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The treatment of extracorporeal organ support for critical ill patients with coronavirus disease 2019: A brief perspective from the front line

To the Editors,

A novel coronavirus pneumonia named coronavirus disease 2019 (COVID-19) resulted in an epidemic all over the world.[1] As a consequence, it is urgent to develop an effective treatment process to manage those patients with severe COVID-19 infection.

The early introduction of extracorporeal organ support (ECOS) can play a critical role in controlling patients with severe pneumonia. However, the morbidity of COVID-19 infection is higher than SARS and about 14% of patients have developed severe complications within a week, such as acute respiratory distress syndrome (ARDS), septic shock, and even multiple organ failure (MOF).[2] According to the experience from the front lines of COVID-19 infection, to prevent patients from developing those complications, ECOS must be applied with the least delay possible to increase the survival rate and save patients' lives.

If standard treatments are useless, mechanical ventilation with the prone position should be introduced immediately. If patients' status continues to deteriorate, the observation period in the indications for ECMO, which is mainly based on CESAR or EOLIA standards, needs to be shortened in favor of an early ECMO insertion, following the principle of lung-protective ventilation (Table 1). The

TABLE 1 Indications of ECOS for severe patients with COVID-19 infection

Indications for mechanical ventilation
ROX < 3.85; Or (2) PaO_2/FiO_2 < 150 mm Hg
Indications for ECMO
(1) PaO_2/FiO_2 < 50 mm Hg over 3 h;
(2) PaO_2/FiO_2 < 80 mm Hg over 6 h;
(3) FiO_2 = 1.0, PaO_2/FiO_2 < 100 mm Hg;
(4) Arterial blood pH value <7.25, $PaCO_2$ >60 mm Hg over 6 h, and respiratory rate >35 times/min;
(5) Respiratory rate >35 times/min, blood pH value <7.2 and the platform pressure >30 cm H_2O;
(6) Severe air leakage syndrome;
(7) CT or X-ray images suggest the percentage of lung involvement progressed by more than 10% per day
ECMO should be applied ECMO immediately in patients with COVID-19 infection who meet one condition. If patients are in mechanical ventilation, the ventilation conditions are maintained at $FiO_2 \geq 0.8$, tidal volume 6 mL/kg, PEEP ≥ 10 cm H_2O
Indications for ECMO+CRRT
ECMO has been applied to patients with COVID-19 infection. And:
(1) Renal insufficiency;
Or (2) Expression of blood cytokines, including IL-6, is over five times to normal value
Indications or ECMO+AELS
ECMO has been applied to patients with COVID-19 infection. And:
(1) Expression of blood cytokines, including IL-6, is over five times to normal value;
Or (2) Daily rise rate of blood cytokines is more than one time;
Or (3) Patients developed a liver disease

Note: ROX = $SpO_2/(FiO_2 \times RR)$.

Abbreviations: AELS, artificial extracorporeal liver support, including hemoadsorption and hemoperfusion therapy; CRRT, continuous renal replacement therapy; ECMO, extracorporeal membrane oxygenation; ECOS, extracorporeal organ support; IL-6, interleukin 6.

multistage drainage tubes should not be applied in venous drainage because these tubes can lead to poor drainage and impede ECMO flow effects. Patients with severe COVID-19 infection may be correlated to myocardial injury, arrhythmias, and even cardiogenic shock. If hemodynamic instability appears for a period of time, V-A ECMO should be inserted for recovery.

The cytokine expression of patients with severe COVID-19 infection, including IL-2, MCP-1, TNF-α, and IL-6, are significantly higher, may lead to cytokine storm, and even MOF.[3] The early introduction of ECMO can also induce the inflammatory cytokines release, resulting in ECMO-related SIRS.[4] Therefore, the blood cytokines, especially those cytokines above mentioned, should be monitored frequently during the ECMO period, and novel extracorporeal organ support therapies, such as hemoperfusion and ECMO with novel coating-canal, may be a better way to remove cytokines and other circulating mediators. To reduce the risk of virus exposure in clinical practice, the early parallel connection of CRRT machines to the ECMO pipeline is applied if the patients with severe COVID-19 infection and ECMO therapy have septic shock or severe acute renal injury.

Compared with the survivors, the morbidity of disseminated intravascular coagulation (DIC) in non-survivors has reached 71.4%. DIC is often associated with hepatic insufficiency, which may be associated with severe ARDS and MOF, and become the trigger for several pathological pathways. For those patients with DIC or bleeding, the artificial extracorporeal liver support should be introduced early to decrease the incidence of ECMO complications and in-hospital mortality.

Overall, patients with severe COVID-19 infection are in critical condition with rapid disease progression and high mortality. ECOS should be applied as soon as possible to improve the survival rate. To lessen the complications, the patients who are undergoing such a complex therapy may still require additional organ support.

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