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Correspondence

Clinical characteristics and outcomes of five critical COVID-19 patients treated with extracorporeal membrane oxygenation in Leishenshan Hospital in Wuhan

A letter to the editor,

Extracorporeal membrane oxygenation (ECMO) is a valuable life-saving treatment for patients with acute respiratory distress syndrome (ARDS) [1,2]. However, information regarding the feasibility of ECMO in patients with critical COVID-19 infection is limited [3]. In the present study, we describe the detailed clinical characteristics of five patients with critical COVID-19 infection treated with ECMO at Leishenshan Hospital, which is one of the designated hospitals to treat patients with COVID-19-related pneumonia in Wuhan, China.

Leishenshan Hospital was established in a short period of 11 days and has a capacity of 1600 beds. The hospital has two ICUs and admitted around 120 severe patients when the Shanghai medical team stationed there. We reviewed the data of five patients treated with ECMO from its opening time on February 8 to the closing time on April 15, 2020. This clinical study was approved by the Ethics Commission of Renji Hospital (Ethical Committee approval number: KY2020-34). Because of the retrospective nature of the study, informed consent was waived and approved by Ethics Commission of Renji Hospital.

All the five patients were native residents of Wuhan with an epidemiological exposure to COVID-19. Their mean age was 61.6 years (SD = 9.18). Patient 5 was successfully weaned from ECMO as expected, and Patient 4 was decannulated out of the plan due to blood infection; both patients received 1-week ECMO support and survived. The other three nonsurvivors received ECMO for a longer duration of more than 2 weeks but ultimately died. The mean duration from the onset of symptoms to hospital admission was 6.4 days (SD = 0.49), whereas the median duration to intensive care unit (ICU) admission was 21 days (SD = 4.98). All patients experienced cough as an onset symptom, and four of them had a fever. Regarding the other common symptoms, one patient had diarrhea, one had malaise, and none had vomiting. All patients deteriorated into dyspnea and received tracheal intubation before ECMO application. The most common chronic diseases they had were hypertension (80%) and diabetes (60%), and coronary disease and sequele stage of cerebral infarction were reported in two patients. It was noteworthy that the five patients' positive nucleic acid testing turned into negative after ICU admission, and all were positive for COVID-19 antibody after ICU treatment. Except for the patient who had been intubated already before the ICU admission, the other four patients received either high-flow nasal cannula or noninvasive ventilation treatment or both before tracheal intubation. Organ damage is a common comorbidity, and cardiac injury and liver dysfunction were observed in all patients. Patient 5 had acute kidney injury, along with three other patients, but was the only one who did not develop hyperglycemia (Table 1). The last laboratory data before ECMO cannulation of five patients are presented in Supplementary Table 1.

Along with low oxygen index or carbon dioxide retention that necessitated ECMO support, the most abnormal data indicated that all patients suffered from infections, cardiac injury, liver dysfunction, and inflammatory responses. Patient 4 had an oxygenation index of 75 and was forced to withdraw from ECMO 1 week later due to blood infection but then survived. Patient 5 who survived received ECMO treatment due to prolonged carbon dioxide retention, which oxygenation index was slightly > 200. The other three nonsurvivors received ECMO because of an extremely low oxygen index. The initial ECMO settings are listed in Table 1.

The role of ECMO in managing the global COVID-19 epidemic remains unclear; especially, the criteria for patient selection and timing of ECMO initiation are yet to be clarified [1]; hence, the application rules of ECMO vary in different regions [4]. We also applied ECMO treatment to Patient 2 who also suffered from lymphoma and the duration from tracheal intubation to ECMO cannulation was more than 7 days in Patients 2 and 5, which also did not comply with the common suggestion for ECMO use. For a flexible use, Patient 5 received ECMO to treat his hypercapnic respiratory failure, which has been reported to receive huge benefit from ECMO technique [5].

