Coronavirus epidemic: preparing for extracorporeal organ support in intensive care

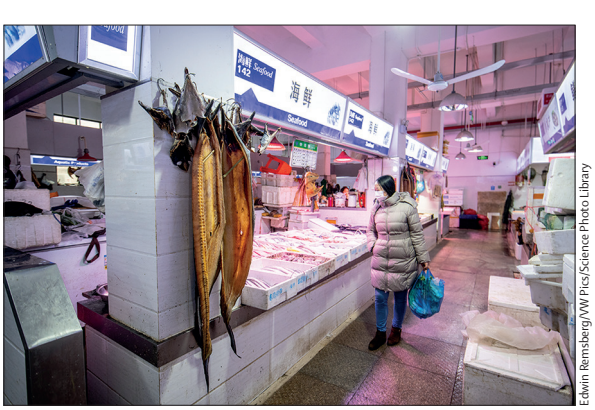
Zoonotic viral infections are more frequently crossing species to infect human populations. In 2003, the severe acute respiratory syndrome (SARS) virus was transmitted to humans from exotic animals in wet markets in China, and in 2015, the Middle East respiratory syndrome (MERS) virus was transmitted from camels in Saudi Arabia. In both cases, and with the 2019 coronavirus outbreak in China, the original host of the virus is likely to be bats.

The 2019 coronavirus (2019-nCoV) was identified as such with the use of electron microscope analysis, to determine its shape, and genomic sequencing. The virus causes an aspecific respiratory syndrome and a generalised inflammatory response in humans. Patient zero was likely to have been infected by 2019-nCoV at a seafood market in Wuhan (Hubei province, China)—WHO has provided the case definition. Although the information surrounding the current situation is changing on a daily basis, transparency and consistent data through official channels for the international scientific community is highly recommended. Experts provide their opinion based on experience and current information, but the basic reproduction number (R_0)—ie, the number of cases generated by one case—is presently unclear, and data about mortality are inconsistent. Both in Europe and the USA, close attention is being paid to the problem despite the apparent low risk of an immediate epidemic diffusion.

What has been confirmed is that some infected individuals have developed acute respiratory distress syndrome (ARDS), which requires mechanical ventilation and, in the most severe cases, extracorporeal membrane oxygenation (ECMO).

Transmission of 2019-nCoV is likely to occur through large droplets, which could provide an explanation for the initial infection at the wet fish market in Wuhan, although contact by aerosols cannot be excluded. In recent reports, the median time from onset of symptoms to first hospital admission was 7·0 days (minimum to maximum 4·0–8·0), to shortness of breath was 8·0 days (5·0–13·0), to ARDS was 9·0 days (8·0–14·0), to mechanical ventilation was 10·5 days (7·0–14·0), and to intensive care unit (ICU) admission was 10·5 days. Beyond the classic prevention measures, strict adherence to suggested precautions should also be followed to prevent transmission. Despite specific sanitary measures at airports and frontiers, we must be able to respond appropriately to the international public health emergency declared by WHO. From our past experience of treating viral infections in critically ill patients, we know the level of severity of illness in patients infected by coronavirus depends on the presence of comorbidities and immune status of the host. On the one hand, anergic patients are likely to develop a severe clinical response; on the other hand, an excessive immune response might also add to severity through a generalised inflammatory status. In both cases, immune dysregulation can lead to a progressive cascade of pathophysiological events leading to critical illness with multiple organ dysfunction.

