



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Response to SARS-CoV-2 Pandemic in a Non-COVID-19 Designated Latin-American Neurosurgery Department

Santiago Núñez-Velasco¹, Rodrigo Mercado-Pimentel¹, Miguel Ochoa-Plascencia¹, Regina Rodríguez-Arias², Gerardo Lopez-Espinoza¹, María Elena González-González^{1,3}, Carlos Estrella-Sánchez¹, Carlos Ramírez-Huerta¹

■ **BACKGROUND:** Mexico declared the first case of novel coronavirus disease (COVID-19) in February 2020. At the time we write this article, our country is facing a community spread phase, expecting a rapid increase in the number of cases and fatalities. The Fray Antonio Alcalde Civil Hospital of Guadalajara has been declared a non-COVID-19 hospital with the mission of providing care to patients already registered and also those transferred from neurosurgical departments of neighboring centers, which have been converted into COVID-19 only hospitals.

■ **METHODS:** An organized response regarding personnel, surgical case selection, operating room behavior, and facility reorganization were designed to prevent an internal coronavirus outbreak in the neurosurgery department at the Fray Antonio Alcalde Civil Hospital of Guadalajara.

■ **RESULTS:** Distancing actions by the staff and residents, including ward case discussions, neurosurgery rounds, and classes, will be carried out virtually. We classified neurosurgical patients into 4 groups depending on whether their condition demands care in 0–6 hours, 6–48 hours, 48 hours to 14 days, and >14 days. Subsequently, a questionnaire with epidemiologic, radiologic, clinical, and serologic criteria will be applied to determine the risk of COVID-19 infection to define to which area they are going to be transferred according to the different risk zones in our facility.

■ **CONCLUSIONS:** Despite not being a COVID-19 center, we consider all patients at the neurosurgical ward and staff members as asymptomatic carriers or infected in the

preclinical period. Specific measures must be taken to ensure the safety and care of neurosurgical patients and medical staff during the community spread phase.

INTRODUCTION

In December 2019, an outbreak of pneumonia associated with a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which the World Health Organization calls novel coronavirus disease (COVID-19), was reported in Wuhan province of Hubei, China, that quickly spread throughout the world and was declared a pandemic on March 11, 2020.¹⁻³ Mexico announced the first case on February 28. On March 30, the Mexican government declared a health emergency, and now we are in community spread and accelerated growing phase. At the time of writing this article, 13,842 cases (an estimate of more than 50,000 cases) have been reported using a sentinel model, and 1305 deaths have occurred. Also, according to Mexican officials, 15% of the positive cases are in health care workers, some of them not assigned to COVID-19 areas.⁴

The state of Jalisco, which up to now has presented 312 confirmed cases and 23 deaths, implemented a hospital reconversion strategy designating several hospitals of Guadalajara as COVID-19 treatment centers. The Fray Antonio Alcalde Hospital Civil, where our department is located, has been designated as a non-COVID-19 center, intended to offer treatment care for neurosurgical pathologies not SARS-CoV-2 related.⁵ This designation is especially crucial for the neurosurgery department because it would be the last public neurologic surgery service

Key words

- COVID-19
- Neurosurgery
- Pandemic
- Response
- SARS-Cov-2

Abbreviations and Acronyms

COVID-19: Novel coronavirus disease

CT: Computed tomography

PPE: Personal protective equipment

RT-PCR: Reverse transcription polymerase chain reaction

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

From the ¹Department of Neurosurgery, ²Department of Anesthesiology, and ³Surgery Division, Fray Antonio Alcalde Civil Hospital of Guadalajara, Guadalajara, Jalisco, Mexico

