



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Financiación

El presente manuscrito no ha recibido financiación alguna.

Conflicto de intereses

Todos los autores reconocen no presentar conflicto de intereses en la realización del presente trabajo.

Bibliografía

1. Delgado Martín M, Fernández Fernández R. Strategies against refractory hypoxemia in acute respiratory distress syndrome. *Med Intensiva*. 2013;37:423–30.
2. Fernández-Mondéjar E, Fuset-Cabanes MP, Grau-Carmona T, López-Sánchez M, Peñuelas Ó, Pérez-Vela JL, et al. The use of ECMO in ICU Recommendations of the Spanish Society of Critical Care Medicine and Coronary Units. *Med Intensiva*. 2019;43:108–20.
3. Habashi NM. Other approaches to open-lung ventilation: Airway pressure release ventilation. *Crit Care Med*. 2005;33:S228–40.
4. Kuhlen R, Rossaint R. The role of spontaneous breathing during mechanical ventilation. *Respir Care*. 2002;47:296–330.
5. Protti A, Andreis DT, Monti M, Santini A, Sparacino CC, Langer T, et al. Lung stress and strain during mechanical ventilation: Any difference between statics and dynamics? *Crit Care Med*. 2013;41:1046–55.
6. Mireles-Cabodevila E, Dugar S, Chatburn RL. APRV for ARDS: The complexities of a mode and how it affects even the best trials. *J Thorac Dis*. 2018;10:S1058–63.
7. Neumann P, Golisch W, Strohmeyer A, Buscher H, Burchardi H, Sydow M. Influence of different release times on spontaneous breathing pattern during airway pressure release ventilation. *Intensive Care Med*. 2002;28:1742–9.
8. Morales Quinteros L, Bringué Roque J, Kaufman D, Artigas Raventós A. Importance of carbon dioxide in the critical patient: Implications at the cellular and clinical levels. *Med Intensiva*. 2019;43:234–42.
9. Schmidt M, Jaber S, Zogheib E, Godet T, Capellier G, Combes A. Feasibility and safety of low-flow extracorporeal CO₂ removal managed with a renal replacement platform to enhance lung-protective ventilation of patients with mild-to-moderate ARDS. *Crit Care*. 2018;22:122.
10. Winiszewski H, Aptel F, Belon F, Belin N, Chaingnat C, Patry C, et al. Daily use of extracorporeal CO₂ removal in a critical care unit: Indications and results. *J Intensive Care*. 2018;6:36.

A. González-Castro*, P. Escudero Acha, J.C. Rodríguez Borregán, Y. Peñasco, C. Blanco Huelga y E. Cuenca Fito

Servicio de Medicina Intensiva, Hospital Universitario Marqués de Valdecilla, Santander, España

*Autor para correspondencia.

Correo electrónico: e409@humv.es (A. González-Castro).

<https://doi.org/10.1016/j.medin.2019.11.001>
0210-5691/ © 2019 Elsevier España, S.L.U. y SEMICYUC. Todos los derechos reservados.

When success means focusing on the oxygen delivery. A case of conventional management of severe hypoxemia in SARS-CoV-2



Cuando el tratamiento adecuado consiste en evaluar el aporte de oxígeno. Manejo convencional de la hipoxemia severa en un paciente con SARS-CoV-2

Dear Editor:

SARS-CoV-2 challenged ICU doctors' ability to support patients with acute respiratory insufficiency. This was due to both the unexpectedly high rate of admissions and the severity of these patients. Through this case we would like to highlight the physiology guided management of a patient with profound hypoxemia. In spite of an apparently life threatening condition this patient had a good course with conventional management guided by invasive hemodynamic monitoring.

