Caballero,<sup>5</sup> Marta Ordóñez-Carmona,<sup>5</sup> Francisco Arteaga-Romero,<sup>5</sup> Marta González-Pombo,<sup>5</sup> José F Alén,<sup>6</sup> Ricardo Gil-Simoes,<sup>6</sup> Cristina V Torres,<sup>6</sup> Marta Navas-García,<sup>6</sup> Guillermo Blasco García de Andoain,<sup>6</sup> Natalia Frade-Porto,<sup>6</sup> Patricia González-Tarno,<sup>6</sup> Adrian Martin Segura,<sup>6</sup> Miguel Gelabert-González,<sup>7</sup> Beatriz Menéndez-Cortezón,<sup>7</sup> Brais Rodríguez-Botana,<sup>7</sup> Rebeca Pérez-Alfayate,<sup>8</sup> Carla Fernández-García,<sup>8</sup> Borja Ferrández-Pujante,<sup>8</sup> Andres C Vargas-Jiménez,<sup>8</sup> Carlos Cotúa,<sup>8</sup> Adolfo de la Lama,<sup>9</sup> Lourdes Calero Félix,<sup>9</sup> Fernando Ruiz-Juretschke,<sup>10</sup> Roberto García-Leal,<sup>10</sup> Marc Valera-Melé,<sup>10</sup> Vicente Casitas Hernando,<sup>10</sup> Belén Rivero,<sup>11</sup> Javier Orduna-Martínez,<sup>12</sup> Juan Casado Pellejero,<sup>12</sup> David Fustero De Miguel,<sup>12</sup> Jorge Díaz Molina,<sup>12</sup> Jesús Moles Herbera,<sup>12</sup> Maria J Castelló-Ruiz,<sup>13</sup> Mario Gomar-Alba,<sup>13</sup> Fernando García-Pérez,<sup>13</sup> Borja J Hernández-García,<sup>14</sup> Jorge J Villaseñor-Ledezma,<sup>15</sup> Álvaro Otero-Rodríguez,<sup>15</sup> Juan J Ailagas de las Heras,<sup>15</sup> Jesus Gonçalves-Estella,<sup>15</sup> Pablo Sousa-Casasnovas,<sup>15</sup> Daniel Pascual-Argente,<sup>15</sup> Laura Ruiz Martín,<sup>15</sup> Juan C Roa Montes de Oca,<sup>15</sup> Daniel Arandia Guzmán,<sup>15</sup> Andoni García Martín,<sup>15</sup> Luis Torres Carretero,<sup>15</sup> Alejandra Garrido Ruiz,<sup>15</sup> Marta Calvo,<sup>16</sup> Pablo Miranda-Lloret,<sup>17</sup> Miguel Rodríguez-Cadarso,<sup>17</sup> Joan Antón,<sup>17</sup> Amparo Roca Barber,<sup>17</sup> Arnold Quiroz-Tejada,<sup>17</sup> Guillermo Carbayo-Lozano,<sup>18</sup> Garazi Bermúdez,<sup>18</sup> Clara Paternain Martin,<sup>18</sup> Pablo De la Fuente Villa,<sup>18</sup> Marina Fidalgo De la Rosa,<sup>18</sup> Íñigo L Sistiaga-Gracia,<sup>18</sup> Gorka Zabalo<sup>18</sup>

**To cite:** Castaño-Leon AM, Paredes I, Lagares A, *et al.* Patients awaiting surgery for neurosurgical diseases during the first wave of the COVID-19 pandemic in Spain: a multicentre cohort study. *BMJ Open* 2022;12:e061208. doi:10.1136/bmjopen-2022-061208

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2022-061208>).

Received 28 January 2022  
Accepted 31 July 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

## Correspondence to

Dr Ana M Castaño-Leon;  
[ana.maria.castano.leon@gmail.com](mailto:ana.maria.castano.leon@gmail.com)

## ABSTRACT

**Objectives** The large number of infected patients requiring mechanical ventilation has led to the postponement of scheduled neurosurgical procedures during the first wave of the COVID-19 pandemic. The aims of this study were to investigate the factors that influence the decision to postpone scheduled neurosurgical procedures and to evaluate the effect of the restriction in scheduled surgery adopted to deal with the first outbreak of the COVID-19 pandemic in Spain on the outcome of patients awaiting surgery.

**Design** This was an observational retrospective study.

**Settings** A tertiary-level multicentre study of neurosurgery activity between 1 March and 30 June 2020.

**Participants** A total of 680 patients awaiting any scheduled neurosurgical procedure were enrolled. 470 patients (69.1%) were awaiting surgery because of

spine degenerative disease, 86 patients (12.6%) due to functional disorders, 58 patients (8.5%) due to brain or spine tumours, 25 patients (3.7%) due to cerebrospinal fluid (CSF) disorders and 17 patients (2.5%) due to cerebrovascular disease.

**Primary and secondary outcome measures** The primary outcome was mortality due to any reason and any deterioration of the specific neurosurgical condition. Second, we analysed the rate of confirmed SARS-CoV-2 infection.

**Results** More than one-quarter of patients experienced clinical or radiological deterioration. The rate of worsening was higher among patients with functional (39.5%) or CSF disorders (40%). Two patients died (0.4%) during the waiting period, both because of a concurrent disease. We performed a multivariate logistic regression analysis to determine independent covariates associated with maintaining the surgical indication. We found that

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This was a multicentre, tertiary-level, observational retrospective study of patients awaiting any neurosurgical procedure during the first wave of the SARS-CoV-2 pandemic in Spain.
- ⇒ The primary outcome was mortality due to any reason and any deterioration of the specific neurosurgical condition.
- ⇒ This study is a snapshot of an evolving pandemic with huge variation of its effects between centres according to the community SARS-CoV-2 incidence at the time of the first peak of the pandemic and hospital size.
- ⇒ The quality of the data depends on the accuracy of data collection by the collaborators, although active supervision and discussion of discordant information were performed during the study.

community SARS-CoV-2 incidence (OR=1.011,  $p<0.001$ ), degenerative spine (OR=0.296,  $p=0.027$ ) and expedited indications (OR=6.095,  $p<0.001$ ) were independent factors for being operated on during the pandemic.

**Conclusions** Patients awaiting neurosurgery experienced significant collateral damage even when they were considered for scheduled procedures.

## INTRODUCTION

The SARS-CoV-2 pandemic has affected healthcare systems worldwide more severely than ever in recent history. Spain was one of the developed countries most severely stricken by the first outbreak.<sup>1</sup> On 30 June 2020, 252 878 cases had been diagnosed, 103 225 were hospitalised, 8372 were admitted to intensive care units (ICUs) and 29 567 had died from the disease.<sup>2</sup>

Difficulties accessing and the fear of non-infected patients visiting the emergency service caused a delay in the diagnosis and treatment of new cases.<sup>3</sup> The large number of infected patients requiring hospital admission and mechanical ventilation resulted in scheduled procedures being postponed, conversion of operating rooms into ICUs and task shifting from surgery to COVID-19 of staff members of surgical teams.<sup>4,5</sup> Thus, surgery might be disproportionately affected by the pandemic more than other medical processes. In addition, outpatient clinics were initially halted until telemedicine emerged as a method to follow the neurological condition of patients awaiting surgery and prioritise patients who should have undergone scheduled surgeries despite the pandemic.<sup>6–8</sup>

Special attention has been given to the effect of COVID-19 on patients undergoing surgery during the first wave of the pandemic,<sup>9,10</sup> but limited information is available about scheduled case management and the effect on patients awaiting surgery at the same stage of the pandemic. High levels of stress due to the waiting time and fear of clinical worsening during the waiting period, even higher than the worry of being infected during hospitalisation, have been documented in neurosurgical patients.<sup>11</sup>

The aims of this study are to investigate the factors that influence the decision to postpone scheduled neurosurgical procedures and to evaluate the effect of the

restriction in scheduled surgery adopted to deal with the first outbreak of the COVID-19 pandemic in Spain on the outcome of patients awaiting surgery.

## MATERIALS AND METHODS

### Study design

On June 2020, a national call for data collection of patients with any neurosurgical disease evaluated during the first wave of the COVID-19 pandemic (COVIDNeurosurg registry) was launched. It was supported and promoted by the Sociedad Española de Neurocirugía and the Sociedad de Neurocirugía de la comunidad de Madrid. A provider-profiling questionnaire was administered in all of the institutions that accepted the invitation to collaborate to evaluate the characteristics of each neurosurgical service and the maximum percentage of hospital beds dedicated to patients with COVID-19 during the first wave of the pandemic (online supplemental file 1).

This was an observational, retrospective, multicentre study conducted according to Strengthening the Reporting of Observational Studies in Epidemiology guidelines.<sup>12</sup> Patients who fulfilled the following inclusion criteria and none of the exclusion criteria were recorded in the registry.

Patient inclusion criteria:

- Children and adult patients awaiting any neurosurgical procedure registered in the surgical lists between 1 March and 30 June. Patients included in the surgical list before the pandemic started but who did not undergo surgery during the period of study were also included in this subgroup of patients.
- Patients who underwent any neurosurgical procedure, irrespective of their urgency and complexity, during the same period of the study.
- Confirmed diagnosis of any neurosurgical disease: intracranial and spinal tumour, haemorrhagic cerebrovascular disease, traumatic brain injury, acute spine injury, degenerative spine disease, cerebrospinal fluid (CSF) disorders and functional neurosurgery.