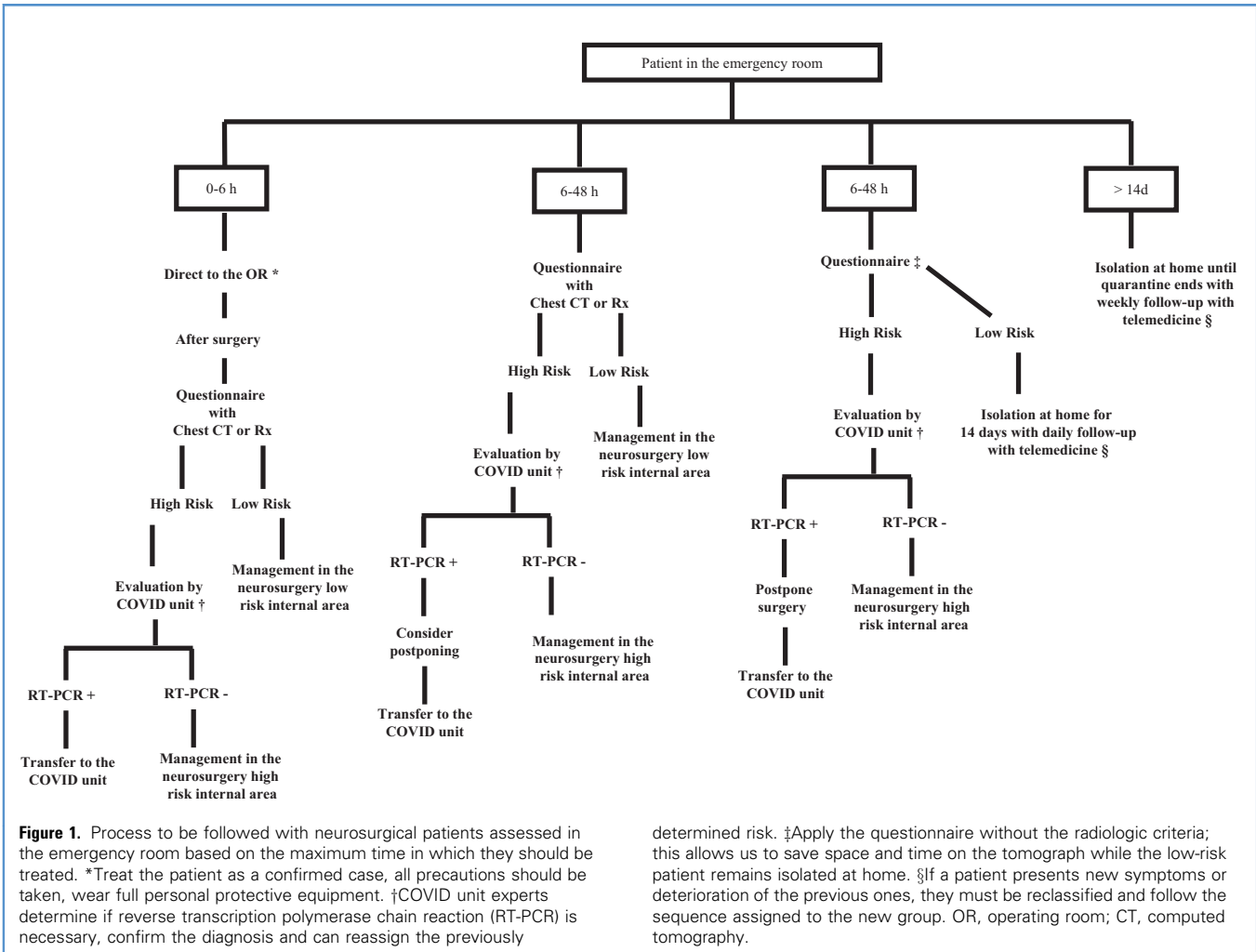
To whom correspondence should be addressed: Santiago Núñez-Velasco, M.D.
[E-mail: snunez@hcg.gob.mx]

Citation: *World Neurosurg.* (2020) 142:506-512.
<https://doi.org/10.1016/j.wneu.2020.05.019>

Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

1878-8750/\$ - see front matter © 2020 Elsevier Inc. All rights reserved.



for the uninsured population in the state to cede its facilities for the exclusive care of COVID-19, and therefore we expect an increase in urgent cases from other centers. However, the city maintains community spread of the virus, and it is not possible to perform reverse transcription polymerase chain reaction (RT-PCR) tests on every admitted patient, so preventive measures must be taken to keep our facilities, patients, and staff free of infection to keep on attending patients with neurosurgical needs under minimal risk.