In conclusion, providing early ECMO support due to carbon dioxide retention and on-time decannulation may be more beneficial to patients. However, the effect of ECMO for end-stage patients is still limited, and preventing the progression from mild to severe case remains the most important issue. The importance of ECMO in critical COVID-19 patients warrants further studies.
Table 1
Characteristics and ECMO settings of five patients.

| Patient | Patient 2 | Patient 3 | Patient 4 | Patient 5 |
|---------|-----------|-----------|-----------|-----------|
| **Clinical characteristics** | | | | |
| Survived or not | No | No | No | Yes | Yes |
| Age | 68 | 47 | 73 | 64 | 56 |
| Duration from onset of symptoms to hospital admission, days | 6 | 6 | 7 | 6 | 7 |
| Duration from onset of symptoms to ICU admission, days | 20 | 18 | 14 | 25 | 28 |
| Symptoms on admission | | | | |
| Fever | Yes | Yes | Yes | No | Yes |
| Cough | Yes | Yes | Yes | Yes | Yes |
| Vomiting | No | No | No | No | No |
| Diarrhea | Yes | No | No | No | No |
| Malaise | No | Yes | No | No | No |
| Dyspnoea | Yes | Yes | Yes | Yes | Yes |
| Chronic disease history | Hypertension, diabetes, cerebral infarction sequela | Hypertension, coronary disease, diabetes | Hypertension |
| Reports during ICU stay | | | | |
| Chest CT confirmation | Yes | Yes | Yes | Yes | Yes |
| Nucleic acid test turn negative | Yes | Yes | Yes | Yes | Yes |
| Positive antibody test | Yes | Yes | Yes | Yes | Yes |
| Treatments during ICU stay | | | | |
| High flow nasal cannula | Yes | Yes | Yes | No | No |
| Non-invasive mechanical ventilation | No | Yes | Yes | Yes | Yes |
| Invasive mechanical ventilation | Yes | Yes | Yes | Yes | Yes |
| Prone position ventilation | Yes | Yes | Yes | Yes | Yes |
| Renal replacement therapy | Yes | No | Yes | No | No |
| Glucocorticoids | No | Yes | Yes | Yes | Yes |
| Immunglobulin | No | Yes | No | No | No |
| Complications during treatment | | | | |
| ARDS | Yes | Yes | Yes | Yes | Yes |
| AKI | Yes | Yes | Yes | Yes | Yes |
| Cardiac injury | Yes | Yes | Yes | Yes | Yes |
| Liver dysfunction | Yes | Yes | Yes | Yes | Yes |
| Hyperglycaemia | Yes | Yes | Yes | Yes | Yes |
| Pneumothorax | No | No | No | No | No |
| Hospital-acquired pneumonia | Yes | Yes | Yes | Yes | Yes |
| Respiratory infection | Klebsiella | Escherichia coli | Stenotrophomonas maltophilia | Klebsiella | Acinetobacter baumannii |
| Laboratory data before ECMO cannulation | | | | |
| Cannulation timing | Mar 3, oxygenation index 63.8 | Mar 17, oxygenation index 45 | Feb 27, oxygenation index 60 | Mar 2, oxygenation index 75 | Mar 12, carbon dioxide retention, PCO2 63.2, oxygenation index 200-300 |
| Decannulation timing | None | None | None | Mar 10, blood infection | Mar 19, oxygenation index 280, pH 7.38, PCO2 44.6, PO2 112 |
| Setting and mode | 3000 rpm, VV | 3000 rpm, 5.3 L/min, VVA | 2500 rpm, 4 L/min, VV | 3000 rpm, 3.5 L/min, VV | 1600 rpm, 1.8 L/min, VV |
| Blood products | Red blood cell, platelet | Red blood cell, plasma, platelet, cryoprecipitate | Red blood cell, platelet | Red blood cell | Red blood cell, plasma, platelet |
| Cardiovascular drugs | Isoproteorenol, nitroglycerin | Adrenaline | Noradrenaline, milrinone, ivisomendam | Noradrenaline | Noradrenaline, nitroglycerin |

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CRediT authorship contribution statement

Wei Xuan: Conceptualization, Formal analysis, Project administration, Writing - original draft. Caiyang Chen: Formal analysis, Writing - original draft, Visualization. Xuliang Jiang: Data curation, Formal analysis, Software. Xiao Zhang: Data curation, Methodology. Hui Zhu: Data curation. Song Zhang: Data curation. Weifeng Yu: Supervision, Resources. Zhiyong Peng: Supervision, Resources. Diansan Su: Supervision, Conceptualization, Funding acquisition, Project administration.
Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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