Patient exclusion criteria:

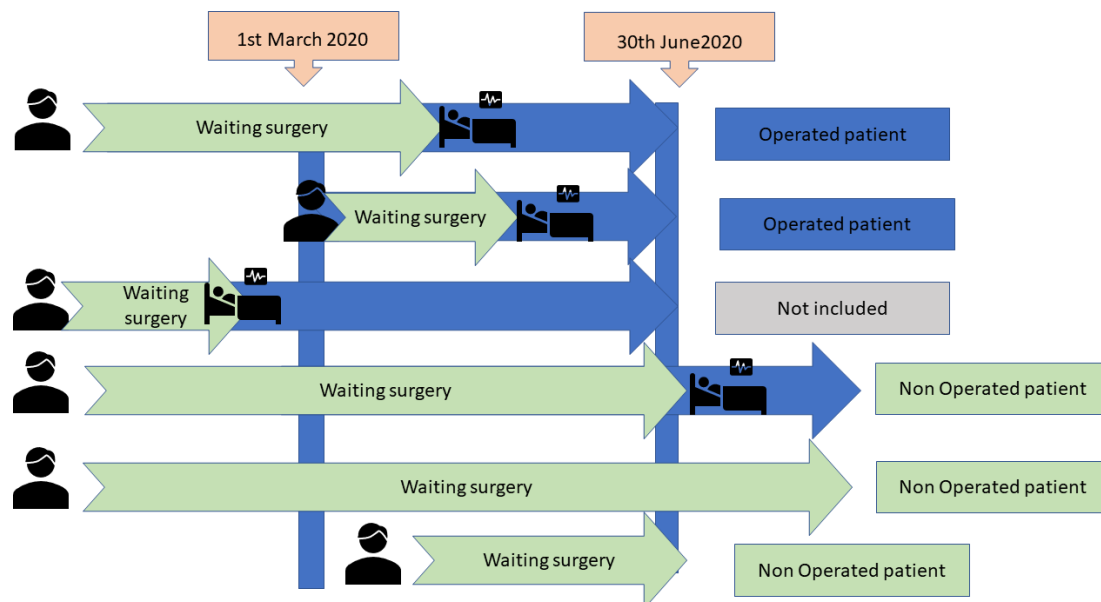
- Patients with any neurosurgical disease for which conservative management was preferred before the pandemic started.

Patient subgroups (non-operated and operated) were created according to their situation at the end of the period of study, as explained in figure 1.

An online database was used to collect anonymised data and stored on a secure data server running the Research Electronic Data Capture web application of data platform.<sup>13</sup> The data were audited for duplicates or discordant information.

### Data variables

Demographic characteristics, medical history, clinical data, date of diagnosis and inclusion in the surgical list, emergency of the procedure, reason to not perform the surgery during the first peak of the pandemic and



**Figure 1** Patient subgroups according to their condition of being operated or not operated during the study period. Created by the authors.

alternative treatment while the patient was awaiting surgery (online supplemental file 2) were recorded. Emergency procedures were defined by the following criteria, and they were assigned by the referring surgeon:

- Immediate: for conditions that are life-threatening.
- Urgent: for conditions that have the potential to deteriorate quickly and should be planned within 48 hours after diagnosis.
- Expedited: conditions requiring surgery desirable within 4 weeks after diagnosis.
- Elective: conditions that can wait more than 4 weeks after diagnosis to be planned.

### Community SARS-CoV-2 incidence

The community SARS-CoV-2 incidence within each participating hospital was extracted from the Ministry of Health official data.<sup>2 14</sup> SARS-CoV-2 incidence was calculated for each epidemiological 1-week (from Monday to Sunday) window based on the number of confirmed SARS-CoV-2 cases at the smallest available administrative level (province). Then, each patient was assigned the 7-day incidence of the week he or she was included in the surgical list.

### Outcome measures

Patient outcomes were reviewed at least up to the end of the period of inclusion of the study. All patients were followed by clinical telephone interviews, and imaging studies were performed in cases of suspicion of worsening according to the attending neurosurgeon.

The primary outcome was mortality at the end of the period of follow-up due to any reason and clinical deterioration or radiological progression of the specific neurosurgical condition according to the opinion of the attending neurosurgeon. In addition, we analysed the rate of confirmed SARS-CoV-2 infection defined by a positive

swab test and/or CT thorax imaging highly suggestive of SARS-CoV-2 infection.

### Statistical analysis

Descriptive statistics are represented as the median and IQR for quantitative measures and absolute frequency and its relative percentage for qualitative measures.

The COVIDNeurosurg registry covered operated and non-operated patients evaluated in the collaborative centres in the period of the study. Although the main objective of this study was non-operated patients, we recruited operated and non-operated patients from the registry to determine which factors were independently associated with not postponing a scheduled procedure during the pandemic. First, we excluded immediate and urgent surgeries that can bias the evaluation of imbalance between operated and non-operated patients. Then, differences in quantitative and categorical data were calculated by the Mann-Whitney U test and X<sup>2</sup> test, respectively. Finally, a multivariable logistic regression analysis was used to calculate ORs and 95% CIs for each independent covariate significantly related to being operated on during the pandemic. Additionally, we investigated whether surgery is a risk factor for acquiring SARS-CoV-2 infection. Thus, we performed a logistic regression analysis including the community SARS-CoV-2 incidence, preoperative swab test and being operated on during the study period to determine their effect on acquiring the infection.

All statistical analyses were performed using SPSS V.25 (IBM).

### Patient and public involvement

Patients were not involved in setting the research question, definition of outcome measures, design or implementation of this study. After the publication of the study,



there are plans for the results to be disseminated to the patient community affected by this research, which would help to motivate them to inform their physician when they experience any kind of worsening.

## RESULTS

### Centres and setting

Eight hospitals from six provinces (attending an approximate population of 10 483 134 people<sup>15</sup>) accepted the invitation to collaborate and registered patients who were included in the surgical list but finally were not operated on during the period of study. All the participating centres are based on the public health system and are tertiary-level hospitals. Madrid is the region with the highest number of participating centres (three centres).

The burden of the COVID-19 pandemic was estimated by means of the total number of in-hospital beds dedicated to patients with COVID-19 during the first wave of the pandemic. Four centres had occupations above 80%, one centre had occupations between 50% and 80%, and three centres had occupations below 20%.

### Patient characteristics

Among 1593 patients included in the COVIDNeurosurg registry, 680 (42.7%) patients were awaiting surgery at the end of the period of inclusion of the study. The sex distribution was 350 (51.5%) and 330 (48.5%) for men and women, respectively. The median age was 56 years old (IQR=21), with 652 adult patients and 28 children. The American Society of Anesthesiologists (ASA) category was grade I or II in most patients (521, 76.7%). According to the patients' medical history, 164 patients (24.1%) had none of interest. Frequently found pre-existing medical conditions were hypertension (245 patients, 36%), smoking (160 patients, 23.5%), diabetes mellitus (88 patients, 12.9%) or dyslipidaemia (48 patients, 7.1%).

Regarding neurosurgical disease, 470 patients (69.1%) were awaiting surgery because of spine degenerative disease, 86 patients (12.6%) due to functional disorders, 58 patients (8.5%) due to brain or spine tumours, 25 patients (3.7%) due to CSF disorders and 17 patients (2.5%) due to cerebrovascular disease. A minority of patients with traumatic spine injury (six patients, 0.9%), traumatic brain injury or its consequences such as calvaria defects (five patients, 0.7%) or infectious disease (two patients, 0.3%) were waiting for surgery.

Patient characteristics are detailed in [table 1](#).

### Scheduled procedures and reason to delay surgery

In relation to the emergency of the procedures, most cases (646 patients, 95%) were considered elective surgeries, and 34 patients (5%) were considered expedited surgeries. When we asked about the main reasons to postpone the procedures to the end of the pandemic, no bed or theatre space available was noted for 417 patients (61.3%). Patient choice to avoid the surgery was indicated for 115 patients (16.9%), but the surgeon's decision to

delay the surgery due to risk to patients was reported for 256 patients (37.6%). A change in clinical status due to other medical conditions (12 patients, 1.8%) was another reason to not operate.

Among the 470 patients with degenerative spine disease, 120 patients (25.5%) were included in a rehabilitation programme, 139 patients (29.6%) were evaluated by chronic pain units and 268 patients (57%) were followed by the attending surgeon during the waiting period. Among the 58 patients with a diagnosis of brain or spine tumours awaiting surgery, 3 patients (5.1%) received neoadjuvant chemotherapy, and 2 patients (3.4%) received neoadjuvant radiation. None of the patients with a diagnosis of cerebrovascular disease were redirected to radiation therapy or endovascular treatment.

### Outcome

At the end of the follow-up, 173 patients (25.4%) experienced clinical deterioration, and for another 6 patients (0.9%), radiological progression of the neurosurgical disease was detected during the waiting period. Twenty-six patients (3.8%) experienced worsening due to concurrent disease not related to COVID-19. The subgroups of patients with the highest rate of deterioration were those waiting for functional neurosurgery (39.5%) and those with CSF disorders (40%). Among functional neurosurgical diseases, 60% were patients with chronic pain (such as chronic back pain, complex regional pain syndrome, trigeminal neuralgia), 28% were patients with refractory epilepsy and 12% were patients with Parkinson's disease or other movement disorders. Among these three main categories, the group with the highest rate of worsening was the epilepsy subgroup of patients (45.8% experienced deterioration).

Six patients (0.9%) had confirmed SARS-CoV-2 infection while they were waiting for surgery. Two patients died (0.4%) during the waiting period, both because of a concurrent disease. Outcome measures are detailed in [table 2](#).

### Comparison between operated and non-operated patients

Emergent and urgent surgeries were discarded to investigate factors related to not postponing a scheduled procedure (expedited or elective surgeries). By means of the univariate analysis, non-operated patients showed a higher rate of hypertension (36% vs 30.7%,  $p=0.043$ ), current smoking (23.5% vs 15.5%,  $p<0.001$ ), asthma (5.7% vs 2.8%,  $p=0.011$ ) and obesity (4.6% vs 1.8%,  $p=0.026$ ). However, we found that non-operated patients had a lower rate of arrhythmia (0.7% vs 2.2%,  $p=0.030$ ). A trend for a higher rate of congestive heart failure (2.9% vs 1.5%) and chronic kidney disease (3.2% vs 1.7%) was also noticed for non-operated patients. The distribution of the ASA grades was also significantly different, with higher grades to the operated subgroup, probably in relation to the severity of the neurosurgical disease that was being treated. According to the specific neurosurgical disease, we observed a different distribution between