METHODS

Based on the epidemiologic and biological information available in the literature on COVID-19, specific measures adapted to our resources were implemented to design a protocol of organized administration of human resources both assistant and administrative, optimized surgical procedures, proper handling of personal protective equipment (PPE), and adaptation of the facilities of the neurosurgery department of the Fray Antonio Alcalde Hospital Civil when treating neurosurgical patients with no SARS-CoV-2 known condition.

RESULTS

We divide our response plan into 3 sections: staff distribution, surgical triage classification, and operating room actions and facilities restructuring.

Staff Distribution

All staff personnel is evaluated daily before walking in the department with a symptoms questionnaire and temperature measurement. In case of any suggestive information, they are referred to the COVID-19 (our center has an isolated, fully equipped tower for patients with COVID-19 and a team of experts) area to determine if they should be isolated or are eligible to return to work. Residents are equally divided into 3 groups. Each group stays for a 3-day on-call round followed by a 6-day off period (this is because the average of the preclinical infection period is 5 days). The members of each group are not able to have contact with another group. Attending physicians follow their daily schedule, observing minimal contact between them. All on-call delivery sessions, ward rounds (1 attending physician and 1 resident will

Table 1. Questionnaire to Determine the Risk of Having COVID-19 with Accessible Data in our Emergency Room

Epidemiologic	Score	Level of Risk
History of direct contact with a confirmed case of COVID-19	2	4 or more = high risk
Occupational risk* or noncompliance with quarantine	2	3 or less = low risk
Contact with an individual with respiratory symptoms not tested for COVID-19	1	
Radiologic		
Signs of pneumonia on the chest tomography, ground-glass opacities	4	
Signs of pneumonia on the chest x-ray	4	
Serum		
Leukopenia	1	
Clinical		
Hyposmia	3	
Fever, headache, and cough (assign 2 points for each)	2	
Dyspnea, myalgia, arthralgia, conjunctivitis, nasal congestion, sore throat, thorax pain (assign 1 point for each)	1	
Total		

*Health care professionals, police, grocery store workers, and others.

do it in person while the rest of the staff will follow the round virtually), and academic activities are carried out via live communications through web platforms. These activities are coordinated by the team on duty at the hospital and are followed by the rest of the medical staff at home or in different hospital locations.

Surgical Triage Classification and Operating Room Actions

We canceled the outpatient clinic and the elective surgery schedule. The only admission route for a patient is through the emergency department. Every neurosurgical case is classified according to the following system: 0–6 hour group, defined as those patients who present with sudden and rapidly progressive deterioration in alertness, pupillary changes, or acute signs of brainstem or spinal cord compression that demand surgery in less than 6 hours. The 6–48 hour group, defined as those suffering from urgent neurosurgical pathologies who demand intrahospital care but can wait up to 48 hours before resolution. The 48 hours to 14 day group, defined as patients with a neurosurgical pathology already diagnosed who can stay at home for up to 14 days and will be able to return in case of progression. The >14 day group, those with a nonurgent surgical pathology that can be resolved in 14 days or later, with minimal chances of deterioration.

Once a patient is classified, a specific algorithm will be applied (Figure 1). The classification of patients will be determined by a multilateral consensus of at least 2 attending physicians and the ward chief resident. The grouping definition is flexible and permits reclassification if a patient develops objective changes in his or her clinical or radiologic condition.

To correctly use this algorithm, we have defined a screening questionnaire (Table 1) that includes the epidemiologic, radiologic, serum, and clinical criteria commonly described in COVID-19 patients and that are readily available in our hospital. This questionnaire allows us to classify patients at high and low risk of developing COVID-19; this form must be completed by the team of on-call neurosurgery residents and reported to the attendings team on duty for verification. However, it is essential to clarify that this instrument does not diagnose COVID-19; it only allows residents and attendings of our department to place patients in a group of risk. The definitive diagnosis and risk definition review, when needed, will be carried out by experts from the COVID-19 area.

