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Extracorporeal membrane oxygenation in the treatment of respiratory failure during COVID-19

By April 14, 2020, a total of 1,819,465 confirmed COVID-19 cases with 115,103 deaths have been reported across the world. Clinically, the infection of the novel coronavirus mainly affects the respiratory system leading to pneumonia, while the virus may also cause other organ damage such as derangement of renal and liver functions, cardiac injury, cellular immune deficiency, and coagulation activation. Currently there are no specific drugs for COVID-19, which is a self-limiting disease requiring sufficient time for a rigorous immune response [1].

Studies have reported that severely and critically ill patients, who were transferred to intensive care units because of complications, account for 15–26% of COVID-19 infections [2]. The main treatment principles for these severe and critical cases included empirical antiviral and symptomatic treatment, preventing complications and secondary infections, and above all, providing timely and efficient oxygen treatment. Respiratory and circulatory support may help to overcome the most dangerous period.

Extracorporeal membrane oxygenation (ECMO; **Fig. 1**) is a principal method for offering respiratory and circulatory support and providing a chance of survival for those desperately ill patients. Since the jelly exudates block alveolar oxygen exchange, mechanical ventilation might provide little help in patients with severe hypoxemia. It was recommended in both the WHO interim guidelines and Chinese expert consensus [3] that ECMO, preferably

the veno-venous (V-V) ECMO mode (**Fig. 1a**), should be applied to eligible patients with COVID-19-related acute respiratory distress syndrome (ARDS). Veno-venous ECMO may benefit patients with COVID-19-related ARDS mainly by providing lung protection and extracorporeal CO₂ removal. It is noteworthy that a few patients may develop concomitant heart failure, resulting from pneumonia-associated right heart failure, fulminant myocarditis, myocardial infarction, or sepsis-related cardiomyopathy, and might require veno-arterial (V-A) ECMO (**Fig. 1b**). A number of observational studies and non-controlled clinical trials in SARS reported a survival rate of 50–71% for patients receiving ECMO [4]. However, according to recently published ECMO cases with COVID-19 and those that we managed, the clinical outcome does not seem so satisfactory. The reason might be that the ECMO intervention was not made in time. Exploring predictors and identifying potential patients requiring ECMO intervention and early initiation of ECMO are therefore of vital importance. A high SOFA score, D-dimer levels of >1 µg/ml, severe lymphopenia, and higher neutrophil counts have been reported as markers for poor prognosis at the early stage [5]. More studies are needed to get a deeper understanding of predictive markers in ECMO use.

The correct use of personal protection equipment (PPE) and handling of infected body secretions are essential skills to empower healthcare workers to man-

age any pandemic. On the premise of the right use of PPE, physicians should consider initiating ECMO in a timely manner, reasonably, and efficiently for those eligible critical cases in the early stage and they should optimize the treatment strategies according to the patients' conditions. Early application of ECMO could avoid lung injury associated with hyperoxia and respirator-associated factors to improve refractory hypoxia and recover homeostasis. Although V-V ECMO cannot provide circulatory support, it could improve cardiac function indirectly by reducing right heart load. The V-A mode should be considered when ARDS has progressed to acute pulmonary heart disease and in the presence of cardiac shock or cardiac arrest due to new ischemia and inflammation. Moreover, during the use of ECMO, monitoring of hemodynamics and echocardiography as clinical observations are essential to prevent common complications of ECMO such as ischemia of the lower limbs, bleeding, thrombosis, infections, and excessive left-heart afterload.

In conclusion, ECMO may provide cardiopulmonary support for critical cases of COVID-19, which has a definite effect on respiratory and cardiac function and the final clinical outcome. Timely identification of potential patients indicated for ECMO, early application of ECMO, and optimization of treatment strategies according to the patient's conditions may help improve the outcome of critical patients with COVID-19.

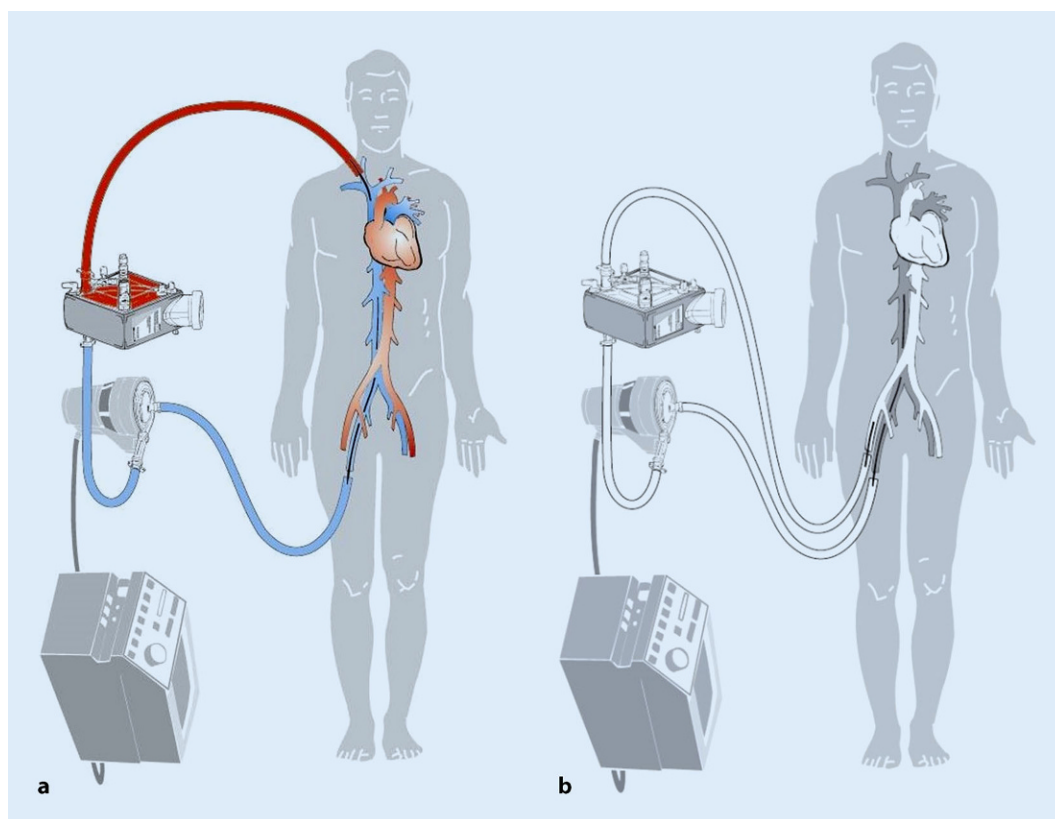


Fig. 1 ◀ Extracorporeal membrane oxygenation (ECMO) model. **a** Veno-venous (V-V) ECMO mode: femoral vein catheterization to extract venous blood with external oxygenation, and pump arterial blood to the superior vena cava. **b** Veno-arterial (V-A) ECMO mode: femoral vein catheterization to extract venous blood with external oxygenation, and pump arterial blood to femoral artery

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Conflict of interest. J. Ge declares that he has no competing interests.

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