**Table 1** Patient demographics and clinical characteristics: comparison between operated and non-operated patients

|                                      | Non-operated                                | Operated                                    | Comparison between groups (p value) |
|--------------------------------------|---------------------------------------------|---------------------------------------------|-------------------------------------|
| <b>Number of patients</b>            | <b>680</b>                                  | <b>913</b>                                  |                                     |
| Age (median. IQR)                    | 56 (21)                                     | 56 (29)                                     | 0.992                               |
| Sex                                  | Male 350 (51.5%)<br>Female 330 (48.5%)      | Male 487 (53.3%)<br>Female 426 (46.7%)      | 0.460                               |
| Epidemiological week*                | 4 (7)                                       | 19 (10)                                     | <0.001                              |
| Community SARS-CoV-2 incidence*      | 7 (31)                                      | 33 (20)                                     | <0.001                              |
| Weight/BMI                           | 75 kg (21)/<br>29.5 kg/m <sup>2</sup> (6.3) | 70 kg (22)/<br>26.1 kg/m <sup>2</sup> (9.5) | 0.026<br>0.051                      |
| ASA grade                            |                                             |                                             |                                     |
| Unknown                              | 9 (1.3%)                                    | 18 (2%)                                     | <0.001                              |
| Grades I and II                      | 521 (76.7%)                                 | 582 (63.7%)                                 |                                     |
| Grades III and IV                    | 149 (22%)                                   | 305 (33.4%)                                 |                                     |
| Grade V                              | 0                                           | 8 (0.9%)                                    |                                     |
| Medical history                      |                                             |                                             |                                     |
| None                                 | 164 (24.1%)                                 | 208 (22.8%)                                 | 0.533                               |
| Hypertension                         | 245 (36%)                                   | 303 (33.2%)                                 | 0.238                               |
| Diabetes                             | 88 (12.9%)                                  | 152 (16.6%)                                 | 0.041                               |
| Dyslipidemia                         | 48 (7.1%)                                   | 75 (8.2%)                                   | 0.393                               |
| Current smoker                       | 160 (23.5%)                                 | 134 (14.7%)                                 | <0.001                              |
| COPD                                 | 37 (5.4%)                                   | 34 (3.7%)                                   | 0.100                               |
| Asthma                               | 39 (5.7%)                                   | 28 (3.1%)                                   | 0.009                               |
| Ischaemic heart disease              | 32 (4.7%)                                   | 36 (3.9%)                                   | 0.456                               |
| Obesity                              | 31 (4.6%)                                   | 23 (2.5%)                                   | 0.026                               |
| Congestive heart failure             | 20 (2.9%)                                   | 19 (2.1%)                                   | 0.272                               |
| Chronic kidney disease               | 22 (3.2%)                                   | 18 (2%)                                     | 0.111                               |
| Arrhythmia                           | 5 (0.7%)                                    | 25 (2.7%)                                   | 0.004                               |
| Specific pathology                   |                                             |                                             |                                     |
| Oncology                             | 58 (8.5%)                                   | 286 (31.3%)                                 | <0.001                              |
| Degenerative spine                   | 470 (69.1%)                                 | 163 (17.9%)                                 |                                     |
| TBI                                  | 5 (0.7%)                                    | 111 (12.2%)                                 |                                     |
| Haemorrhagic cerebrovascular disease | 17 (2.5%)                                   | 115 (12.6%)                                 |                                     |
| CSF                                  | 25 (3.7%)                                   | 93 (10.2%)                                  |                                     |
| Functional                           | 86 (12.6%)                                  | 42 (4.6%)                                   |                                     |
| Traumatic spine injury               | 6 (0.9%)                                    | 40 (4.4%)                                   |                                     |
| Infectious                           | 2 (0.3%)                                    | 24 (2.6%)                                   |                                     |
| Paediatric specific                  | 11 (1.6%)                                   | 39 (4.2%)                                   |                                     |
| Priority of the surgery              |                                             |                                             |                                     |
| Emergent                             | 0                                           | 193 (21.1%)                                 | <0.001                              |
| Urgent (<48 hours)                   | 0                                           | 120 (13.1%)                                 |                                     |
| Expedite (<4 weeks)                  | 34 (5%)                                     | 248 (27.2%)                                 |                                     |
| Elective (>4 weeks)                  | 646 (95%)                                   | 352 (38.6%)                                 |                                     |
| SARS-CoV-2 infection                 |                                             |                                             |                                     |
| Not confirmed/suspected              | 674 (99.1%)                                 | 889 (97.4%)                                 | Not appropriate                     |
| Awaiting surgery                     | 6 (0.9%)                                    | 5 (0.5%)                                    |                                     |
| Preoperative screening               | 0                                           | 6 (0.7%)                                    |                                     |
| In-hospital admission                | 0                                           | 5 (0.5%)                                    |                                     |
| After hospital discharge <30 days    | 0                                           | 7 (0.8%)                                    |                                     |
| After hospital discharge >30 days    | 0                                           | 1 (0.1%)                                    |                                     |

\*median week and SARS-CoV-2 rate of new cases at province level by the time which the procedure was performed for Operated patients or patient was included into the surgical list for Nonoperated patients.

ASA, American Society of Anesthesiologists; BMI, body mass index; COPD, chronic obstructive pulmonary disease; CSF, cerebrospinal fluid; TBI, traumatic brain injury.

**Table 2** Outcomes of non-operated patients at the end of the study period

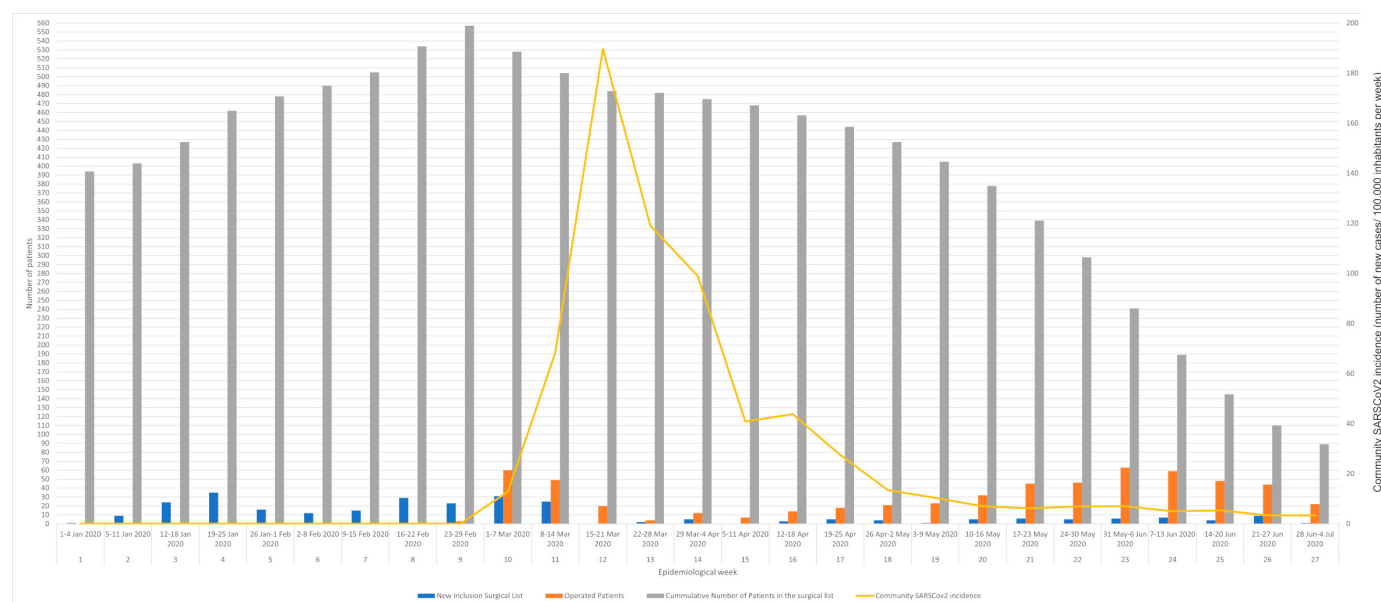
|                                      | Clinical deterioration and radiological progression | Clinical deterioration without radiological progression | Radiological progression without clinical deterioration | New-onset disease, non-related to COVID-19 | Non-deterioration | Death    |
|--------------------------------------|-----------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|--------------------------------------------|-------------------|----------|
| Oncology                             | 1 (1.7%)                                            | 2 (3.4%)                                                | 0                                                       | 1 (1.7%)                                   | 53 (91.4%)        | 1 (1.7%) |
| Degenerative spine                   | 12 (2.6%)                                           | 110 (23.4%)                                             | 5 (1.1%)                                                | 16 (3.4%)                                  | 326 (69.4%)       | 1 (0.2%) |
| TBI                                  | 0                                                   | 1 (20%)                                                 | 0                                                       | 0                                          | 4 (80%)           | 0        |
| Haemorrhagic cerebrovascular disease | 1 (5.9%)                                            | 0                                                       | 0                                                       | 3 (17.6%)                                  | 13 (76.5%)        | 0        |
| CSF                                  | 0                                                   | 10 (40%)                                                | 0                                                       | 2 (8%)                                     | 13 (52%)          | 0        |
| Functional                           | 0                                                   | 34 (39.5%)                                              | 0                                                       | 3 (3.5%)                                   | 49 (57%)          | 0        |
| Traumatic spine disease              | 0                                                   | 1 (16.7%)                                               | 0                                                       | 1 (16.7%)                                  | 4 (66.7%)         | 0        |
| Infectious                           | 0                                                   | 0                                                       | 1 (50%)                                                 | 0                                          | 1 (50%)           | 0        |
| Paediatric                           | 0                                                   | 1 (0.1%)                                                | 0                                                       | 0                                          | 10 (90.9%)        | 0        |

CSF, cerebrospinal fluid; TBI, traumatic brain injury.

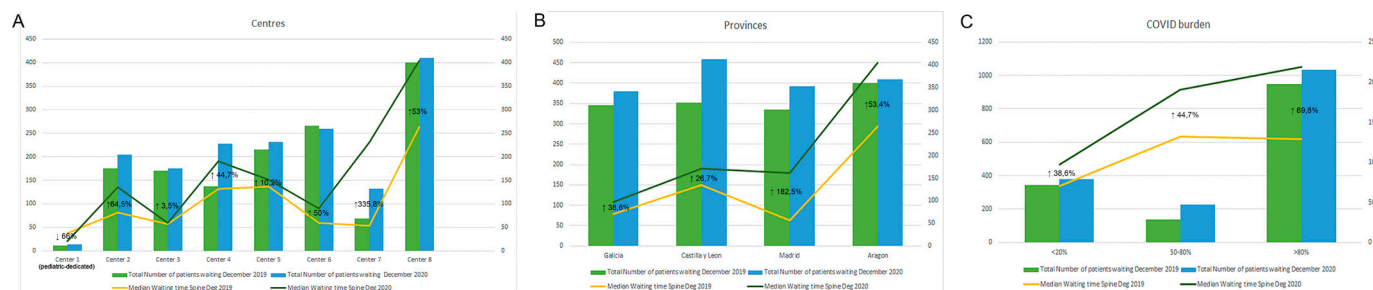
subgroups, which was especially relevant to degenerative spine disease (69.1% vs 25.8%) and neuro-oncology (8.5% vs 43.5%). Among oncology patients, we found that the percentage of surgeries indicated for a tumour with suspicion of malignancy was significantly lower in the non-operated subgroup (5.2% vs 46.7%,  $p < 0.001$ ). No significant difference was observed in the rate of surgical indication for relapsed tumours between non-operated and operated patients. A comparison of operated and non-operated patients in this new dataset after exclusion of immediate and urgent cases is detailed in online supplemental file 3.