For high-risk patients after being evaluated by the COVID-19 unit, we have designed a table that indicates the surgical decisions that must be made in patients according to their RT-PCR results and the group to which they were assigned (Table 2).

Table 2. Surgical Behavior to be Followed in High Risk COVID-19 Patients According to Their Group Classification.

	High Risk	
	RT-PCR (–)	RT-PCR (+)
0–6 hours	Go With full PPE protocol and postoperative aerosol/high-risk care for all staff. Do not wait for COVID test results	
6–48 hours	Go With full PPE protocol and postoperative aerosol/high-risk care for all staff	Go only if it is not possible to preserve life without surgery (individualize cases). Apply full PPE protocol and postoperative aerosol/high-risk care for all staff
48 hours to 14 days	Go	Do not Go
>14 days	If after home isolation. Observation rules out COVID	Prioritize COVID treatment

RT-PCR, reverse transcription polymerase chain reaction; PPE, personal protective equipment.

Table 3. Fray Antonio Alcalde Hospital Civil Neurosurgery Department Checklist for Donning and Doffing Personal Protective Equipment, Adapted to the Areas in Which it Must be Placed and Removed. Especially in the Doffing Process, Every Time You Touch an Object or Surface You Should Sanitize your Hands or Internal Gloves. Shower is Recommended but not Mandatory

Donning		Doffing	
Don	Special Action	Special Action	Doff
Dressing rooms		Operating room doffing area near the exit door	
Remove personal and electronic objects		Gloves sanitization	Surgical gown/external gloves
Surgical uniform		Gloves sanitization	Face shield
		Gloves sanitization	Full-face cap or neck cover‡
		Gloves sanitization	External boots
		Gloves sanitization	Waterproof pants*
Staff black-gray area transfer		Staff black-gray area transfer	
Internal surgical cap		Gloves sanitization	Internal boots
Internal boots		Move to the black area	
Waterproof pants*	Hand sanitization	Gloves sanitization	External surgical mask†
N95 mask or similar/sealing test	Hand sanitization	Gloves sanitization	Safety goggles
Safety goggles	Hand sanitization	Gloves sanitization	N95 mask or similar
External surgical mask†	Hand sanitization	Gloves sanitization	Internal surgical cap
Full-face cap or neck cover‡	Hand sanitization	Go to dressing room	
External boots	Move to the gray area		
Scrub zone		Dressing room	
Face shield	Surgical hand scrub	Gloves sanitization	Surgical uniform
		Take a shower	
Operating room			
Internal sterile gloves			
Surgical gown			
External sterile gloves			

*In our center, the available gowns do not reach to the ankles, and we do not have full leg boots, so we propose the use of waterproof pants to ensure better protection. In case of having the supplies mentioned in the Table, you can ignore the pants.

†The external surgical mask helps to protect the N95 in case of reuse.

