



COVID-19 Countermeasures in Acute Stroke

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The impact of coronavirus disease 2019 (COVID-19) is continuing, and the most important issue facing medical staff is how to provide medical care while preventing nosocomial infections. Since acute stroke treatment, particularly mechanical thrombectomy, is urgent, infection protection measures may not always be followed, which increases the risk of infection exposure. The measures and methods for patient screening, transport, zoning, and use of personal protective equipment (PPE) employed to prevent nosocomial infections of COVID-19 at our facility are described herein.

Keywords ▶ coronavirus disease 2019, Cord Yellow, mechanical thrombectomy

Introduction

Since its initial emergence in December 2019,¹⁾ coronavirus disease 2019 (COVID-19) has spread rapidly worldwide and its impact is continuing. Although COVID-19 causes pneumonia and acute respiratory distress syndrome,²⁾ thromboembolism due to increased coagulation has been reported.^{3,4)} The incidence of cerebrovascular diseases in hospitalized patients ranges between 0.9 and 5.7%, and is higher in those with severe disease.^{3,5,6)} Although the etiology of thromboembolism currently remains unknown, embolization due to elevated d-Dimer levels, the cytokine storm, and virus-related cardiac injury have been implicated as causative factors.⁷⁾

A number of treatment strategies are now employed for COVID-19 in patients with cerebrovascular diseases; however, since the time to treatment initiation is critical for the

prognosis of these patients, medical practice may be prioritized over infection protection. Therefore, in an effort to shorten the time to treatment initiation, infection prevention measures are more likely to be neglected in patients with large vessel occlusion (LVO). Once nosocomial infections occur, hospitals have to downsize their functions, and community healthcare may collapse. To prevent this, healthcare workers are required to provide treatment with minimal time losses while maximizing infection protection. Although COVID-19 protocols and guidelines have been established for acute endovascular treatment,^{8–10)} difficulties are associated with their implementation to the same degree in all hospitals; therefore, individualized measures are needed for each hospital. At our institution, we conduct our own infection prevention measures for patients with suspected COVID-19.

Measures and Methods

Since the use of individual measures by each department at our hospital may result in many rules and confusion among staff, a team was established to create countermeasures for COVID-19. The members comprised a hospital director, deputy director, nursing director, comedic director, administrative director, infection committee member, and hospital safety management director. Information was collected on COVID-19 countermeasures in the literature and at other hospitals, and the most appropriate infection control methods for our hospital were discussed. The team selected

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and manualized infection prevention measures for all departments. All manuals were made into a single book that is accessible to all staff in the hospital at any time. This documentation not only facilitates an understanding of the measures that need to be followed by staff but also allows them to refer to the book at any time to resolve any questions they may have.

Patient screening

Patients who are transported to the emergency room are screened in two stages: at the time of patient transport and at the time of admission. A checklist consisting of three items (life history, fever, and symptoms) is prepared, and these three items are checked with information from the ambulance crew to establish whether COVID-19 is suspected. Furthermore, regarding examination findings after visiting the hospital, screening is performed again to establish whether COVID-19 is suspected, even at the time of admission, and patients are color-coded according to the results obtained. Hospital beds, transportation methods, and personal protective equipment (PPE) are selected based on this color coding system.

Screening based on information obtained from the ambulance crew (Table 1)

At the time of receiving a request to transport an emergency patient, their life history, fever, and symptoms are scored according to our checklist. A score of 5 or higher is defined as A with suspected COVID-19, whereas a score of 4 or lower is B with a low suspicion of COVID-19. In cases defined as A, staff examine the patient with full PPE and prioritize chest CT and blood sampling to color code the patient as soon as possible. Since we cannot treat patients at our hospital without a color code, we prioritize chest CT and blood sampling.

Screening on admission

Polymerase chain reaction (PCR) sensitivity is reportedly 71–83%,^{11,12)} with the probability of positives not being detected. Therefore, a negative PCR cannot completely exclude COVID-19. To manage false-negative patients, the degree of suspicion of COVID-19 at the time of admission is color-coded, and the infection control measures and the bed for patient hospitalization are determined based on the color coding. Color coding is based on life history, fever, blood sampling results, and chest CT. Red (R) is PCR positive, Yellow/Red (YR) is strongly suspected of COVID-19, Yellow (Y) is suspected of COVID-19,

Table 1 A three-point check of life history, fever, and symptoms is performed to establish whether COVID-19 is suspected