In figure 2, we display for each epidemiological week the number of new inclusions in the surgical list, number

of patients being operated on and the remaining number of patients waiting for surgery and its relationship with community SARS-CoV-2 incidence. Data regarding the epidemiological weeks before the start of data collection in this study are limited to those patients who were included in the surgical list during those weeks and were not operated on by the end of the time frame of this study. Thus, we found that there was a reduction in the number of new inclusions in the surgical list while the first wave of the pandemic evolved. This occurred even when the community SARS-CoV-2 incidence declined significantly, leading to a partial recovery of scheduled surgical activity. However, we also compared the total number of patients who were waiting for a scheduled procedure at the end



**Figure 2** Bar plot of the number of new inclusions (blue), cumulative number of patients in the surgical list (grey) and number of operated patients (orange) per epidemiological week and their association with community SARS-CoV-2 incidence. Created by the authors.



**Figure 3** Bar plot of the median number of total number of patients who were waiting for a scheduled procedure at the end of 2019 and 2020 and the median waiting time for degenerative spine disease for the same periods. (A) Data for each collaborative centre, (B) data for each province, (C) data according to COVID-19 burden (percentage of hospital beds occupied by patients with COVID-19). Created by the authors.

of 2019 and 2020 and the median waiting time for degenerative spine disease for the same periods (data available from our Ministry of Health). We detected an important increase in median time that patients were waiting to be operated on for degenerative spine disease proportional to the COVID-19 burden (figure 3).

Afterwards, we performed a multivariate logistic regression analysis to determine independent covariates associated with maintaining the surgical indication. All covariates associated with being operated on according to the univariate analysis by a p value of <0.10 were included in the model. We found that community SARS-CoV-2 incidence (OR=1.011, 95% CI 1.006 to 1.016, p<0.001), degenerative spine (OR=0.296, 95% CI 0.101 to 0.869, p=0.027) and expedited indications (OR=6.095, 95% CI 3.956 to 9.389, p<0.001) were independent factors for being operated on during the pandemic.

In relation to COVID-19, a higher percentage of operated patients (24 patients, 2.6%) acquired the infection at different time points compared with non-operated patients (6 patients, 0.8%). Although it seemed to be a significant difference according to the univariate analysis (p=0.037), when we ran a logistic regression analysis including the community SARS-CoV-2 incidence, the results from the screening swab test and being operated on in the model, we found that the only factor independently related to the acquisition of the infection was the community SARS-CoV-2 incidence (OR=1.012, 95% CI 1.06 to 1.018, p<0.001).

Details of the logistic regression analyses are described in table 3.

## DISCUSSION

### Summary of key results

A rise in mortality and complications in patients undergoing any kind of surgery and being infected by SARS-CoV-2 in the perioperative period has been previously reported.<sup>9</sup> Additionally, the detrimental effect of the pandemic, even in the absence of perioperative infection on patients undergoing neurosurgery, was also described by our group. This fact is probably secondary to the overload of the healthcare system with the shifting of personal and hospital resources to patients with COVID-19.

**Table 3** Logistic regression analysis for determining factors associated with being operated on and acquiring SARS-CoV-2 infection during the first outbreak of the pandemic

| Multivariate logistic regression analysis for being operated during the first outbreak of the pandemic                  |       |                |         |
|-------------------------------------------------------------------------------------------------------------------------|-------|----------------|---------|
|                                                                                                                         | OR    | 95% CI         | P value |
| Community SARS-CoV-2 incidence                                                                                          | 1.011 | 1.006 to 1.016 | <0.001  |
| Weight                                                                                                                  |       |                | 0.449   |
| Hypertension                                                                                                            |       |                | 0.154   |
| Current smoker                                                                                                          |       |                | 0.373   |
| Asthma                                                                                                                  |       |                | 0.586   |
| Obesity                                                                                                                 |       |                | 0.422   |
| Congestive heart failure                                                                                                |       |                | 0.22    |
| Chronic kidney disease                                                                                                  |       |                | 0.405   |
| Arrhythmia                                                                                                              |       |                | 0.063   |
| ASA grade                                                                                                               |       |                | 0.717   |
| Degenerative spine disease                                                                                              | 0.296 | 0.101 to 0.869 | 0.027   |
| Expedited indication for surgery                                                                                        | 6.095 | 3.956 to 9.389 | <0.001  |
| R <sup>2</sup> Nagelkerke                                                                                               |       |                | 0.418   |
| Multivariate logistic regression analysis for acquiring SARS-CoV-2 infections during the first outbreak of the pandemic |       |                |         |
|                                                                                                                         | OR    | 95% CI         | P value |
| Community SARS-CoV-2 incidence                                                                                          | 1.012 | 1.06 to 1.018  | <0.001  |
| Screening swab test                                                                                                     |       |                | 0.604   |
| Surgery                                                                                                                 |       |                | 0.991   |
| R <sup>2</sup> Nagelkerke                                                                                               |       |                | 0.167   |

ASA, American Society of Anesthesiologists.



To our knowledge, this is the first multicentre study to evaluate the consequences of the restriction to scheduled surgery developed to cope with the pandemic outbreak. The results of our study are a glimpse of the impact of the first peak of the COVID-19 pandemic in neurosurgery patients in Spain. Neurosurgeons are trained to recognise emergencies and those operations that will need ICU management and therefore mechanical ventilation support. Only two patients died during the study period, one oncology patient and one patient with degenerative spine disease, and both deaths were related to concurrent diseases. We consider that telephone supervision is effective in detecting life-threatening worsening that could be managed even during healthcare crises. However, more than a quarter of the patients awaiting surgery during this period of the pandemic experienced a deterioration of their clinical condition that could not be dealt with during the pandemic. This occurred even though periodical telephone interviews were established as a method to follow up in most of the collaborative centres, and most patients were considered for scheduled surgeries. Differences in baseline patient characteristics were observed between non-operated and operated patients, but patient comorbidities did not remain as independent factors related to being operated on. Interestingly, being operated on during the first peak of the pandemic was not a risk factor for acquiring COVID-19 according to our data. Then, hospitals were a safe place for COVID-19-free patients when their neurosurgical conditions needed attention. This finding can likely be explained by the establishment of a preoperative swab test and separated circuits and dedicated professionals for non-infected and infected patients.<sup>9</sup> According to the results displayed in figure 2, the number of new inclusions in the surgical list remained reduced compared with the pre-pandemic levels, although the community SARS-CoV-2 incidence significantly decreased after the lockdown. We hypothesise that this can be partially explained by the residual effect from the first outbreak on a limited recovery of the availability to neuroimaging and other diagnostic processes in combination with the drop in outpatient activity of those departments that usually transfer patients to the neurosurgery department, such as family medicine, neurology and orthopaedic surgery. Additionally, uncertainty about the next waves to overcome could strengthen the reluctance of neurosurgeons and patients to increase the surgical list.

Only 58 (8.5%) patients awaiting surgery were neuro-oncology patients. Most of them were suggestive of meningioma (14, 24.6%), pituitary adenomas (12, 21%) or schwannoma (10, 17.5%). How to triage neuro-oncology cases has been recommended by different associations focusing on malignant tumours or those patients with symptoms related to raised intracranial pressure.<sup>16 17</sup> Accordingly, surgical resources have been almost entirely dedicated to malignant neuro-oncology cases (high-grade gliomas, metastasis). However, this shift can be debated, as surgical treatment improves progression-free survival

more significantly than overall survival.<sup>18</sup> We detected that 8.6% of patients experienced deterioration, and thus it is critical that outpatient radiology and contact with the attending neurosurgeon remain accessible for patients even during the worst phases of the pandemic.

For the rest of the neurosurgical conditions, the determination of clinical or radiological factors to recommend the delay of the procedure is more challenging. Several surgical and neurosurgical societies have proposed different algorithms and triage systems to prioritise among the variety of conditions considered, but they lack applicability to evaluate individual risks.<sup>8 19–21</sup> Then, mild disagreement was noticed in a survey among neurosurgeons who were asked to determine the risk and urgency of different scenarios.<sup>22</sup> According to our data, the largest shift to being non-operated during the first peak of the pandemic was experienced by patients with degenerative spine disease, and it remained the only clinical condition independently associated with postponed procedures. When we compared the pre-pandemic and pandemic conditions (figure 3), the median waiting time of these patients raised significantly, especially in centres with high burden of patients with COVID-19. Of these patients, 27% experienced deterioration during the waiting period even when telephone follow-up was provided to them. We could not imagine the application of another triage structure that would have allowed these procedures to be performed when resources were extremely limited. However, the aim of this study is to evaluate the consequences of that measure on patient outcomes and to be aware of the further effect of going on with this measure during future waves. Although these conditions are not life-threatening, delayed treatment can influence definite loss of functionality<sup>23</sup> and increase indirect costs related to work absenteeism. Consequently, psychological symptoms, such as anger and sadness, and the economic impact due to surgical cancellation of elective surgeries have also been documented.<sup>24</sup>

On the other hand, clinical deterioration was even more frequently observed in patients with functional (39.5%) or CSF disorders (40%). These subgroups of patients can be considered more vulnerable to becoming critically ill if they become infected, but treatment on time can reduce mortality and the need for residential nursing care. Attention to the consequences of postponing surgical treatment in normal pressure hydrocephalus was brought up before by La Corte and Palandri.<sup>25</sup> They found an increase of 60% in visit appointments due to clinical deterioration, which is a higher rate compared with our findings, as 40% of patients with CSF disorders experienced worsening during the waiting period.