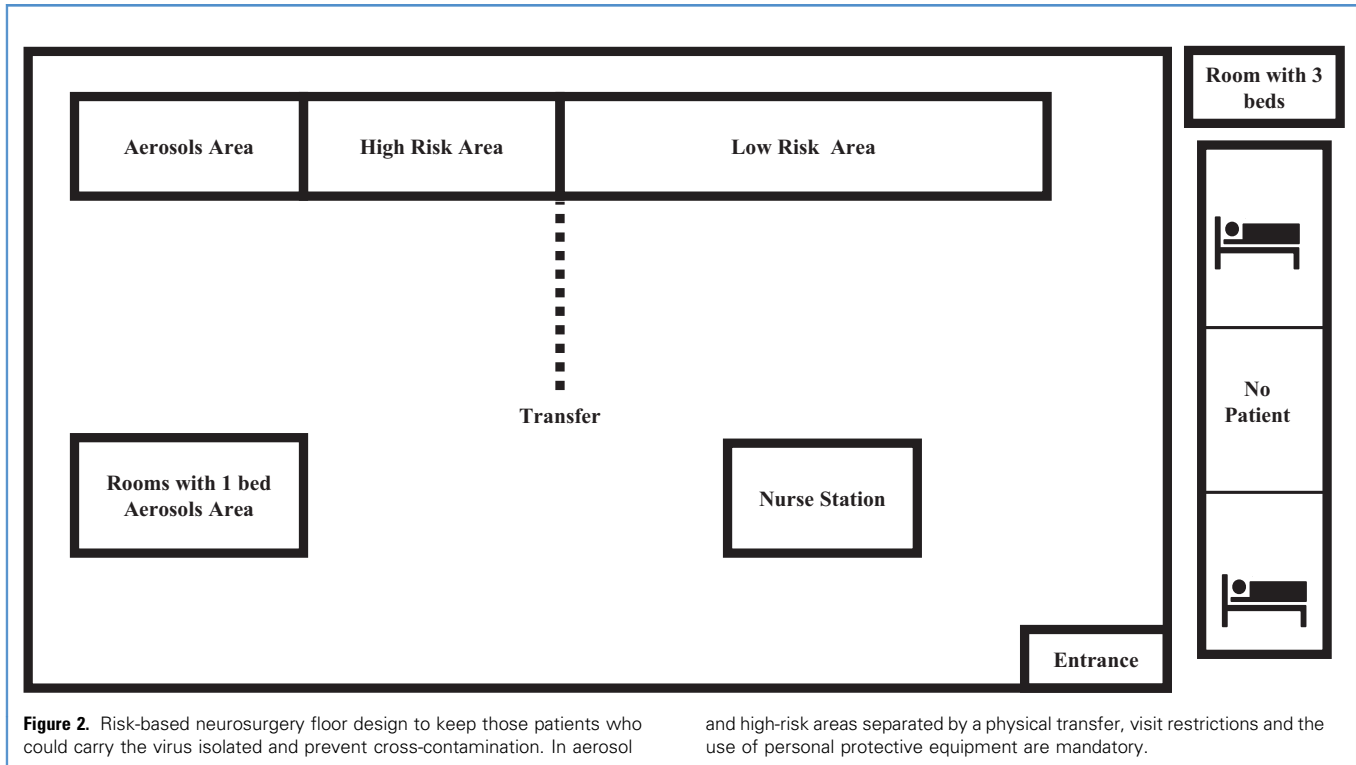
‡In case of the absence of the full-face cap, a surgical boot can be adapted to protect the neck. A lead collar can also be used.

The staff was trained in the process of donning and doffing PPE, noting that the sequence for the surgical field that requires sterile hand washing is different from that published for that personnel who perform actions that do not require sterility. Therefore we built a modified checklist from that published by the University of South Carolina,^{6,7} which includes not only the steps to follow, adapted to the PPE available in our hospital, but also the area of the operating room complexes in which they must be placed and removed (Table 3). All patients admitted at the operating room will be considered as SARS-CoV-2 asymptomatic carriers until proven negative, and hence every standardized process according to this scenario will be strictly followed.⁸⁻¹⁰

Facilities Restructuration

Offices, lecture rooms, and on-call ward rooms were signalized with visual aids on the floor and furniture surfaces to indicate the 2 m distance demanded between every person. Our department has 2 areas for hospitalized patients: a 29-bed floor for elective cases (divided in 9 3-bed rooms and 2 single-bed rooms), and a trauma ward with 24 beds distributed in 2 opposite rows. These areas already have barrier curtains for a physical separation of each patient.