Life history	
<input type="checkbox"/> History of contact with COVID-19 patients within 14 days	
<input type="checkbox"/> History of a visit to hospitals with clusters within 14 days	
<input type="checkbox"/> History of a visit to high-risk facilities for infection	
• Applicable to one or more items	→ 5 point
• Life history cannot be taken	→ 3 point
• No mask when going out	→ 1 point
Fever	
<input type="checkbox"/> Fever of 37.5°C or higher at the time of the visit to the hospital	
<input type="checkbox"/> Fever of 37.5°C or higher that continues for several days	
• Applicable to one or more items	→ 3 point
Symptoms	
<input type="checkbox"/> Respiratory symptoms, such as cough and sputum	→ 2 point
<input type="checkbox"/> Dyspnea or decreased SpO2	→ 2 point
<input type="checkbox"/> Taste and smell disorder	→ 2 point
<input type="checkbox"/> Listlessness	→ 1 point

A score of 5 or higher is defined as suspected COVID-19, whereas a score of 4 or lower is a low suspicion of COVID-19. COVID-19: coronavirus disease 2019

Yellow/White (YW) is a low suspicion of COVID-19 that has not yet been completely ruled out, and White (W) is not suspected of infection. Life history and fever are judged based on the checklist to identify the possibility of infection. Blood sampling and chest CT are defined as positive based on the following findings:

- 1) An elevated or decreased white blood cell count, abnormal liver function, and elevated C-reactive protein (CRP) in blood samples
- 2) Suspected pneumonia due to COVID-19, such as ground glass opacities just below the pleura and segmental infiltration opacities in chest CT

Color coding is performed as follows (**Fig. 1**): YR, when two or more of the four items are abnormal YR, PCR is performed and a positive result is R, while a negative result is Y. If there is a problem with one item of fever, blood sampling, and chest CT, patients are defined as Y. If a problem is found only in life history on the checklist, patients are defined as YW. If no abnormality is found in any item, patients are defined as W. Negative PCR results are defined as Y because of the possibility of false-negative results. Therefore, even if PCR is negative, hospitalization is managed as Y. PCR is performed again 1 week later, and when a negative result is confirmed, the color code of the

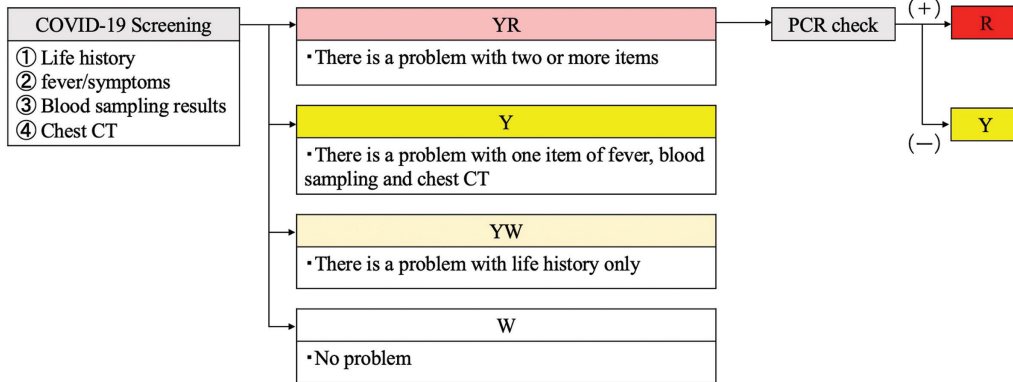


Fig. 1 Flowchart of screening on admission. Color coding is based on life history, fever, blood sampling results, and chest CT. If abnormalities are observed in 2 or more of the 4 items or if findings are detected on chest CT, the patient is color-coded as YR. PCR is performed on YR patients, and patients with a positive result are defined as R and those with a negative result as Y. If only one abnormality is noted in one of the four items, the patient is defined as Y, and if a problem is found only in life history on the checklist, the patient is defined as YW. If no abnormality is found in any item, the patient is defined as W. COVID-19: coronavirus disease 2019; PCR: polymerase chain reaction; R: Red; YR: Yellow/Red; Y: Yellow; YW: Yellow/White; W: White