The collateral damage of the COVID-19 pandemic in patients with other diseases is probably not feasible to accurately measure due to several factors: the sum effect of deaths of unknown cause before reaching the hospital during lockdown, delayed diagnosis, difficulties in accessing care, postponed scheduled procedures and increased mortality in the perioperative period owing



to SARS-CoV-2 infection and reallocation of resources. However, the silent detrimental effect of the pandemic in patients without COVID-19 will continue for the near future as subsequent waves beat a weakened health system and professionals. After several waves, the number of patients awaiting surgery increased exponentially to a higher level compared with the pre-COVID-19 era due to the ratio of inclusion in surgical lists/scheduled surgeries and the partial resumption of diagnostic tests and outpatient clinics. We still claim to heads of the healthcare systems and governments to ensure the care of patients with neurosurgical diseases. In these conditions, early treatment determines a favourable prognosis in terms of neurological recovery, quality of life and reduction of indirect cost. Strategies could be based on the sparing of theatre capacities, working hours and hospitals dedicated to surgical patients.

## Limitations

This study has some limitations. First, this study is a snapshot of an evolving pandemic with huge variation of its effects between centres according to the community SARS-CoV-2 incidence at the time of the first peak of the pandemic and hospital size. Although we launched a national call to collaborate, the registry covered data from neurosurgical departments from 6 out of 17 Spanish main regions; thus, there is a risk of bias to over-representation of centres more severely affected by the first wave of the pandemic, as represented by the percentage of total beds dedicated to patients with COVID-19. Second, the definition of deterioration is based on the opinion of the attending neurosurgeon for each patient, and we were not able to discern the symptoms or radiological changes experienced by each patient. Finally, the quality of the data depends on the accuracy of data collection by the collaborators, although active supervision and discussion of discordant information were performed during the study.

## CONCLUSIONS

More than one-quarter of patients awaiting scheduled neurosurgery experienced clinical or radiological deterioration. The rate of worsening was higher among patients with functional or CSF disorders. Apart from measures related to the state of the community SARS-CoV-2 epidemiology, the diagnosis of spine degenerative disease was the single independent factor to be not operated during the first peak of the pandemic.

## Author affiliations

- <sup>1</sup>Neurosurgery Department, Hospital Universitario 12 de Octubre, Madrid, Spain
- <sup>2</sup>Instituto de Investigación Sanitaria Hospital 12 de Octubre (imas12), Madrid, Spain
- <sup>3</sup>Departamento de Cirugía, Facultad de Medicina, Universidad Complutense de Madrid, Madrid, Spain
- <sup>4</sup>Neurosurgery Department, Hospital Universitario de Burgos, Burgos, Spain
- <sup>5</sup>Neurosurgery Department, Hospital Universitario Virgen del Rocío, Sevilla, Spain
- <sup>6</sup>Neurosurgery Department, Hospital Universitario de la Princesa, Madrid, Spain
- <sup>7</sup>Neurosurgery Department, Complejo Hospitalario Universitario de Santiago de Compostela, Santiago de Compostela, Spain

- <sup>8</sup>Neurosurgery Department, Hospital Clínico Universitario San Carlos, Madrid, Spain
- <sup>9</sup>Neurosurgery Department, Complejo Hospitalario de Vigo Alvaro Cunqueiro, Vigo, Spain
- <sup>10</sup>Neurosurgery Department, Hospital General Universitario Gregorio Marañón, Madrid, Spain
- <sup>11</sup>Neurosurgery Department, Hospital Infantil Universitario Niño Jesús, Madrid, Spain
- <sup>12</sup>Neurosurgery Department, Hospital Universitario Miguel Servet, Zaragoza, Spain
- <sup>13</sup>Neurosurgery Department, Complejo Hospitalario Universitario Torrecardenas, Almería, Spain
- <sup>14</sup>Neurosurgery Department, Hospital Universitario La Paz, Madrid, Spain
- <sup>15</sup>Neurosurgery Department, Complejo Asistencial Universitario de Salamanca, Salamanca, Spain
- <sup>16</sup>Neurosurgery Department, Hospital General Universitario de Ciudad Real, Ciudad Real, Spain
- <sup>17</sup>Neurosurgery Department, Hospital Politécnico y Universitario La Fe, Valencia, Spain
- <sup>18</sup>Neurosurgery Department, Hospital Universitario Cruces, Barakaldo, Spain

**Twitter** Igor Paredes @IgorParedesS

**Contributors** IP and AMC-L have contributed equally to this paper and should be considered as joint first authors. AL has played a key role as a guarantor accepting full responsibility for the work, conduct of the study, had access to the data, and controlled the decision to publish. PDD-L, AK, JFA, MG-G, RP-A, ALZ, FR-J, BR, JOM, MJC-R, BJH-G, JJV-L, MC, PM-L and GC-L were the principal investigators of each centre and took a key role in the study design and data collection. COVIDNeurosur collaborative: PAG, LJ-R, AP-N, PG-L, JD-F, CEF, DG-P, LMM-G, OE-S, JM-A, JT-C, MO-C, FA-R, MG-P, RG-S, CVT, MN-G, GBGdA, NF-P, PG-T, AMS, BM-C, BR-B, CF-G, BF-P, ACV-J, CC, LCF, RG-L, MV-M, VCH, JCP, DFD, JDM, JMH, MG-A, FG-P, AO-R, JAdIH, JG-E, PS-C, DP-A, LRM, JCRMdO, DAG, AGM, LTC, AGR, MR-C, JA, ARB, AQ-T, GB, CPM, PDIFV, MFDIR, ILS-G and GZ played a crucial role in data acquisition. All authors read and approved the final manuscript.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Ethics approval** The institutional review board (IRB) of the coordinator centre (Hospital Universitario 12 de Octubre) gave ethical approval (CEIM 20/217), and then local principal investigators were responsible for endorsing ethical approval in their IRB. Informed consent was waived by the principal investigators' IRB.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

## ORCID iDs

Ana M Castaño-Leon <http://orcid.org/0000-0002-7918-5049>  
Igor Paredes <http://orcid.org/0000-0002-3846-4164>  
Juan Delgado-Fernández <http://orcid.org/0000-0002-4251-8356>  
Pedro D Delgado-López <http://orcid.org/0000-0002-9317-6958>

## REFERENCES

- 1 Henríquez J, Gonzalo-Almorox E, García-Goñi M, *et al.* The first months of the COVID-19 pandemic in Spain. *Health Policy Technol* 2020;9:560–74.
- 2 COVID-19. Available: <https://cneccovid.isciii.es/covid19/> [Accessed 30 Jul 2021].
- 3 Aboukais R, Devalckeneer A, Boussemart P, *et al.* Impact of COVID-19 pandemic on patients with intracranial aneurysm rupture. *Clin Neurol Neurosurg* 2021;201:106425.
- 4 Robertson FC, Lippa L, Broekman MLD, Editorial BMLD. Editorial. task shifting and task sharing for neurosurgeons amidst the COVID-19 pandemic. *J Neurosurg* 2020;1–3.
- 5 Tsermoulas G, Zisakis A, Flint G, *et al.* Challenges to neurosurgery during the coronavirus disease 2019 (COVID-19) pandemic. *World Neurosurg* 2020;139:519–25.
- 6 Eichberg DG, Shah AH, Luther EM, *et al.* Letter: academic neurosurgery department response to COVID-19 pandemic: the University of Miami/Jackson Memorial Hospital model. *Neurosurgery* 2020;87:E63–5.
- 7 Mohanty A, Srinivasan VM, Burkhardt J-K, *et al.* Ambulatory neurosurgery in the COVID-19 era: patient and provider satisfaction with telemedicine. *Neurosurg Focus* 2020;49:E13.
- 8 Burke JF, Chan AK, Mummaneni V, *et al.* Letter: the coronavirus disease 2019 global pandemic: a neurosurgical treatment algorithm. *Neurosurgery* 2020;87:E50–6.
- 9 Glasbey JC, Nepogodiev D, Simoes JFF, *et al.* Elective cancer surgery in COVID-19-Free surgical pathways during the SARS-CoV-2 pandemic: an international, multicenter, comparative cohort study. *J Clin Oncol* 2021;39:66–78.
- 10 COVIDSurg Collaborative. Machine learning risk prediction of mortality for patients undergoing surgery with perioperative SARS-CoV-2: the COVIDSurg mortality score. *Br J Surg* 2021;108:1274–92.
- 11 Doglietto F, Vezzoli M, Biroli A, *et al.* Anxiety in neurosurgical patients undergoing nonurgent surgery during the COVID-19 pandemic. *Neurosurg Focus* 2020;49:E19.
- 12 von Elm E, Altman DG, Egger M, *et al.* The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007;370:1453–7.
- 13 Harris PA, Taylor R, Thielke R, *et al.* Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–81.
- 14 Información estadística para El análisis del impacto de la crisis COVID-19. Available: [https://www.ine.es/covid/covid\\_inicio.htm](https://www.ine.es/covid/covid_inicio.htm) [Accessed 02 Aug 2021].
- 15 INEbase / Demografía Y población / Cifras de población Y Censos demográficos / Cifras de población / Últimos datos. Available: [https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica\\_C&cid=1254736176951&menu=ultiDatos&idp=1254735572981](https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176951&menu=ultiDatos&idp=1254735572981) [Accessed 02 Aug 2021].
- 16 Ramakrishna R, Zadeh G, Sheehan JP, *et al.* Inpatient and outpatient case prioritization for patients with neuro-oncologic disease amid the COVID-19 pandemic: general guidance for neuro-oncology practitioners from the AANS/CNS tumor section and Society for neuro-oncology. *J Neurooncol* 2020;147:525–9.
- 17 Bernhardt D, Wick W, Weiss SE, *et al.* Neuro-Oncology management during the COVID-19 pandemic with a focus on who grade III and IV gliomas. *Neuro Oncol* 2020;22:928–35.
- 18 Das S. The ethics of neuro-oncology in the era of COVID-19: lessons to be learned. *Neuro Oncol* 2020;22:1399.
- 19 Rispoli R, Diamond ME, Balsano M, *et al.* Spine surgery in Italy in the COVID-19 era: proposal for assessing and responding to the regional state of emergency. *World Neurosurg* 2021;145:e1–6.
- 20 EANS advice: triaging non-emergent neurosurgical procedures during the COVID-19 outbreak.
- 21 Germanò A, Raffa G, Angileri FF. COVID-19 and neurosurgery: literature and neurosurgical societies recommendations update. *World Neurosurg* 2019;2020:e812–7.
- 22 Jean WC, Ironside NT, Sack KD, *et al.* The impact of COVID-19 on neurosurgeons and the strategy for triaging non-emergent operations: a global neurosurgery study. *Acta Neurochir* 2020;162:1229–40.
- 23 Shlobin NA, Rosenow JM, Ford PJ. Using functionality rather than elective nature to characterize Neurosurgeries during pandemic triage. *Am J Bioeth* 2020;20:196–8.
- 24 Kaiser R, Svoboda N, Waldauf P, *et al.* The economic and psychological impact of cancellations of elective spinal surgeries in the COVID-19 era. *Br J Neurosurg* 2021;1–5.
- 25 La Corte E, Palandri G. Letter to the Editor: COVID-19 and the Neurosurgical Treatment of Idiopathic Normal Pressure Hydrocephalus: Shall We Continue to Postpone "Non-emergent" Surgical Procedures? *World Neurosurg* 2020;141:578–9.