A 46 years old male was admitted to the ICU with pre-emptive diagnosis of SARS-CoV-2. Respiratory symptoms had started 10 days before admission to the emergency room. Due to hypoxemia and tachypnea as well as an X-ray with bilateral infiltrates, the patient was early transferred to ICU. Support with high flow oxygen was started but escalation to invasive mechanical ventilation (MV) was required

due to persistent hypoxemia. Due to a PaO₂ = 60 mmHg despite FiO₂ 1 (with protective mechanical ventilation settings PEEP 10 cmH₂O, tidal volume 6 ml/kg, plateau pressure 20 cmH₂O) the patient was subjected to prone positioning therapy. The patient showed no change in respiratory mechanics during prone positioning but a slight improvement in oxygenation was observed. He completed a 16 h prone therapy session. Once in supine, oxygenation was severely deteriorated again with a PaO₂/FIO₂ < 80 mmHg hence extracorporeal membrane oxygenation (ECMO) therapy was proposed.¹ Additionally, he underwent invasive monitoring with a Swan-Ganz catheter. The patient showed moderate pulmonary hypertension (PASP 45 mmHg, PVRi 388 dyn·s·cm⁵), cardiac index 3.5 l·min⁻¹·m² and a preserved mixed blood oxygen saturation around 75%. These data were complemented with a transthoracic echocardiogram that showed no right ventricular (RV) dysfunction (which was concordant with a pulmonary artery pulsatility index = 1.7), preserved left ventricular function and no signs of hypovolemia. Based on the preserved RV function and an adequate oxygen delivery with protective MV settings the decision of starting ECMO was postponed. Prone positioning sessions were continued up to a number of 5 and during the following days both the patient's lung function (which was more prominent in prone) as well as pulmonary hemodynamics progressively improved. The patient was extubated 2 weeks later.

During times of health services overwhelming, the selection of patients who will benefit from therapies related with a high consumption of resources should be carefully and effi-

ciently performed. In the ICU one of these therapies is ECMO. There are doubts about the long term prognosis of patients with SARS-CoV-2 who develop severe hypoxemia despite the gentlest MV. Besides this, the physiology of the patient with SARS-CoV-2 has been proposed to be different from typical ARDS²: (1) A high proportion of them have good compliance (Gattinoni's phenotype L) and in consequence management with low PEEP is recommended and (2) they show a blunted pulmonary vasoconstriction. Also, at least in our experience a low rate of systemic hemodynamic involvement is seen. Such differences could affect the indications of ECMO in these patients.³

Respiratory ECMO is indicated to ensure oxygen delivery in patients in whom this cannot be reached under protective MV settings.⁴ Other indications or goals are at least doubtful. Following this reasoning, comparing with typical ARDS, for the same arterial oxygen content, probably a lower proportion of SARS-CoV-2 patients would be subsidiaries of ECMO. A high compliance in a patient managed with relatively low PEEP could make it easier to reach safe settings including low plateau pressure, low driving pressure and tidal volume around 6 ml/kg⁵. If we put this altogether with the decreased pulmonary vascular response to hypoxia, a low prevalence of RV failure could be expected. Finally, in the absence of RV dysfunction, patients with preserved left ventricle function can maintain a cardiac output enough to keep an adequate oxygen delivery. Therefore, deciding starting ECMO based only on PaO₂ may not be adequate to cover the entire physiologic process in some patients with severe respiratory insufficiency in the context of COVID-19. This resolution should be adjusted to the current recommendations regarding the availability of resources.⁶

Another important finding of this case is the apparently low O₂ extraction which could be compatible with low systemic involvement at least at the disease stage at which the patient was. Also this could be due to the adequate sedation and the use neuromuscular blockade. In this context we would like to highlight that oxygen delivery depends essentially on cardiac output, hemoglobin concentration and SaO₂. Therefore in patients without risk of low cardiac output, taking into account SaO₂/FiO₂ instead of PaO₂/FiO₂ could be a better index when taking the decision of escalating toward therapies such as ECMO.

Finally, we would like to remark that despite the severity of the hypoxemia in this patient, he did improve with conventional therapies. Moreover, in spite of the doubts regarding the usefulness of prone positioning in the presence of good compliance, the patient's improvement was initially more evident with this approach. This could be due to a more marked dependence of pulmonary perfusion on gravity when hypoxic vasoconstriction is blunted. From this point of view prone positioning could be helpful in keeping the patient safe while waiting for the lung to heal.