Because it is not possible to anticipate the extent of the epidemic and the consequent number of patients who require intensive care management, intensive care clinicians must be prepared to provide specific organ support treatments and to consider that this type of treatment might be necessary for a large number of patients. Extracorporeal therapies can be helpful to support different organs, such as the lungs, heart, kidneys, and liver, through the application of specific devices. Venovenous ECMO is a complex and sophisticated support for treatment of the most severe forms of acute hypoxaemic respiratory failure; it is performed in specialised, experienced referral centres that are commonly organised into networks, serving large regions or whole countries. The number of critically ill individuals who are infected with 2019-nCoV and who will require ECMO is unknown. In some regions, more than in others, a shortness of ECMO devices could occur and might impose choices that come with important ethical questions. Without predefined criteria to guide the decision on who will get the treatment and in what order, this will lead unavoidably to a first-come-first-serve approach. Clinical presentation, comorbidities, age, number of days of mechanical ventilation before indication for ECMO, and risk for complications are all factors influencing a potentially favourable outcome. 2019-nCoV might also cause severe myocarditis resulting in acute heart failure,



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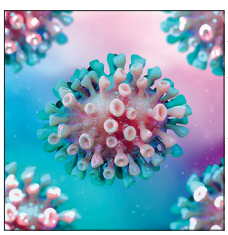

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For more on the **first cases of 2019-nCoV in Wuhan** see **Articles** *Lancet* 2020; published online Jan 24. https://doi.org/10.1016/S0140-6736(20)30183-5

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For more on **extracorporeal membrane oxygenation centres** see *JAMA* 2011; **306:** 1659–68

For more on the **role of ECMO in pandemic management** see *J Extra Corpor Technol* 2010; **42:** 268-80

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For more on **acute myocarditis associated with novel MERS coronavirus** see *Ann Saudi Med* 2016; **36:** 78–80

For **more on ECCO2R** see **Review** *Lancet Respir Med* 2018; **6:** 874–84

For more on **ECCO2R removal** see *Crit Care* 2014; **18:** 222

For more on **cardiorenal syndrome in sepsis** see *J Crit Care* 2018; **43:** 122–27

For more on **extracorporeal organ support in critical illness and acute kidney injury** see *Intensive Care Med* 2018; **44:** 1447–59

For more on **extracorporeal organ support in critically ill patients** see *Blood Purif* 2019; **48:** 99–105

For more on **cytosorb adsorption columns** see *Blood Purif* 2019; **48:** 196–202

For more on **sorbent devices** see *Blood Purif* 2019; **47:** 94–100

For more on **the call to action for research on use of extracorporeal life support** see *Chest* 2018; **153:** 788–91

which might indicate, in the most severe forms, the need for venous-arterial ECMO support.

Extracorporeal CO_2 removal (ECCO2R) is a technique that can be performed in more ICUs due to the much lower level of complexity than is required for ECMO, but ECCO2R is not really helpful for severely hypoxaemic patients who actually need full ECMO treatment. Acute kidney injury in these patients is not common, but it might result from a systemic inflammatory syndrome involving combined myocardial and kidney function. In these cases, continuous renal replacement therapies by haemofiltration and haemodiafiltration can contribute to resolution of organ failure. Liver dysfunction can also rarely occur in patients with severe viral infection and it might require extracorporeal blood purification techniques to support the patient until hepatocyte recovery occurs. Finally, a sepsis-like syndrome might occur frequently due to the virus itself or to a superimposed bacterial infection and in this case, since pharmacological approaches have shown poor results, new extracorporeal organ support therapies including haemoadsorption and haemoperfusion, with new sorbent cartridges designed to remove cytokines and other circulating mediators, should be considered.

However the 2019-nCoV epidemic evolves, ICU personnel must be prepared and trained to apply early and optimal interventions. Extracorporeal organ support therapies might represent an important part of the response and clinicians and other health-care professionals need to be familiar with this sophisticated therapy. A call to action should be made to raise awareness of the different extracorporeal techniques, each with specific criteria and modalities of prescription, delivery, and monitoring.

We declare no competing interests.

*Claudio Ronco, Paolo Navalesi, Jean Louis Vincent
cronco@goldnet.it

Department of Medicine, University of Padua, Padua, Italy (CR, PN); International Renal Research Institute, Vicenza, Italy (CR, PN); Division of Nephrology, Dialysis and Transplantation, San Bortolo Hospital, Vicenza, Italy (CR); Anesthesia and Intensive Care Unit, Padua University Hospital, Padua, Italy (PN); and Department of Intensive Care, Erasme University Hospital, Bruxelles, Belgium (JLV)