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Coronavirus Disease 2019 (COVID-19) Outbreak: Single-Center Experience in Neurosurgical and Neuroradiologic Emergency Network Tailoring

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THE ENEMY TO FACE

The World Health Organization officially declared coronavirus disease 2019 (COVID-19) a pandemic on March 11, 2020.[1] After the COVID-19 pandemic developed in Asia, a second outbreak grew in Italy. From the province of Cremona, where the first cases were registered, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) quickly spread in the Lombardy region, with main the epicenters of infections seen in the provinces of Bergamo and Brescia. The capillary circulation of the infection was rapid and uncontrollable. On March 21, exactly 1 month after the first infection, a total number of 53,578 cases with 4825 deaths had been recorded. To date, April 13, 2020, in Italy 156,363 cases of COVID-19 have been confirmed, with 19,899 deaths.[2] To cope with the unstoppable advance of COVID-19, the Italian Government approved a series of decrees (the latest issued on April 10, 2020) defining standards and rules of quarantine status.

THE EMERGENCY TO REALIZE

Lombardy is the most populous (10,060,574 people)[3] and, at the same time, the region with the greatest number of COVID-19 infections, hospitalized patients, and dead. Like a spear, the SARS-CoV-2 has pierced the heart of Lombardy, bringing the Regional Health System to its knees and the health network just a few steps from internal collapse. Most hospitals quickly became overcrowded, and the medicine, oxygen, mechanical ventilators, and personal protective equipment that were available on hand were no longer enough. Military hospitals, equipped with all the necessary instrumentation for the management of patients with COVID-19, were set up outside the main institutions. Health care workers were often not enough, both in and outside the hospital. In this emergency situation, the help from other countries was fundamental, with the sending of health care materials and medical and nursing staff. Cemeteries and crematoriums could not accommodate all the dead, so some corpses were transported by military means out of the region to guarantee a worthy burial.

THE PROPOSAL TO REACT

Given the rapid spread of SARS-CoV-2 throughout Northern Italy, hospitals quickly were overburdened with patients with COVID-19 at different levels of care, from the ordinary hospitalization regime to subintensive and intensive ones. The need to reorganize the health and emergency network was evident to have an optimal distribution of material and personnel resources. With the issue of Decree XI/2906,[4] the Lombard Health System emergency network reorganized the existing hub-and-spoke model. The emergency activity was concentrated in 4 hub hospitals (i.e., 3 emergency hubs and 1 oncologic hub), whereas spoke hospitals focused on the management of patients with COVID-19.[5] This system was designed to ensure that the majority of the working force was targeted to patients with COVID-19. Emergencies have been classified into 5 groups: 1) neurosurgery, 2) stroke, 3) major trauma, 4) interventional cardiology, and 5) cardiac surgery and vascular surgery. The neurosurgical and neuroradiologic emergencies of a hub hospital were classified as follows: 1) cerebral hemorrhages (subarachnoid and intraparenchymal), 2) acute hydrocephalus, 3) tumors at risk of intracranial hypertension, 4) spinal cord compressions with neurologic deficit or at risk of, and 5) traumatic cranial and spinal trauma emergencies. The 4 hubs can deal with all these emergencies, except for the A+ (requiring treatment within a maximum of 7–10 days) and A (with the need of treatment within a month) tumor emergencies, which must be centralized to the oncologic hub.[5] For each group of emergencies, a specific hub-and-spoke hospital was defined. As for our center, Di Circolo and Fondazione Macchi Hospital in Varese represents one of the hub hospitals appointed for the management of neurosurgical and neuroradiologic interventional emergencies.

THE REAL LIFE TO COMPREHEND

Recently, Bernucci et al.[6] published an article regarding the shocking effect of the SARS-CoV-2 outbreak on the Department of Neurosurgery of Papa Giovanni XXIII Hospital in Bergamo. As proposed in Decree XI/2906, within the new hub-and-spoke system, the Papa Giovanni XXIII Hospital was supposed to be the reference point for pediatric trauma. However, no pediatric traumatic emergencies were sent to this hospital, and the structure was progressively filled with patients with COVID-19. Doctors of all specialties, including neurosurgeons, were reassigned to the new COVID-19 wards. The explosion of COVID-19 in Bergamo and neighboring territories led

Key words
- COVID-19
- Emergency
- Hub and spoke
- Lombardy
- Single center

Abbreviations and Acronyms
COVID-19: Coronavirus disease 2019
SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2

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Table 1. Each Group of Neurosurgical Emergencies Hospitalized and Surgically Treated at Our Center, Comparing the Data Collected in the First Month Since the Approval of the New Hub-and-Spoke System with Those of the Previous Year

	Number of Cases from March 9, 2019, to April 8, 2019		Number of Cases from March 9, 2020, to April 8, 2020		Percentage Increase	
	Hospitalized	Surgically Treated	Hospitalized	Surgically Treated	Hospitalized	Surgically Treated
Cerebral hemorrhages and intracranial complications	9	6	34	19	277%	216%
Acute hydrocephalus	1	1	3	3	200%	200%
Tumors	4	4	9	7	125%	75%
Spinal cord compressions	2	2	4	4	100%	100%
Cranic and spina trauma	4	3	23	6	475%	100%

Papa Giovanni XXIII Hospital to fully embody the role of a spoke hospital, completely disrupting the activity of this hospital.