Because there is not a specific area for neurosurgical intensive care patients, it is not rare to look after critically ill patients under assisted ventilation at any of these general locations at our department when there are no beds available at the central

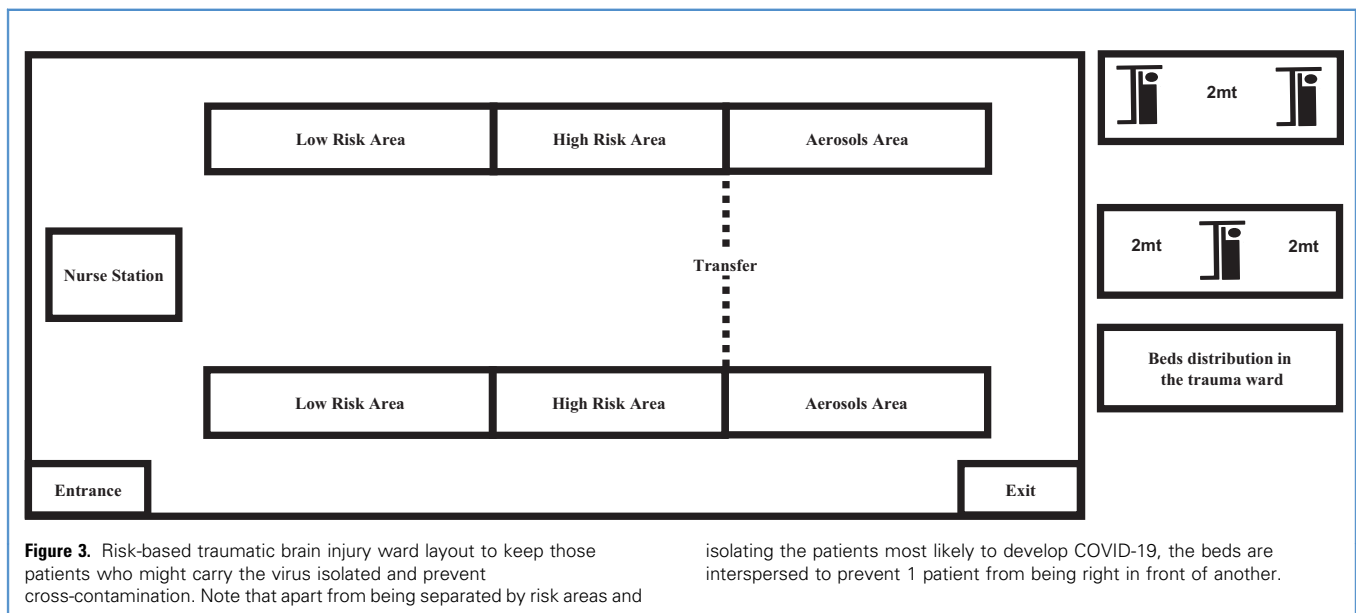


intensive care unit. These areas are now organized in 3 different sections: aerosols contamination risk, high risk, and low risk.

The aerosols area is where the mechanical-assisted ventilation patients are located. High risk area is designated for patients according to their COVID-19 questionnaire rates. Barrier care precautions, visit restrictions (only 1 family member during

established hours will be allowed), and high-index PPE are considered as mandatory in these 2 previously mentioned areas. Low-risk area is designated for those patients with limited likelihood of being infected, and it is located closest to the entrance.

In the case of the floor cubicles, the intermediate bed will never be occupied (Figure 2), and in the case of the trauma ward rows,



the beds are arranged at a 2 m distance between them and will be inserted so that no patient has the opposite bed occupied (Figure 3). All patients with RT-PCR positive for SARS-CoV-2 will be transferred to the corresponding COVID-19 area.

DISCUSSION

The novel coronavirus (SARS-CoV-2) is a beta-coronavirus associated with transmission between humans with a molecular structure similar to the Middle East respiratory syndrome-CoV and SARS-CoV-1 that previously caused outbreaks.¹¹ The transmission of this pathogen occurs via person-to-person mainly by droplets and aerosols produced by simple conversation, sneezing, coughing, and medical care procedures.¹²⁻¹⁴ Another form of transmission is through contact with surfaces contaminated with exhaled droplets that carry the virus itself, and that can survive on surfaces for a certain time.¹⁵