|                                                                                                |                                                               |
|------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| <b>PROVIDER PROFILING</b>                                                                      |                                                               |
| Record ID                                                                                      |                                                               |
| <b>SURVEY RESPONDENT</b>                                                                       |                                                               |
| Are you medically qualified?                                                                   | Yes                                                           |
|                                                                                                | No                                                            |
| What is your medical qualification?                                                            | Resident                                                      |
|                                                                                                | Staff                                                         |
| Number of years of your expertise                                                              |                                                               |
| <b>HOSPITAL CHARACTERISTICS</b>                                                                |                                                               |
| Type of healthcare facility                                                                    | Government                                                    |
|                                                                                                | Private                                                       |
| Type of hospital                                                                               | Primary-level hospital                                        |
|                                                                                                | Secondary-level hospital                                      |
|                                                                                                | Tertiary-level hospital                                       |
| City                                                                                           |                                                               |
| <b>NEUROSURGERY DEPARTMENT CHARACTERISTICS</b>                                                 |                                                               |
| Total number of beds dedicated to neurosurgical patients                                       |                                                               |
| Does your neurosurgical unit manage just adults, just children or both?                        | Adults only                                                   |
|                                                                                                | Children only                                                 |
|                                                                                                | Both                                                          |
| Number of members of your department                                                           |                                                               |
| Number of theatres scheduled per week                                                          |                                                               |
| Number of craniotomies done in the last year                                                   |                                                               |
| Number of spinal surgeries done in the last year                                               |                                                               |
| Number of urgent surgeries done in the last year                                               |                                                               |
| Is there at least one staff neurosurgeon on call everyday?                                     | Yes                                                           |
|                                                                                                | No                                                            |
| Is your institution the unit that manages cerebrovascular emergencies?                         | Yes, we manage all cerebrovascular emergencies referred to us |
|                                                                                                | Yes, but there is a                                           |
|                                                                                                | No, we routinely transfer such cases to a different centre    |
| Is your institution the unit that manages severe TBI and Spinal cord Injury emergencies?       | Yes, we manage all emergencies referred to us                 |
|                                                                                                | No, we routinely transfer such cases to a different centre    |
| <b>STRATEGIES DEVELOPED TO DEAL WITH COVID-19 PANDEMIC</b>                                     |                                                               |
| What is the maximum percentage of total beds occupation to COVID patients during the pandemic? | <20%                                                          |
|                                                                                                | 20-50%                                                        |
|                                                                                                | 50-80%                                                        |
|                                                                                                | >80%                                                          |
| Do you routinely perform screening of COVID-19 infection before elective surgery?              | Yes, in all cases                                             |
|                                                                                                | Yes, but only in the case of suspicion                        |
|                                                                                                | No                                                            |

|                                                                                                                                            |                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <b>What type of test do you usually use at your institution?</b>                                                                           | Structured questionnaire                                                                                                                   |
|                                                                                                                                            | Swab test                                                                                                                                  |
|                                                                                                                                            | CT thorax                                                                                                                                  |
| <b>What is the time period considered valid between the test and the surgery ?</b>                                                         | 24h                                                                                                                                        |
|                                                                                                                                            | 48-72h                                                                                                                                     |
|                                                                                                                                            | >72h                                                                                                                                       |
| <b>At the scenario of a patient requiring urgent surgery for a life-threatening condition, what do you usually do at your institution?</b> | A swab test is done, and the procedure is performed following recommendations for confirmed COVID-19 patients                              |
|                                                                                                                                            | A CT-thorax is done and the procedure is performed depending of the findings revealed                                                      |
|                                                                                                                                            | The procedure is performed following recommendations for confirmed COVID-19 patients, the swab test is delayed to the postoperative period |
| <b>Do you transfer patients requiring expedite surgery?</b>                                                                                | Yes                                                                                                                                        |
|                                                                                                                                            | No                                                                                                                                         |
| <b>How many members of your department suffered confirmed COVID-19 infection?</b>                                                          |                                                                                                                                            |



| PATIENT'S BASELINE CHARACTERISTICS                                     |                                                                                       |
|------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Record ID</b>                                                       |                                                                                       |
| <b>Sex</b>                                                             | Male                                                                                  |
|                                                                        | Female                                                                                |
| <b>Age</b>                                                             |                                                                                       |
| <b>Weight</b>                                                          |                                                                                       |
| <b>BMI</b>                                                             |                                                                                       |
| <b>ASA grade</b>                                                       | Grade I, A normal healthy patient                                                     |
|                                                                        | Grade II, A patient with mild systemic disease                                        |
|                                                                        | Grade III, A patient with severe systemic disease                                     |
|                                                                        | Grade IV, A patient with severe systemic disease that is a constant threat to life    |
|                                                                        | Grade V, A moribund patient who is not expected to survive without the operation      |
|                                                                        | Unknown                                                                               |
| <b>Karnofsky Performance Status Scale (only for oncology patients)</b> | 100 Normal no complaints; no evidence of disease                                      |
|                                                                        | 90 Able to carry on normal activity; minor signs or symptoms of disease               |
|                                                                        | 80 Normal activity with effort; some signs or symptoms of disease                     |
|                                                                        | 70 Cares for self; unable to carry on normal activity or to do active work            |
|                                                                        | 60 Requires occasional assistance, but is able to care for most of his personal needs |
|                                                                        | 50 Requires considerable assistance and frequent medical care                         |
|                                                                        | 40 Disabled; requires special care and assistance                                     |
|                                                                        | 30 Severely disabled; hospital admission is indicated although death not imminent     |
|                                                                        | 20 Very sick; hospital admission necessary; active supportive treatment necessary     |
|                                                                        | 10 Moribund; fatal processes progressing rapidly                                      |
| <b>Medical past history</b>                                            | None                                                                                  |
|                                                                        | Hypertension                                                                          |
|                                                                        | Diabetes                                                                              |
|                                                                        | Dyslipidemia                                                                          |
|                                                                        | Current smoker                                                                        |
|                                                                        | Asthma                                                                                |
|                                                                        | Cancer                                                                                |
|                                                                        | Chronic kidney disease                                                                |
|                                                                        | Chronic obstructive pulmonary disease                                                 |
|                                                                        | Congenital abnormalities (cardiac)                                                    |
|                                                                        | Congenital abnormalities (non cardiac)                                                |
|                                                                        | Ischemic heart disease                                                                |
|                                                                        | Congestive heart failure                                                              |
|                                                                        | Obesity                                                                               |
|                                                                        | Dementia                                                                              |
|                                                                        | Peripheral vascular disease                                                           |
|                                                                        | Stroke/TIA                                                                            |
|                                                                        | Other                                                                                 |

| NEUROSURGICAL DISEASE                                                            |                                     |
|----------------------------------------------------------------------------------|-------------------------------------|
| Record ID                                                                        |                                     |
| Main group                                                                       | Oncology                            |
|                                                                                  | Hemorrhagic cerebrovascular disease |
|                                                                                  | Traumatic brain injury              |
|                                                                                  | Traumatic spine injury              |
|                                                                                  | Degenerative spine disease          |
|                                                                                  | CSF disorders                       |
|                                                                                  | Pediatric                           |
|                                                                                  | Functional                          |
|                                                                                  | Infectious                          |
| In cases of hemorrhagic cerebrovascular disease, the symptom at diagnosis was... | Cerebral hematoma                   |
|                                                                                  | Seizure                             |
|                                                                                  | Steal                               |
|                                                                                  | Asymptomatic                        |
| Specific hemorrhagic cerebrovascular disease                                     | Aneurysm                            |
|                                                                                  | AVM                                 |
|                                                                                  | Dural AV fistula                    |
|                                                                                  | Cavernoma                           |
|                                                                                  | Hypertensive hematoma               |
|                                                                                  | Malignant stroke                    |
| Neoplasm location                                                                | Supratentorial intracerebral        |
|                                                                                  | Supratentorial extracerebral        |
|                                                                                  | Intraventricular                    |
|                                                                                  | Infratentorial intracerebral        |
|                                                                                  | Infratentorial extracerebral        |
|                                                                                  | Sellar region                       |
|                                                                                  | Spinal                              |
| Neoplasm histology                                                               | Low-grade Glioma (WHO I and II)     |
|                                                                                  | High-grade Glioma (WHO III and IV)  |
|                                                                                  | Meningioma (WHO I)                  |
|                                                                                  | Meningioma (WHO II and III)         |
|                                                                                  | Metastasis                          |
|                                                                                  | Lymphoma                            |
|                                                                                  | Schwannoma                          |
|                                                                                  | Pituitary adenoma                   |
|                                                                                  | Other                               |
| Planned surgery is considered...                                                 | Primary curative                    |
|                                                                                  | Surgery for relapse disease         |
| Determine the level of the spine affected by the degenerative disease            | Cervical                            |
|                                                                                  | Dorsal                              |
|                                                                                  | Lumbar                              |