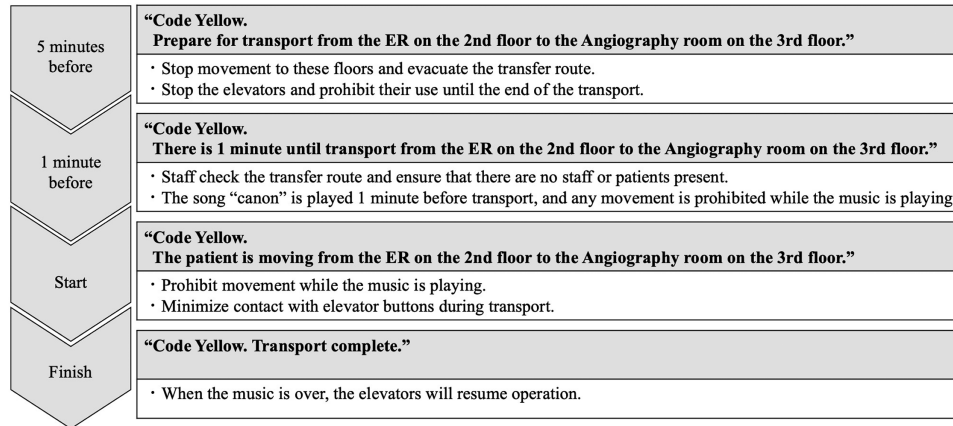


Fig. 2 Method of transporting patients with suspected COVID-19 during emergency endovascular treatment. A broadcast is issued 5 minutes before transportation. After this broadcast, the use of all elevators, except for that for transportation, is prohibited. Another broadcast is issued 1 minute before transportation. Music is then played, during which time all staff and patients must remain at the same location. After broadcasting the start of transportation, transport of the patient is initiated. When transport of the patient is completed, the end of Code Yellow is broadcast. COVID-19: coronavirus disease 2019

patient is changed to W. Color coding is performed by the infection control team.

If the patient is color-coded as R, Y, or YW, the patient is managed in the intensive care unit (ICU) as being positive for or suspected of having COVID-19. Full PPE is used when the patient requires treatment, and the patient is transported using Code Yellow as described below.

Transportation

Since the transportation of patients is associated with a risk of infection, it is important to reduce contact with people and items as much as possible. At our facility, we use Code Yellow to transport patients identified as R, Y, or YW

(Fig. 2). Transportation in the case of emergency catheter treatment is described as follows. The clerk issues a broadcast 5 minutes before transportation. After the broadcast, the use of all elevators, except for that for transportation, is prohibited. The clerk issues a broadcast again 1 minute before transportation. Music is played after this broadcast, during which time staff and patients on the relevant floors (in this case, the second floor where the emergency room is located and the third floor where the angiography room is located) must remain in the same location. After broadcasting the start of transport, the patient is moved. The end of Code Yellow is broadcast when transportation of the patient is completed.

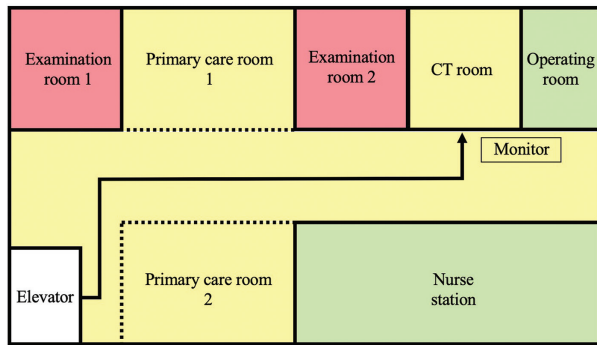


Fig. 3 Zoning and emergency patient flow in the emergency room. The emergency room was divided into contaminated (Red), intermediated (Yellow), and non-contaminated areas (Green). Patients identified as A according to the checklist are first transported to the CT room for chest CT imaging (Arrow). If the chest CT shows suspicious findings for COVID-19, the patient is transported to the examination room 1 or 2. If there are no suspicious findings for COVID-19 on chest CT, the patient is transported to the primary care room. If the patient is determined to be B according to the checklist, the patient is transported to the primary care room. COVID-19: coronavirus disease 2019

This system prevents any contact with other staff or patients during transport. The only contact with objects is the elevator button, which is immediately disinfected with alcohol after exiting the elevator.

