

# Nursing care for patients with COVID-19 on extracorporeal membrane oxygenation (ECMO) support

Aya Umeda\*, Yuko Sugiki

Nursing Department, National Center for Global Health and Medicine, Tokyo, Japan.

**Abstract:** In Japan, four medical facilities including our own - the National Center for Global health and Medicine (NCGM) - have been designated for the treatment of specified infectious diseases by the Minister of Health, Labour, and Welfare. Here, we report our nursing care for patients with severe COVID-19 on extracorporeal membrane oxygenation (ECMO) support. In addition to infection control measures in the form of an N95 mask, a water-repellent isolation gown, a cap, a shielded mask on top of the N95, and double-layered gloves, nurses were required to wear one-piece suits (DuPont™ Tyvek®) and use powered air-purifying respirators (PAPRs). While closed system catheters are normally changed once a day to limit aerosol exposure, they are now changed once every 4 days. Nursing care included equipment checks, monitoring of hemodynamics and respiratory status, management of anticoagulants, observation of the patient's general condition, management of sedatives and analgesics, prevention of medical device-related pressure ulcers and bedsores, and maintenance of hygiene. Fundamentally sound nursing remains the best practice for patient treatment and management. During nursing care for patients with COVID-19 on ECMO, infection control measures should be faithfully and properly followed.

**Keywords:** COVID-19, ECMO, nursing care, personal protective equipment

## Medical facilities for specified infectious diseases in Japan

In Japan, four medical facilities have been designated for the treatment of specified infectious diseases by the Minister of Health, Labour, and Welfare. Medical facilities for specified infectious diseases are hospitals that accept patients with new infectious diseases: Class 1 infectious diseases, such as Ebola hemorrhagic fever, and Class 2 infectious diseases, such as Middle East respiratory syndrome (MERS) or pandemic influenza (I). The National Center for Global health and Medicine (NCGM) has been designated as a medical facility for specified infectious diseases and is home to four of ten such beds available nationwide. These four beds are in the New Infectious Diseases Ward (NIDW), which is opened only when patients with the diseases in question are admitted for treatment. The NIDW is staffed by two full-time infection monitoring room nurses and 24 nurses who work there in addition to their usual ward duties. A certified infection control nurse who works full-time in the infection monitoring room is the leader of the ward, and all nurses who work there meet once per month to exchange information, review manuals, and practice putting on and removing personal protective equipment (PPE). Moreover, nurses meet with government officials and personnel from other hospitals three times a year

to participate in simulations to prepare for patient admittance.

To date, the NIDW at NCGM has admitted patients with pandemic influenza, severe acute respiratory syndrome-like diseases, Ebola hemorrhagic fever, and MERS-like diseases. Reported here is the nursing care for patients with severe COVID-19 on ECMO support receiving treatment in the NIDW of our center.

## ECMO

ECMO is a life-support technique that involves the use of a heart-lung machine; when used in patients with severe respiratory failure, it is called respiratory ECMO. Cases in which ECMO was used to save lives were reported during the pandemic outbreak of H1N1 influenza in 2009 (2,3). That same year, the CESAR Study (4), a randomized clinical trial of respiratory ECMO, proved its effectiveness, leading to the acceptance of ECMO worldwide.

The effectiveness of ECMO as a therapy for COVID-19 has not yet been established, but there are reports of it saving lives in severe cases (5-7), and emergency guidelines have been promulgated (8,9).

## Nursing system for patients on ECMO support in NIDW

Treatment of respiratory failure *via* ECMO requires specialized knowledge and training for not only doctors but also nurses, clinical engineers, and several other staff members (10,11). ECMO is known to improve the prognosis for patients in facilities that have used it in more cases (4); this therapy requires considerable experience and skill on the part of the medical team administering it.

The NIDW opens only when necessary, the NIDW nurses are normally posted to a variety of different wards, and most do not normally oversee intensive care. Thus, ICU nurses who were experts in ECMO were asked to provide support, and they contributed in setting up the NIDW quickly. Over the several days that it took the patient to stabilize following the introduction of ECMO, these ICU nurses worked alongside NIDW nurses. They helped teach monitoring methods and nursing techniques and reviewed and updated our equipment and rules. Moreover, NIDW nurses were instructed by clinical engineers on how to use the ECMO machine and learned how the machine works and basic troubleshooting procedures.

Use of ECMO lasted three weeks, thus, the head nurse gathered all expert nurses within the hospital and adjusted their schedules so that they could rotate through the NIDW in shifts. Initially, the patient was managed by a small team to limit contact with others. However, as the situation developed and ECMO management was projected to become more long-term, work assignments were adjusted so that nurses who work in the NIDW in addition to their duties in other wards could all oversee the management of this patient. These nurses were posted alongside expert or experienced nurses who had managed many patients and who worked to ensure patient safety. This helped assuage the worries of nurses with limited experience.