It is clear that there is an asymptomatic carrier state and that it can transmit the disease, a preclinical incubation period of approximately 5 days has also been described, in which the patient may not present signs or symptoms but may spread.¹⁶⁻¹⁹ Being designated as a non-COVID-19 hospital does not mean that we will not receive infected SARS-CoV-2 patients because it is already in community dispersion, and just as nursing homes and restaurants have been contaminated, our neurosurgery department could become contaminated too, especially if we do not have proper care. This would lead us to a catastrophic scenario because there are reports of 12% of hospital-associated transmission of the virus as the mechanism of infection of patients, that in our cases are weak and many of them immunosuppressed; thus cases of contamination of health care personnel have also been reported, especially in nondesignated COVID areas in which precautions might relax.¹⁸⁻²²

Ideally, we would like to offer all of our patients RT-PCR and antigen-antibody testing at the time they are admitted, given that there have been several cases of patients who underwent surgery without symptoms and who developed COVID-19 days later, and these examples can be easily reproduced in our center.^{23,24}

However, this is not currently possible despite the efforts of our local government.

Hence it was necessary to build a screening algorithm adapted for our environment that would allow us to identify high-risk cases for timely referral to COVID-19 experts, keeping patients who need to be hospitalized and could be a source of infection for others, isolated. We also can closely follow those patients who can be at home, so they can comply with a 14-day isolation (the COVID-19 mean clinical course) and then bring them back to the hospital with the certainty that the risk is minimal.^{12,14,19}

The main signs and symptoms of the disease are fever, headache, cough, hyposmia, respiratory distress, myalgia, arthralgia, and chest pain. These were included in our risk questionnaire, weighted according to their prevalence of presentation, and following the operational definitions of our country.^{4,12,19,25,26}

An important part of the questionnaire has to do with imaging studies; chest tomography has shown to be an excellent diagnostic substitute when RT-PCR is not available,^{27,28} however, although it will always be preferable to have computed tomography (CT), the possible saturation of the CT department makes us include the chest radiography to use in cases in which it is impossible to access CT.²⁷

PPE is a great tool that health professionals have for the defense against the virus, so it is important not only to know the procedures and sequences to wear them but to adapt these to the scenarios in which we will develop, in our case, the operating room.

That is why we decided to adapt our checklist to the resources we have available and also include the spaces in which each element should be placed.

CONCLUSIONS

Hospitals designated as non-COVID-19 centers must maintain a specific plan and sufficient precautions to avoid SARS-CoV-2 contamination within them and maintain quality care for all those patients who require urgent treatment, and this has been deferred because of the hospitals' COVID-19 resignations.

REFERENCES

- Zhao S, Lin Q, Ran J, et al. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: a data-driven analysis in the early phase of the outbreak. *Int J Infect Dis.* 2020;92:214-217.
- Nicogossian A. In the news. *World Med Heal Policy.* 2012;4:2020.
- World Health Organization. Coronavirus disease (COVID-19) outbreak. Available at: <https://www.who.int>. Accessed April 25, 2020.
- Mexican Government. Covid-19 Mexico. Available at: <https://coronavirus.gob.mx/datos/>. Accessed April 25, 2020.
- Jalisco's Plan Covid-19. Available at: <https://coronavirus.jalisco.gob.mx>. Accessed April 25, 2020.
- Centers for Disease Control and Prevention. Guidance for donning and doffing personal protective equipment (PPE) during management of patients with Ebola virus disease in U.S. hospitals. Ebola: personal protective equipment (PPE) donning and doffing procedures. Available at: <https://www.cdc.gov/vhf/ebola/hcp/ppe-training/index.html>. Published July 25, 2019. Accessed April 24, 2020.
- Evans HL, Thomas CS, Bell LH, et al. Development of a sterile PPE donning and doffing procedure to protect surgical teams from SARS-CoV-2 exposure during the COVID-19 pandemic. Available at: https://docs.google.com/document/d/16uwMGaiXpYGAdPDcd_C4-e7azAULVetOb-ODNd1WgA/mobilebasic. Accessed April 25, 2020.
- Tien HC, Chughtai T, Jokeklar A, Cooper AB, Brenneman F. Elective and emergency surgery in patients with severe acute respiratory syndrome (SARS). *Can J Surg.* 2005;48:71-74.
- Wong J, Goh QY, Tan Z, et al. Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore [e-pub ahead of print]. *Can J Anesth* <https://doi.org/10.1007/s12630-020-01620-9>, accessed April 25, 2020.
- Forrester JD, Nassar AK, Maggio PM, Hawn MT. Precautions for operating room team members during the COVID-19 pandemic [e-pub ahead of print]. *J Am Coll Surg* <https://doi.org/10.1016/j.jamcollsurg.2020.03.030>, accessed April 25, 2020.
- Paraskevis D, Kostaki EG, Magiorkinis G, Panayiotakopoulos G, Sourvinos G, Tsiodras S. Full-genome evolutionary analysis of the novel corona virus (2019-nCoV) rejects the hypothesis of emergence as a result of a recent recombination event. *Infect Genet Evol.* 2020;79:104212.
- Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. *J Autoimmun.* 2020;109:102433.