|                                                                       |                                             |
|-----------------------------------------------------------------------|---------------------------------------------|
| <b>Specific pediatric pathology</b>                                   | Supratentorial intracerebral tumor          |
|                                                                       | Supratentorial extracerebral tumor          |
|                                                                       | Intraventricular tumor (I-III ventricle)    |
|                                                                       | Infratentorial intracerebral tumor          |
|                                                                       | Infratentorial extracerebral tumor          |
|                                                                       | Intraventricular infratentorial tumor       |
|                                                                       | Sellar region                               |
|                                                                       | Hydrocephalus                               |
|                                                                       | Intraventricular hemorrhage                 |
|                                                                       | Arachnoid cyst                              |
|                                                                       | Craniosynostosis (one suture)               |
|                                                                       | Craniosynostosis (multiple sutures)         |
|                                                                       | Occipito-cervical junction disorder         |
|                                                                       | Simple lipoma                               |
|                                                                       | Complex lipoma                              |
|                                                                       | Vascular                                    |
| <b>Specific functional pathology</b>                                  | Parkinson and other movement disorder       |
|                                                                       | Epilepsy                                    |
|                                                                       | Pain                                        |
| <b>Specific infectious pathology</b>                                  | Brain abscess                               |
|                                                                       | Epidural/ subdural cranial empyema          |
|                                                                       | Epidural/ subdural spinal empyema           |
|                                                                       | Superficial surgical site cranial infection |
|                                                                       | Superficial surgical site spine infection   |
|                                                                       | Osteosynthesis-associated infection         |
|                                                                       | Osteomyelitis                               |
| <b>Date of diagnosis</b>                                              |                                             |
| <b>Date of inclusion in surgical list</b>                             |                                             |
| <b>Urgency of surgery</b>                                             | Immediate                                   |
|                                                                       | Urgent                                      |
|                                                                       | Expedited                                   |
|                                                                       | Elective                                    |
| <b>Confirm if it was the initial decision for surgical treatment?</b> | Yes                                         |
|                                                                       | No                                          |

| TREATMENT DECISION AND EFFECTS OF THE PANDEMIC                                                                           |                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Record ID                                                                                                                |                                                                                                         |
| Did the patient undergo any neurosurgical procedure during the pandemic?                                                 | Yes                                                                                                     |
|                                                                                                                          | No                                                                                                      |
| Which of the following reasons was the most influencing one to maintain your indication?                                 | Imminent effect on survival or suspect of malignancy                                                    |
|                                                                                                                          | Mass effect in neuroimaging/ progressive neurological decline                                           |
|                                                                                                                          | There is no reduction in hospital resources due to pandemic                                             |
|                                                                                                                          | Patients assume excess of risk of being operated during the pandemic regardless surgeon recommendations |
| Although the patient was operated during the pandemic, do you consider that the pandemic has affect the surgery someway? | No change to care                                                                                       |
|                                                                                                                          | Delayed surgery                                                                                         |
|                                                                                                                          | Advanced surgery                                                                                        |
|                                                                                                                          | Change in the surgical technique                                                                        |
|                                                                                                                          | Transfer to a COVID-free center                                                                         |
|                                                                                                                          | Neoadjuvancy was administered while the patient was waiting for the procedure.                          |
| If no operation was performed by 3 months from study entry, is there still a plan for surgery?                           | Yes                                                                                                     |
|                                                                                                                          | No                                                                                                      |
| What was/were the main reason/s to not performed any operation by 3 months from study?                                   | Patient choice to avoid surgery during pandemic                                                         |
|                                                                                                                          | Surgeon decision to delay surgery due to risk to patient                                                |
|                                                                                                                          | No bed/intensive care space/theatre space                                                               |
|                                                                                                                          | Disease progression, surgery no longer indicated                                                        |
|                                                                                                                          | SARS-CoV2 detection in the preoperative screening                                                       |
|                                                                                                                          | Change in clinical status unrelated to neurosurgical pathology                                          |
|                                                                                                                          | Died awaiting surgery                                                                                   |
|                                                                                                                          | Other reason                                                                                            |



| PERIOPERATIVE DETAILS                                        |                                                      |
|--------------------------------------------------------------|------------------------------------------------------|
| Record ID                                                    |                                                      |
| GCS                                                          |                                                      |
| GCS- motor response                                          | Obeys commands                                       |
|                                                              | Localising                                           |
|                                                              | Normal flexion                                       |
|                                                              | Abnormal flexion                                     |
| GCS- verbal reponse                                          | Extension                                            |
|                                                              | None                                                 |
|                                                              | Orientated                                           |
|                                                              | Confused                                             |
|                                                              | Words                                                |
|                                                              | Sounds                                               |
| GCS- Eye opening                                             | None                                                 |
|                                                              | Spontaneous                                          |
| Preoperative focal deficits due to neurosurgical pathology   | To sound                                             |
|                                                              | To pressure                                          |
|                                                              | None                                                 |
|                                                              | None                                                 |
|                                                              | Language                                             |
|                                                              | Motor                                                |
|                                                              | Sensitivity                                          |
|                                                              | Visual acuity                                        |
|                                                              | Cognitive                                            |
|                                                              | Cranial nerves palsy                                 |
|                                                              | Cerebellar syndrome                                  |
|                                                              | Spinal cord syndrome                                 |
|                                                              | Radiculopathy                                        |
|                                                              | Non testable due to level of consciousness           |
| Preoperative airway support                                  | None / nasal prongs                                  |
|                                                              | Venturi mask                                         |
|                                                              | Non-invasive high pressure respiratory support       |
|                                                              | Mechanical ventilation                               |
|                                                              | OMECS                                                |
| Was COVID-19 infection suspected at the time of the surgery? | Yes                                                  |
|                                                              | No                                                   |
| Reason to suspect COVID-19 infection                         | Symptoms                                             |
|                                                              | Recent close contact to a confirmed COVID 19 patient |
|                                                              | Laboratory findings                                  |
|                                                              | Thorax imaging                                       |

|                                                                                         |                            |
|-----------------------------------------------------------------------------------------|----------------------------|
| <b>Symptoms of suspicion</b>                                                            | Fever                      |
|                                                                                         | Cough                      |
|                                                                                         | Dyspnea                    |
|                                                                                         | Anosmia                    |
|                                                                                         | Abdominal pain or diarrhea |
|                                                                                         | Nausea/vomits              |
|                                                                                         | Tiredness/ muscle aches    |
| <b>CT thorax findings</b>                                                               | Not done                   |
|                                                                                         | Normal                     |
|                                                                                         | Consolidation              |
|                                                                                         | Ground glass opacity       |
|                                                                                         | Linear opacity             |
|                                                                                         | Other                      |
| <b>Swab test result in suspect patients</b>                                             | Positive                   |
|                                                                                         | Negative                   |
|                                                                                         | Not done                   |
| <b>In absence of COVID19 suspicion, was COVID19 screening performed preoperatively?</b> | Yes                        |
|                                                                                         | No                         |
| <b>Type of screening test</b>                                                           | Structured survey          |
|                                                                                         | Swab test                  |
|                                                                                         | CT thorax                  |
| <b>Date of screening test</b>                                                           |                            |
| <b>Swab test result in non- suspect patients</b>                                        | Positive                   |
|                                                                                         | Negative                   |
|                                                                                         | Not done                   |
| <b>Chest X ray findings in non-suspect patients</b>                                     | Not done                   |
|                                                                                         | Normal                     |
|                                                                                         | Abnormal                   |
| <b>CT thorax findings in non-suspect patients</b>                                       | Not done                   |
|                                                                                         | Normal                     |
|                                                                                         | Consolidation              |
|                                                                                         | Ground glass opacity       |
|                                                                                         | Linear opacity             |
|                                                                                         | Other                      |
| <b>Date of surgery</b>                                                                  |                            |
| <b>Anaesthesia</b>                                                                      | General                    |
|                                                                                         | Regional                   |
|                                                                                         | Local                      |

|                                               |                                                    |
|-----------------------------------------------|----------------------------------------------------|
| <b>Operation performed?</b>                   | Supratentorial craniotomy                          |
|                                               | Infratentorial craniotomy                          |
|                                               | Endoscopic trans-sphenoidal                        |
|                                               | Burr-holes                                         |
|                                               | CSF diversion                                      |
|                                               | Spine surgery (oncology)                           |
|                                               | Spine surgery (non-oncology) with stabilization    |
|                                               | Spine surgery (non-oncology) without stabilization |
|                                               | Intraventricular endoscopy                         |
|                                               | Craniofacial remodeling                            |
|                                               | ICP monitoring/ external ventricular drainage      |
|                                               | Deep brain stimulation                             |
|                                               | Vague nerve stimulation device                     |
|                                               | Other                                              |
| <b>Operative time (minutes)</b>               |                                                    |
| <b>Surgical resources used at the theatre</b> | None especial                                      |
|                                               | Neuronavigation                                    |
|                                               | Neurophysiological monitoring                      |
|                                               | Tractography                                       |
|                                               | Specific fluorescence                              |
|                                               | Intraoperative echography                          |
|                                               | Intraoperative MRI                                 |
|                                               | Awake surgery                                      |
|                                               | Cortical mapping                                   |
| <b>Opinion about surgical conditions</b>      | No change to care                                  |
|                                               | Reduced with direct effect on outcome              |
|                                               | Reduced without effect on outcome                  |

| POSTOPERATIVE COURSE          |                                                              |
|-------------------------------|--------------------------------------------------------------|
| Record ID                     |                                                              |
| Postoperative ICU stay        | No                                                           |
|                               | Planned before theatre                                       |
|                               | No planned, due to intraop findings                          |
|                               | No planned, due to postop complications                      |
| Post-operative airway support | None / nasal prongs                                          |
|                               | Venturi mask                                                 |
|                               | Non-invasive high pressure respiratory support               |
|                               | Mechanical ventilation                                       |
|                               | OMECS                                                        |
| Re-operation                  | Yes                                                          |
|                               | No                                                           |
| Complications                 | None                                                         |
|                               | Acute renal injury (creatinine >2mg/dl)                      |
|                               | Respiratory failure/ Pneumonia                               |
|                               | Blood transfusion                                            |
|                               | Cardiac arrest                                               |
|                               | Neurological new focal symptoms                              |
|                               | Deep vein thrombosis                                         |
|                               | Pulmonary thromboembolism                                    |
|                               | Myocardial infarction                                        |
|                               | Sepsis                                                       |
|                               | Septic shock                                                 |
|                               | Stroke/TIA                                                   |
|                               | SSI superficial                                              |
|                               | SSI deep                                                     |
|                               | Meningitis                                                   |
|                               | Urinary tract infection                                      |
|                               | CSF leak                                                     |
|                               | Postoperative hematoma (asymptomatic)                        |
|                               | Postoperative hematoma (symptomatic but not requiring re-op) |
|                               | Postoperative hematoma requiring re-op                       |
|                               | Seizure                                                      |
|                               | Status epilepticus                                           |
|                               | Other                                                        |
| Date of hospital discharge    |                                                              |