Zoning

Emergency room

Zoning is important in emergency rooms, in which overcrowding frequently occurs. The emergency room is divided into contaminated, intermediated, and non-contaminated areas (**Fig. 3**). A negative pressure room and a room equipped with an air purifier with a high efficiency particulate air (HEPA) filter are used as contaminated areas to examine patients suspected of having COVID-19. The nurse station and CT operation room are designated as non-contaminated areas, and doctors providing test orders do not move from these areas and do not come into contact with patients. The doctors examining the patient are not allowed to enter the non-contaminated area, and a monitor is set up outside the operation room for the viewing of images. The primary care room, CT room, and passages were designated as the intermediated areas. The flow of a patient examination in the emergency room is based on zoning rules described below. Patients identified as A according to the checklist are first transported to the CT room for chest CT. If the chest CT shows suspicious findings for COVID-19, the patient is transferred to the examination room 1 or 2. If there are no suspicious findings for COVID-19 on chest CT, the patient is transferred to the primary care room. If the patient is

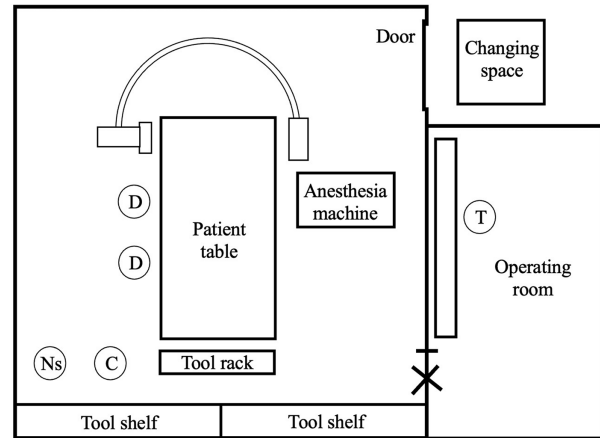


Fig. 4 Zoning around the angiography room. The doors of the operation room and angiography room, through which many people enter/exit, are locked to prevent passage (X). Items that are often used in treatment are placed in the tool rack in advance. Staff members put on PPE in the space outside the angiography room. Only two doctors, one nurse, and clinical engineer are permitted to enter the angiography room. C: clinical engineer; D: doctor; Ns: nurse; PPE: personal protective equipment; T: radiology technician

determined to be B according to checklist, the patient is transferred to the primary care room.

CT and MRI rooms

Since the CT room is adjacent to the emergency room, we follow the checklist judgment of the emergency room. If the patient is identified as A according to the checklist, disposable sheets are placed on the examination table, and alcohol disinfection is performed after the examination. When MRI is performed, because the emergency room and MRI room are on different floors, patients are color-coded before being transported to the MRI room. Patients identified as R, Y, or YW are transported to the MRI room using Code Yellow. The examination table is covered with disposable sheets, and forced ventilation is used during MRI. After MRI, the examination table is disinfected with alcohol and forced ventilation is performed for 20 minutes. Since MRI is associated with a higher risk of infection, in cases in which acute cerebral infarction is suspected, treatment indications are selected based on CT and CTA, and MRI is not performed.

Angiography room (Fig. 4)

The operation room is designated as a non-contaminated area, and the doors of the operation room and radiography room are locked to prevent passage. Staff who come into contact with the patient have the same access as the patient. Items that are often used in treatment are placed in the tool rack in advance to prevent contamination of other items on

the tool shelf. A space has been created outside the angiography room for staff to put on PPE before entering. The angiography room is designated as a contaminated area and no one is permitted to enter or leave during treatment. Two doctors, one nurse, and one clinical engineer treat the patient, and other staff do not enter the angiography room. After treatment, the angiography room is prohibited from use for 1 hour and is disinfected with alcohol after ventilation.

Personal Protective Equipment

Personal protection is the most important aspect of infection control, and maximum protection is desired when in contact with patients with suspected COVID-19. N95 masks are effective when aerosols are generated and are essential protective equipment when intubating the trachea or inserting a nasogastric tube.¹³⁾ In addition, eye protection is significantly protective against infection,¹⁴⁾ and thus, wearing a face shield is important. In our institution, when we encounter patients with suspected COVID-19, a N95 mask is worn with a face shield. We also wear surgical caps, gowns, gloves, and shoe covers. Double gloves are worn and gowns are placed inside the gloves to prevent any gaps.

Care is needed when putting on and taking off PPE. Contamination from protective gear may occur during its removal, particularly at the palms when gloves are taken off and at the chest when removing the gown.¹⁵⁾ Therefore, places to remove protective gear have been established, and staff are instructed to slowly and carefully remove PPE.

Conclusion

In our hospital, from April 2020 to March 2021, 7100 patients visited the emergency room, among whom 35 were COVID-19 patients. Fortunately, nosocomial infections had been admitted to our hospital, but there are still many unclear points about COVID-19, and it is difficult to completely prevent nosocomial infections. Continued updates with the latest information on COVID-19 and considerations of the best countermeasures are crucial.

Disclosure Statement

The authors declare that they have no conflict of interest.

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