13. Meselson M. Droplets and aerosols in the transmission of SARS-CoV-2 [e-pub ahead of print]. *N Engl J Med* <https://doi.org/10.1056/NEJMc2009324>, accessed April 25, 2020.
14. Li Q, Guan X, Wu P, et al. Early Transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med.* 2020;382:1199-1207.
15. Taylor D, Lindsay AC, Halcox JP. Correspondence aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N Engl J Med.* 2020; 382:1564-1567.
16. Bai Y, Yao L, Wei T, et al. Presumed asymptomatic carrier transmission of COVID-19. *JAMA.* 2020;323:1406-1407.
17. Rothe C, Schunk M, Sothmann P, et al. Transmission of 2019-NCOV infection from an asymptomatic contact in Germany. *N Engl J Med.* 2020; 382:970-971.
18. Arons MM, Hatfield KM, Reddy SC, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility [e-pub ahead of print]. *N Engl J Med* <https://doi.org/10.1056/NEJMoa2008457>, accessed April 25, 2020.
19. Guan W, Ni Z, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med.* 2020;382:1708-1720.
20. Heinzerling A, Stuckey MJ, Scheuer T, et al. Transmission of COVID-19 to health care personnel during exposures to a hospitalized patient: Solano County, California, February 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:472-476.
21. McMichael TM, Currie DW, Clark S, et al. Epidemiology of Covid-19 in a long-term care facility in King County, Washington [e-pub ahead of print]. *N Engl J Med* <https://doi.org/10.1056/nejmoa2005412>, accessed April 25, 2020.
22. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA.* 2020;323:1061-1069.
23. Lei S, Jiang F, Su W, et al. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection [e-pub ahead of print]. *EClinicalMedicine* <https://doi.org/10.1016/j.eclinm.2020.100331>, accessed April 25, 2020.
24. Zhu W, Huang X, Zhao H, Jiang X. A COVID-19 patient who underwent endonasal endoscopic pituitary adenoma resection: a case [e-pub ahead of print]. *Neurosurgery* <https://doi.org/10.1093/neuros/nyaa147>, accessed April 25, 2020.
25. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet.* 2020;395:497-506.
26. Song C-Y, Xu J, He J-Q, Lu Y-Q. COVID-19 early warning score: a multi-parameter screening tool to identify highly suspected patients [e-pub ahead of print]. *medRxiv* <https://doi.org/10.1101/2020.03.05.20031906>, accessed April 25, 2020.
27. Wong HYF, Lam HYS, Fong AH, et al. Frequency and distribution of chest radiographic findings in COVID-19 positive patients [e-pub ahead of print]. *Radiology* <https://doi.org/10.1148/radiol.2020201160>, accessed April 25, 2020.
28. Ai T, Yang Z, Xia L. Correlation of chest CT and RT-PCR testing in coronavirus disease. *Radiology.* 2020;2019:1-8.

Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 26 April 2020; accepted 2 May 2020

Citation: World Neurosurg. (2020) 142:506-512. <https://doi.org/10.1016/j.wneu.2020.05.019>

Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

1878-8750/\$ - see front matter © 2020 Elsevier Inc. All rights reserved.