### **Infection control measures**

The entire situation was managed by a certified infection control nurse, a full-time member of the hospital infection monitoring room. Monitoring is important (12). Patient vital sign monitors and feeds from cameras installed in the sickroom, antechamber, and testing room were all linked to the monitoring room so that nurses could ensure that proper infection control measures were being followed. Personal protective equipment used included the following. For normal care, nurses used N95 masks, water-repellent isolation gowns, caps, a shielded mask on top of the N95, and double-layered gloves. During intubation, extubation, and insertion/removal of the ECMO cannulae, all of which are treatments likely to generate aerosols, nurses were additionally required to wear one-piece suits (DuPont™ Tyvek®) and use powered air-purifying respirators (PAPRs). Finally, while closed system catheters are normally changed once a day to limit aerosol exposure,

they were changed once every 4 days. Although closed system catheter replacement can be done instantly, for safety, nurses wore PAPRs while performing this procedure (Table 1).

### **Nursing care for patients with COVID-19 on ECMO support**

Nursing care for COVID-19 patients on ECMO support involves a wide variety of different tasks, including equipment checks, monitoring of hemodynamics and respiratory status, management of anticoagulants, observation of the patient's general condition, management of sedatives and analgesics, prevention of medical device-related pressure ulcers and bedsores, and maintenance of hygiene (Table 2). Because the nature of this case required all these tasks to be done with PPE, nurses experienced much more fatigue than usual. Water-repellent isolation gowns cause sweating with even the smallest tasks, and breathing through an N95 mask feels labored and restricted. Double-layered gloves dull one's sense of touch, requiring far more concentration than usual when performing delicate tasks. The hood that is worn when using a PAPR machine presses tightly against the head when worn for long periods. Moreover, because infections are known to most commonly occur while removing PPE, nurses rotated shifts before they became too tired to prevent them from losing concentration so that they would adhere to proper equipment removal procedures.

Because the patient's family was also quite worried about the patient's health, they met regularly with a supervising doctor (13). For the patient to remain connected with loved ones while in isolation, we arranged for the use of a smartphone to allow calls and the exchange of messages.

Apart from the need to use PPE at all times and to be mindful of sterile practices, there were no differences in the protocol used here from the usual ECMO management procedures, and no special care was needed to treat this patient with COVID-19.

### **Conclusion**

Reported here is the nursing care for patients with severe COVID-19 that involved the use of ECMO. These patients require more nursing care (14), the patients' condition were managed while adhering to strict infection control procedures to prevent transmission of COVID-19. This work caused a significant amount of physical and mental stress. Despite the fact that patients on ECMO need a great deal of bedside nursing, at present there have been no cases of infection among the healthcare staff at our facility. A nurse is charged with providing all patients, regardless of illness or condition, with safe, comfortable care, to attend to their needs so that they can draw on their own strength, and to

**Table 1. Personal protective equipment for treating patients with COVID-19 on ECMO support**

Type	Normal	Special
Situation	<ul style="list-style-type: none"> <li>• Normal care</li> </ul>	<ul style="list-style-type: none"> <li>• Performing invasive procedures</li> <li>• Performing an aerosol-generating procedure</li> </ul>
Ex.	<ul style="list-style-type: none"> <li>• Checking vital signs</li> <li>• Sponge bath</li> <li>• Changing the patient's body position</li> <li>• Oral care</li> <li>• Closed-system suctioning</li> </ul>	<ul style="list-style-type: none"> <li>• Changing the "closed suction system" (every 4 days)</li> <li>• Assisting with intubation &amp; extubation</li> <li>• Assisting with the insertion &amp; removal of ECMO cannulae</li> </ul>
Photo		
Equipment	<ul style="list-style-type: none"> <li>• Disposable scrub brush</li> <li>• N95</li> <li>• Water-repellent isolation gown</li> <li>• Surgical mask with face shield (on the N95)</li> <li>• Double gloves</li> <li>• Cap</li> </ul>	<ul style="list-style-type: none"> <li>• DuPont™ Tyvek®</li> <li>• Surgical mask</li> <li>• Cap</li> <li>• Hood with integrated head suspension</li> <li>• Powered air-purifying respirator</li> <li>• Isolation gown</li> <li>• Double gloves</li> <li>• Foot cover</li> </ul>

ECMO, extracorporeal membrane oxygenation.

