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## Extracorporeal membrane oxygenation in patients with SARS-CoV-2

Coronaviruses are single-stranded RNA viruses that cause respiratory and intestinal infections in humans. The coronaviruses (HCoV-NL63, HCoV-229E, HCoV-OC43 and HKU1), were known to cause mild infections in immunocompromised persons. However, at the beginning of the XXI century, two new coronaviruses with high pathogenicity were described; the severe acute respiratory syndrome coronavirus (SARS-CoV) and the middle east respiratory syndrome coronavirus (MERS-CoV). In the Wuhan city, the capital of China's Hubei province in december 2019 a new coronavirus (2019-nCoV) was identified.<sup>1,2</sup> Provisionally named 2019-nCoV, the International Committee on Taxonomy of Viruses (ICTV) was renamed as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The World Health Organization (WHO) named the pathology as coronavirus disease 2019 (COVID-19).<sup>3</sup>

The infection by SARS-CoV-2 occurs for respiratory droplets and aerosols released from coughing and sneezing. The viral particles can fall on surfaces and objects, causing the virus to remain on them for several hours. Transmission can occur through direct contact of the hands on mucous membranes of the mouth, nose and eyes.<sup>4,5</sup>

Fever, muscle pain, cough and dyspnoea are symptoms frequently reported in patients infected with SARS-CoV-2.<sup>6</sup> A lot of people have a positive prognosis; however, in the elderly population and individuals with underlying chronic diseases (diabetes, hypertension and cardiovascular diseases) the infection causes more serious manifestations, with a high mortality rate. Although the most of patients affected by COVID-19 have mild symptoms, some may develop acute respiratory distress syndrome (ARDS), requiring admission to the intensive care unit (ICU).<sup>7</sup> ARDS is a state of severe acute hypoxia, caused by increased capillary permeability and consequent damage to alveolar cells.<sup>5</sup> Histopathological examinations of lung samples from patients with SARS-CoV-2, are similar to those seen in SARS-CoV and MERS-CoV infections, demonstrating diffuse alveolar damage, fibrinous exudates, pulmonary edema and interstitial inflammatory infiltrates consisting of lymphocytes.<sup>8</sup>

The World Health Organization recommends the use of extracorporeal membrane oxygenation (ECMO) in patients affected by COVID-19 with refractory hypoxemia who do not respond to conventional treatment on mechanical ventilation.<sup>9</sup> The ECMO can serve as a rescue therapy for these patients and the venovenous type is the choice. However, the SARS-CoV-2 can causes cardiovascular complications and, in these cases, can be considered the configuration venoarterial.<sup>10,11</sup>

In patients with SARS-CoV-2, evaluation of candidates for mechanical circulatory support devices is a decision that needs to be careful, factors such as government and hospital policies should be considered. If the medical team feels that ECMO is appropriate, the patient needs to present a favorable prognosis for the use this assistance. These are criteria for ECMO in patients with COVID-19: patients with severe ARDS; Murray Score of 3–4; Horowitz Index (<50–70 mmHg on PEEP > 15 cm H<sub>2</sub>O) and pH (< 7,25 with PCo<sub>2</sub> ≥

60 mmHg for > 6 h. There are no absolute contraindications to ECMO in COVID-19, as each patient is considered individually, though there are conditions, which can be used. Contraindications criteria: Age >70 – 75 years (Clinical judgement); pH (<6,8 or Murray Score <3,0; Multi-Organ Failure and Mechanical Ventilation > 7 days.<sup>7,11</sup>

The immunological condition of patient must be observed when electing a possible candidate for ECMO. Lymphocytopenia is observed in patients with COVID-19 and this condition is associated with the high mortality rate. It must be considered that the extracorporeal circuit causes immune responses to the organism; in this case, the lymphocyte count should be management more carefully.<sup>10</sup>

Individuals with SARS-CoV-2 can develop several types of organ dysfunction. The virus causes a serious condition in the human body, which induces an uncontrolled inflammatory state and, consequently, release of proinflammatory cytokines in the systemic circulation. This condition induces the acute kidney injury and liver failure, in these cases the hemofiltration, hemodiafiltration, hemodialysis or plasmapheresis, could be applied to remove excess circulating cytokines. These techniques demonstrate possible beneficial effects for hemodynamic support and organic recovery.<sup>12</sup>

The SARS-CoV-2 pandemic requires specific strategies from the multiprofessional health team. The patients who undergo the extracorporeal membrane oxygenation must meet the criteria proposed by WHO<sup>9</sup> and Extracorporeal Life Support Organization (ELSO),<sup>7</sup> taking into consideration the characteristics of this new disease. Therefore, specific conditions must be created for optimum performance of the circulatory support to which the patient is submitted. The Hemofiltration, hemodialysis, hemofiltration and plasmapheresis suggestions can demonstrate excellent results if started early in patients undergo ECMO. However, these techniques require more scientific information, in respect effectiveness in patients with COVID-19.

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