In conclusion, through this case we would like to remark the importance of oxygen delivery in the management of patients with SARS-CoV-2 as this pathology could behave differently from typical ARDS. In this line of thought we recommend to be patient as long as we are able to reach the combination of protective MV settings and adequate peripheral oxygenation. This therapeutic attitude could contribute to a decrease in the necessity of more resource consuming therapies, which should be allocated following

recommendations that take into account their scarcity during the pandemic, as pointed out by specific guidelines.⁷

Conflict of interest

Authors have nothing to disclosure.

Bibliografía

1. Bartlett RH, Ogino MT, Brodie D, McMullan DM, Lorusso R, MacLaren G, et al. Initial ELSO guidance document: ECMO for COVID-19 patients with severe cardiopulmonary failure. *ASAIO J.* 2020;66:472–4, <http://dx.doi.org/10.1097/MAT.0000000000001173>.
2. Gattinoni L, Chiumello D, Caironi P, Busana M, Romitti F, Brazzi L, et al. COVID-19 pneumonia: different respiratory treatments for different phenotypes? *Intensive Care Med.* 2020, <http://dx.doi.org/10.1007/s00134-020-06033-2>. Epub ahead of print.
3. Zochios V, Brodie D, Parhar KK. Towards precision delivery of ECMO in COVID-19 cardiorespiratory failure. *ASAIO J.* 2020;1, <http://dx.doi.org/10.1097/MAT.0000000000001191>.
4. Brodie D, Slutsky AS, Combes A. Extracorporeal life support for adults with respiratory failure and related indications: a review. *JAMA.* 2019;322:557–68, <http://dx.doi.org/10.1001/jama.2019.9302>.
5. Pan C, Chen L, Lu C, Zhang W, Xia J-A, Sklar MC, et al. Lung recruitability in COVID-19-associated acute respiratory distress syndrome: a single-center observational study. *Am J Respir Crit Care Med.* 2020;201:1294–7, <http://dx.doi.org/10.1164/rccm.202003-0527LE>.
6. Ballesteros Sanz MÁ, Hernández-Tejedor A, Estella Á, Jiménez Rivera JJ, González de Molina Ortiz FJ, Sandiumenge Camps A, et al. Recomendaciones de «hacer» y «no hacer» en el tratamiento de los pacientes críticos ante la pandemia por coronavirus causante de COVID-19 de los Grupos de Trabajo de la Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias (SEMICYUC). *Med Intens.* 2020, <http://dx.doi.org/10.1016/j.medin.2020.04.001>. S0210-5691(20)30098-X. Online ahead of print.
7. Rascado Sedes P, Ballesteros Sanz MA, Bodí Saera MA, Carrasco Rodríguez-Rey LF, Castellanos Ortega A, Catalán González M, et al. Plan de contingencia para los servicios de medicina intensiva frente a la pandemia COVID-19. *Med Intens.* 2020, <http://dx.doi.org/10.1016/j.medin.2020.03.006>. S0210-569130095-4. Online ahead of print.

J.L. Franqueza^a, E. Rosas^a, A.-M. Ioan^a,
A. Durante-López^b, C. Pérez-Calvo^a, A. Santos^{a,c,*}

^a *Intensive Care Medicine Department, Hospital Universitario Fundación Jiménez Díaz, Madrid, Spain*

^b *Department of Cardiology, Hospital Universitario Fundación Jiménez Díaz, Madrid, Spain*

^c *CIBER de Enfermedades Respiratorias (CIBERES), Madrid, Spain*

* Corresponding author.

E-mail address: asantosviedo@yahoo.com (A. Santos).

<https://doi.org/10.1016/j.medin.2020.06.003>

0210-5691/ © 2020 Published by Elsevier España, S.L.U.