**Table 2. Nursing care for patients with COVID-19 on ECMO support**

Items	Initiation of ECMO	Continuation of ECMO	ECMO weaning, decannulation
Nursing management	Mainly ICU nurses manage the patient Day shift: 3 nurses Night shift: 2 nurses  Education for Nurses Explanation of equipment from a clinical engineer Distribution of leaflets prepared by a nurse certified in intensive care	New nurses work with experienced nurses Expert nurses work at regular intervals Day shift: 3 nurses Night shift: 2 nurses Ensure a smooth handoff with a note	Day shift: 3 nurses Night shift: 2 nurses  Ensure a smooth handoff with a note
Nursing Care	Monitoring ECMO Ensuring a sufficient flow rate Monitoring ventilation Checking vital signs Management of sedation Preventing MDRPUs (medical device-related pressure ulcers) Hygiene and personal care Providing comfort care	Monitoring ECMO Ensuring a sufficient flow rate Monitoring ventilation Checking vital signs Management of sedation Preventing MDRPUs (medical device-related pressure ulcers) Hygiene and personal care Providing comfort care Mobilization	Monitoring ECMO Ensuring a sufficient flow rate Monitoring ventilation Checking vital signs Management of sedation Preventing MDRPUs (medical device-related pressure ulcers) Hygiene and personal care Providing comfort care Mobilization Preparation for removal of ECMO
Family support	Family meeting Explaining the purposes and trajectory of ECMO and its time-limited nature	Family meeting Discussing where we have been, what the present looks like, and time-limited trials Family meets with the patient <i>via</i> video call	Family meeting Explaining the likelihood of recovery risks Family meets with the patient <i>via</i> video call

ECMO, extracorporeal membrane oxygenation.

perform management and monitoring with the necessary technology and equipment; this exhortation continues to hold true for patients with COVID-19. If basic infection control measures are faithfully and properly adhered to, we believe that there is no need to be unduly afraid of COVID-19.

While there will certainly be more patients with COVID-19 in the coming months, our experience taught us that fundamentally sound nursing remains the best practice for patient treatment and management.

## References

1. Act on the Prevention of Infectious Diseases and Medical Care for Patients with Infectious Diseases. Act No. 114 of 1998, Last Version: Amendment of Act No. 115 of 2014. <http://www.japaneselawtranslation.go.jp/law/detail/?id=2830&vm=04&re=02> (accessed March 20, 2020) (in Japanese)
2. Australia and New Zealand Extracorporeal Membrane Oxygenation (ANZ ECMO) Influenza Investigators, Davies A, Jones D, *et al.* Extracorporeal membrane oxygenation for 2009 influenza A (H1N1) acute respiratory distress syndrome. *JAMA*. 2009; 302:1888-1895.
3. Arabi YM, Al-Omari A, Mandourah Y, *et al.* Critically Ill patients with the Middle East respiratory syndrome: A multicenter retrospective cohort study. *Crit Care Med*. 2017; 45:1683-1695.
4. Peek GJ, Mugford M, Tiruvoipati R, Wilson A, Allen E, Thalanany MM, Hibbert CL, Truesdale A, Clemens F, Cooper N, Firmin RK, Elbourne D; CESAR trial collaboration. Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): A multicentre randomised controlled trial. *Lancet*. 2009; 374:1351-1363.
5. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X, Peng Z. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*; doi: 10.1001/jama.2020.1585.
6. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Xia J, Yu T, Zhang X, Zhang L. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. *Lancet*. 2020; 395:507-513.
7. Yang X, Yu Y, Xu J, *et al.* Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: A single-centered, retrospective, observational study. *Lancet Respir Med*. 2020 Feb 24. doi: 10.1016/S2213-2600(20)30079-5.
8. Alhazzani W, Møller MH, Arabi YM, *et al.* Surviving Sepsis Campaign: Guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19). 2020; doi: 10.1007/s00134-020-06022-5.
9. World Health Organization. Clinical management of severe acute respiratory infection when COVID-19 is suspected. Interim guidance. 2020. [https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected) (accessed March 20, 2020)
10. Zakhary B, Shekar K, Diaz R, *et al.* Position paper on global extracorporeal membrane oxygenation education and educational agenda for the future: A statement from the Extracorporeal Life Support Organization ECMOed Taskforce. *Crit Care Med*. 2020; 48:406-414.
11. Ramanathan K, Antognini D, Combes A, Paden M, Zakhary B, Ogino M, MacLaren G, Brodie D, Shekar K. Planning and provision of ECMO services for severe ARDS during the COVID-19 pandemic and other outbreaks of emerging infectious diseases. *Lancet Respir Med*. 2020; doi: 10.1016/S2213-2600(20)30121-1.
12. Huang L, Lin G, Tang L, Yu L, Zhou Z. Special attention to nurses' protection during the COVID-19 epidemic. *Crit Care*. 2020; 24:120.
13. Stephens AL, Bruce CR. Setting expectations for ECMO: Improving communication between clinical teams and decision makers. *Methodist Debakey Cardiovasc J*. 2018; 14:120-125.
14. Lucchini A, Elli S, De Felippis C, Greco C, Mulas A, Ricucci P, Fumagalli R, Foti G. The evaluation of nursing workload within an Italian ECMO Centre: A retrospective observational study. *Intensive Crit Care Nurs*. 2019; 55:102749.

Received March 23, 2020; Revised March 31, 2020; Accepted April 8, 2020.

Released online in J-STAGE as advance publication April 16, 2020.

\*Address correspondence to:

Aya Umeda, Nursing Department, National Center for Global Health and Medicine, 1-21-1 Toyama Shinjuku-ku, Tokyo 162-8655, Japan.

Email: a-umeda@umin.ac.jp