| OUTCOME                                     |                                                                                         |
|---------------------------------------------|-----------------------------------------------------------------------------------------|
| Record ID                                   |                                                                                         |
| Mortality                                   | Yes                                                                                     |
|                                             | No                                                                                      |
| Situation at the end of the period of study | Alive, in-hospital                                                                      |
|                                             | Alive, admitted at other hospital                                                       |
|                                             | Alive, at rehabilitation nursing                                                        |
|                                             | Alive, at home                                                                          |
| Outcome of patients awaiting surgery        | No clinical worsening or radiological progression                                       |
|                                             | No clinical worsening but the patient experienced radiological progression              |
|                                             | Clinical worsening without radiological progression                                     |
|                                             | Clinical worsening and radiological progression                                         |
|                                             | Change in clinical status unrelated to neurosurgical pathology or COVID19 infection     |
|                                             | Death due to neurosurgical disease progression                                          |
|                                             | Death unrelated to neurosurgical pathology or COVID19 infection (new medical condition) |
|                                             | Death due to accident                                                                   |
| Date of death                               | Death related to COVID-19 or its complications                                          |
|                                             | On table                                                                                |
|                                             | Postoperative day 0-7                                                                   |
|                                             | Postoperative day 8-30                                                                  |
|                                             | Postoperative >30                                                                       |
| Cause of death                              | Death in a non-operated patients                                                        |
|                                             | Death due to neurosurgical disease                                                      |
|                                             | Death unrelated to neurosurgical pathology or COVID19 infection (new medical condition) |
|                                             | Death related to COVID-19 or its complications                                          |
|                                             | Unknown                                                                                 |



| CONFIRMED COVID-19 INFECTION                         |                                                                                                                                              |
|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Record ID                                            |                                                                                                                                              |
| Did the patient suffered COVID-19 post-operatively ? | Yes                                                                                                                                          |
|                                                      | No                                                                                                                                           |
| When was detected a confirmed COVID-19 infection?    | Awaiting surgery                                                                                                                             |
|                                                      | Preoperative screening                                                                                                                       |
|                                                      | During in-hospital stay                                                                                                                      |
|                                                      | After hospital discharge within 30 days                                                                                                      |
|                                                      | After hospital discharge > 30 days                                                                                                           |
| Date of positive swab test                           |                                                                                                                                              |
| Severity of COVID-19 infection                       | Mild: patient was not admitted to hospital care                                                                                              |
|                                                      | Moderate: patient required hospital admission but not airway support                                                                         |
|                                                      | Severe: those patients that required airway support (at least venturi mask) or ICU admission or suffered severe thromboembolic complications |
| Prognostic factors related to COVID-19 outcome       | Respiratory rate                                                                                                                             |
|                                                      | Heart rate                                                                                                                                   |
|                                                      | SBP                                                                                                                                          |
|                                                      | DBP                                                                                                                                          |
|                                                      | Peripheric O2 saturation                                                                                                                     |
|                                                      | Hemoglobin                                                                                                                                   |
|                                                      | Leucocytes                                                                                                                                   |
|                                                      | Linfocytes                                                                                                                                   |
|                                                      | C reactive protein                                                                                                                           |
|                                                      | Albumin                                                                                                                                      |
|                                                      | Ure                                                                                                                                          |
|                                                      | Creatinine                                                                                                                                   |
|                                                      | Ferritin                                                                                                                                     |
|                                                      | LDH                                                                                                                                          |
|                                                      | D dimer                                                                                                                                      |
|                                                      | Arterial gasometry pO2                                                                                                                       |
|                                                      | Arterial gasometry pCO2                                                                                                                      |
|                                                      | Arterial gasometry pO2 Lactate                                                                                                               |
|                                                      | Arterial gasometry pO2 Bicarbonate                                                                                                           |
| Did the patient receive NSAIDS                       | No                                                                                                                                           |
|                                                      | Yes, preoperatively                                                                                                                          |
|                                                      | Yes, after admission                                                                                                                         |
|                                                      | Both                                                                                                                                         |
| Specific treatment for COVID19 infection             | Antibiotics                                                                                                                                  |
|                                                      | Lopinavir/ritonavir                                                                                                                          |
|                                                      | Quinine                                                                                                                                      |
|                                                      | Corticosteroids                                                                                                                              |
|                                                      | Interferon                                                                                                                                   |
|                                                      | IV immunoglobulines                                                                                                                          |
|                                                      | Anti-IL6                                                                                                                                     |

|                                                        |                                                |
|--------------------------------------------------------|------------------------------------------------|
|                                                        | Anti-IL1                                       |
|                                                        | Remdesivir                                     |
|                                                        | Antibodies                                     |
| <b>Highest airway support during COVID19 infection</b> | None / nasal prongs                            |
|                                                        | Venturi mask                                   |
|                                                        | Non-invasive high pressure respiratory support |
|                                                        | Mechanical ventilation                         |
|                                                        | OMECC                                          |
| <b>Days of invasive mechanical ventilation</b>         |                                                |
| <b>Renal dialysis during admission?</b>                | Yes                                            |
|                                                        | No                                             |
|                                                        |                                                |

**Supplemental file 3: Patient's demographics and clinical characteristics after excluding urgent and emergency surgeries. Comparison between operated and non-operated patients.**

|                                       | Non-Operated                             | Operated                                 | Comparison between groups (p value) |
|---------------------------------------|------------------------------------------|------------------------------------------|-------------------------------------|
| <b>Number of patients</b>             | 680                                      | 600                                      |                                     |
| <b>Age (Median. IQR)</b>              | 56 (21)                                  | 55 (26)                                  | 0.755                               |
| <b>Sex</b>                            | Males 350 (51.5%)<br>Females 330 (48.5%) | Males 320 (53.3%)<br>Females 280 (46.7%) | 0.505                               |
| <b>Epidemiological week</b>           | 4 (7)                                    | 9 (17)                                   | <0.001                              |
| <b>Community SARS-CoV-2 incidence</b> | 7 (31)                                   | 14 (10)                                  | <0.001                              |
| <b>Weight/ BMI</b>                    | 75Kg (21)/<br>29.5 Kg/m2 (6.3)           | 73 Kg (21)<br>26.6 Kg/m2 (10)            | 0.132<br>0.060                      |
| <b>ASA grade</b>                      |                                          |                                          |                                     |
| Unknown                               | 9 (1.3%)                                 | 1 (0.2%)                                 | <0.001                              |
| Grades I and II                       | 521 (76.7%)                              | 419 (69.8%)                              |                                     |
| Grades III and IV                     | 149 (22%)                                | 180 (30%)                                |                                     |
| Grade V                               | 0                                        | 0                                        |                                     |
| <b>Past medical history</b>           |                                          |                                          |                                     |
| None                                  | 164 (24.1%)                              | 141 (23.5%)                              | 0.796                               |
| Hypertension                          | 245 (36%)                                | 184 (30.7%)                              | 0.043                               |
| Diabetes                              | 88 (12.9%)                               | 91 (15.2%)                               | 0.252                               |
| DL                                    | 48 (7.1%)                                | 53 (8.8%)                                | 0.240                               |
| Current smoker                        | 160 (23.5%)                              | 93 (15.5%)                               | <0.001                              |
| Chronic Obstructive Pulmonary Disease | 37 (5.4%)                                | 22 (3.7%)                                | 0.131                               |
| Asthma                                | 39 (5.7%)                                | 17 (2.8%)                                | 0.011                               |
| Ischemic heart disease                | 32 (4.7%)                                | 19 (3.2%)                                | 0.160                               |
| Obesity                               | 31 (4.6%)                                | 11 (1.8%)                                | 0.006                               |
| Congestive heart failure              | 20 (2.9%)                                | 9 (1.5%)                                 | 0.084                               |
| Chronic kidney disease                | 22 (3.2%)                                | 10 (1.7%)                                | 0.073                               |
| Arrhythmia                            | 5 (0.7%)                                 | 13 (2.2%)                                | 0.030                               |
| <b>Specific pathology</b>             |                                          |                                          |                                     |
| Oncology                              | 58 (8.5%)                                | 261 (43.5%)                              | <0.001                              |
| Degenerative spine                    | 470 (69.1%)                              | 155 (25.8 %)                             |                                     |
| TBI                                   | 5 (0.7%)                                 | 14 (2.3%)                                |                                     |
| Hemorrhagic cerebrovasc               | 17 (2.5%)                                | 43 (7.2%)                                |                                     |
| CSF                                   | 25 (3.7%)                                | 44 (7.3%)                                |                                     |
| Functional                            | 86 (12.6%)                               | 42 (7%)                                  |                                     |
| Traumatic spine injury                | 6 (0.9%)                                 | 19 (3.2%)                                |                                     |
| Infectious                            | 2 (0.3%)                                 | 7 (1.2%)                                 |                                     |
| Pediatric-specific                    | 11 (1.6%)                                | 40 (6.7 %)                               |                                     |
| <b>Priority of the surgery</b>        |                                          |                                          |                                     |
| Expedite (< 4 weeks)                  | 34 (5%)                                  | 248 (41.3%)                              | <0.001                              |
| Elective (> 4 weeks)                  | 646 (95%)                                | 352 (58.7%)                              |                                     |
| <b>SARS-CoV2 infection</b>            |                                          |                                          |                                     |
| Not confirmed/ suspected              | 674 (99.1%)                              | 586 (97.7%)                              | NA                                  |
| Awaiting surgery                      | 6 (0.9%)                                 | 4 (0.7%)                                 |                                     |
| Preoperatively screening              | 0                                        | 1 (0.2%)                                 |                                     |
| In-hospital admission                 | 0                                        | 3 (0.5%)                                 |                                     |
| After hospital discharge <30d         | 0                                        | 6 (1%)                                   |                                     |

|                               |   |   |
|-------------------------------|---|---|
| After hospital discharge >30d | 0 | 0 |
|-------------------------------|---|---|