THE FRONT LINE TO FIGHT

Di Circolo and Fondazione Macchi Hospital in Varese represents 1 of the 4 Lombard hub hospitals. The spoke hospitals that belong to our institution are Legnano Hospital and Sant'Anna Como Hospital for neurosurgical emergencies, and Gallarate Hospital for both neurosurgical and stroke emergencies. As a hub hospital, Di Circolo and Fondazione Macchi Hospital doubles the number of neurosurgeons on duties and guarantees 24/7 acceptance of cranial or spinal emergency cases. Neurovascular emergency management was performed in collaboration with the Department of Neurointerventional Radiology, tailoring the treatment (i.e., open surgery and/or endovascular procedure) to the single patient. A pharyngeal swab for COVID-19 research was collected for all patients entering our ward, regardless of the patient's clinic and thoracic radiologic findings.

The Neurosurgical Intensive Care Unit became a COVID-19 Intensive Care Unit and the Post Intensive Care Unit became a non–COVID-19 Intensive Care Unit with the need to support vital functions or postoperative monitoring in case of time-dependent emergencies.

All elective neurosurgery and neuroradiology activities have been suspended. The operating block has been divided into 2 areas with separate paths for patients with and without COVID-19. In the non-COVID-19 block, neurosurgery has 2 dedicated rooms. These rooms include patients whose pathologies of traumatological cranial and/or spine, vascular, or determining intracranial hypertension, defined by the Regional Directive, have a degree of urgency that allows the surgeon to wait for the outcome of the nasopharyngeal swab. In the COVID-19 block, an operating room has been set up with beds and equipment suitable for emergency neurosurgical operations that do not allow waiting for the outcome of the swabs. Patients with COVID-19 or those with a suggestive medical history are treated in these rooms as well. For all personnel involved, second-level personal protective equipment is mandatory (cap, protective goggles, FFP2 masks, 2 pairs of gloves, surgical gown or full suit, overshoes). The dressing and undressing must take place by adhering to the methods provided by the guidelines for the containment of the spread of the infection. The angio-suite, the magnetic resonance imaging unit, the computed tomography unit, and the radiology unit do not allow separate zoning. We use dedicated units (e.g., anesthesia ventilators) when it is possible; the personal protective equipment for personnel is chosen according to need. The rooms are properly sanitized after each procedure. At the end of the surgical or radiologic procedure, the patients are transferred to the relevant departments, following dedicated intrahospital lines.

THE PRELIMINARY DATA TO CONFRONT

The number of cases for each group of neurosurgical and neuroradiologic emergencies treated and hospitalized at our center is

Table 2. Each Group of Neuroradiological Emergencies Hospitalized and Endovascularly Treated at Our Center, Comparing the Data Collected in the First Month Since the Approval of the New Hub-and-Spoke System with Those of the Previous Year

	Number of Cases from March 9, 2019, to April 8, 2019		Number of Cases from March 9, 2020, to April 8, 2020		Percentage Increase	
	Hospitalized	Endovascularly Treated	Hospitalized	Endovascularly Treated	Hospitalized	Endovascularly Treated
Hemorrhagic stroke	3	3	7	7	133%	133%
Ischemic stroke	5	5	8	8	60%	60%

summarized in the Tables 1 and 2, comparing the data collected in the first month since the approval of the hub-and-spoke system with those of the previous year. Oncologic patients are only limited to A++ tumor emergencies (needing immediate treatment), as cases A+ and A have been sent to the oncologic hub. Compared with the previous year, there was an increase in both the number of hospitalized and surgically treated cases for all categories of surgical emergencies. It should be emphasized that, despite the restraint measures issued by the Regional Health System,[7] in our institution there was an increase of 475% and 100%, respectively, of hospitalized and surgically treated traumas.

These data are in line with the role of hub hospital of our institution, focusing on emergency management and translating the assistance of patients with COVID-19 in the satellite spoke hospitals. Despite this, patients with COVID-19 also have been hospitalized in our center, with progressive growth in their numbers. Already at the time of the issuance of Decree XI/2906, 8 patients with COVID-19 were intubated in intensive care. On April 13, the number of patients with COVID-19 hospitalized in intensive care unit was 84.

THE EXPERIENCE-BASED MODEL TO TREASURE

About a month after the establishment of the new hub-and-spoke system,[4] the first data collected demonstrated the central role assumed by the hub unit for the management and treatment of neurosurgical and neuroradiologic emergencies. The first confirmations on the effectiveness of this reorganized emergency network will have to be reassessed over time when new data become available. Di Circolo and Fondazione Macchi Hospital remains, like the other Lombard Hub centers, the beating heart and the gravitational center of emergency management and surgical activity. The reorganization of the emergency network allowed to curb the imminent collapse that the Regional Health System was facing. The COVID-19 outbreak is leaving an indelible scar on our health care system.

The whole world is facing a common and invisible enemy; a winning weapon can be found in the sharing of resources and experiences between the various centers. May our experience serve as a model for the other regions of the world that will face sudden emergency conditions.

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