

CASE REPORT

PEER REVIEWED | OPEN ACCESS

Polymyxin B hemoperfusion therapy and extracorporeal CO₂ removal in a patient with COVID-19: A case report

Monastra Luca, Perrella Alessandro, Garzia Raffaele, Fraganza Fiorentino

ABSTRACT

Introduction: In December 2019, an outbreak of pneumonia caused by a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) quickly spread and the corona virus disease 2019 (COVID-19) became a pandemic. We report on a 54-year-old patient with SARS-CoV-2 infection suffering from septic shock due to nosocomial infection and pulmonary derangement caused by SARS-CoV-2. The patient was treated with polymyxin B hemoperfusion (PMX-HP), a blood purification therapy against septic shock, followed by continuous low flow extracorporeal CO₂ removal therapy.

Case Report: A 54-year-old man was hospitalized for coronavirus disease 2019 (COVID-19). Chest computed tomography (CCT) showed extensive non-segmental ground glass opacity. Despite the initiation of standard therapy, respiratory failure progressed. After two days of polymyxin B hemoperfusion therapy (PMX-HP) with adjunctive corticosteroid for multi-resistant Gram-negative infection (*Acinetobacter*) the patient's condition improved. In rapidly progressive COVID-19 cases with secondary infection, the early use of PMX-HP may avoid the need for mechanical ventilation by suppressing local inflammation of the lung.

Conclusion: The concern of life-threatening bacterial infections in critically ill COVID-19 patients due to antibiotics resistance is high. Secondary bacterial infections may develop during or following COVID-19 infection. The use of PMX-HP in septic shock patients has resulted in decreased dependency on ventilators, which is a serious issue during this COVID-19 pandemic. Combined and less invasive approaches might be considered in COVID-19 patients with multiple organ failure (MOF).

Keywords: Acute respiratory distress syndrome, Coronavirus disease 19, Extracorporeal CO₂ removal, Hemoperfusion, Polymyxin B, Septic shock, Severe acute respiratory syndrome coronavirus 2

How to cite this article

Luca M, Alessandro P, Raffaele G, Fiorentino F. Polymyxin B hemoperfusion therapy and extracorporeal CO₂ removal in a patient with COVID-19: A case report. Case Rep Int 2021;10:100093Z06ML2021.

Article ID: 100093Z06ML2021

doi: 10.5348/100093Z06ML2021CR

Monastra Luca¹, Perrella Alessandro², Garzia Raffaele³, Fraganza Fiorentino⁴

Affiliations: ¹Physician Anesthesiology, Critical Care and Intensive Care Unit, D. Cotugno Hospital, Naples, Italy; ²Hospital Health Direction, Infectious Disease Unit, A. Cardarelli Hospital, Naples, Italy; ³CPSI Anesthesiology, Critical Care and Intensive Care Unit, D. Cotugno Hospital, Naples, Italy; ⁴Anesthesiology, Director Critical Care and Intensive Care Unit, D. Cotugno Hospital, Naples, Italy.

Corresponding Author: Dr. Monastra Luca, San Sebastiano al Vesuvio, Via Cianciulli 31, 80040 NA, Italy; Email: luca-monastra@alice.it

Received: 11 November 2020

Accepted: 06 February 2021

Published: 23 March 2021

INTRODUCTION

A novel coronavirus, SARS-CoV-2, emerged in December 2019 in Wuhan, China. The coronavirus disease, COVID-19, became a pandemic and a major challenge to healthcare systems worldwide. Patients who are infected with SARS-CoV-2 may present with a wide range of clinical manifestations from mild to moderate or severe illness. Severe cases may include severe pneumonia, acute respiratory failure, acute respiratory distress syndrome (ARDS), acute kidney injury, endothelial damage, coagulopathy, sepsis, and septic shock [1–3]. Pneumonia

is the most common complication in COVID-19 patients. In severe cases this may be accompanied by a dysregulated immune response. Up to 60% of COVID-19 patients have gastrointestinal symptoms at admission or developed during hospitalization [4]. Gastrointestinal dysfunction may lead to increased mucosal permeability and leakage of endotoxin. Patients who are hospitalized for extended periods in an intensive care unit (ICU) are more prone to superimposed infections [5]. Gram-negative infection and/or direct mucosal gut translocation lead to the circulation of endotoxin (endotoxemia) [6].

We report a case of COVID-19 complicated with ARDS and septic shock treated with polymyxin B hemoperfusion and extracorporeal CO₂ removal.

CASE REPORT

A 54-year-old man with a medical history of obesity and hypertension developed fever, cough, and diarrhea. After five days of gradual worsening he was brought to the hospital by ambulance. At the emergency department he presented with fever and severe respiratory failure. Blood samples were drawn. Arterial blood gas analysis revealed a PO₂/FiO₂ of 63. The patient was asthenic and dyspneic and was immediately intubated (rapid sequence intubation) and transferred to the ICU. A swab test for SARS-CoV-2 infection resulted positive.

Tocilizumab (1–8 mL/kg) and antibiotics (meropenem, tigecycline, colistin) therapy were initiated. Intermittent positive pressure ventilation (IPPV) with a tidal volume of 6 mL/kg, positive end-expiratory pressure (PEEP) 10 cm H₂O, P_{peak} 31 mmHg, an average compliance of 40, average driving pressure of 11 mmHg, FiO₂ 100 to achieve a SpO₂ of at least 95%. Various cycles of pronation were performed without notable effect and PO₂/FiO₂ remained <100. Chest computed tomography (CCT) scan showed extensive non-segmental ground glass opacity (Figure 1A). Blood cultures resulted positive for multi-resistant Gram-negative infection (*Acinetobacter*).

The patient's clinical condition did not improve over the following days and septic shock was diagnosed. Endotoxin activity assay (EAA) was 0.92 EU. We therefore decided to initiate polymyxin B hemoperfusion therapy (medical device Toraymyxin, Toray Medical, Japan). Two sessions of PMX-HP, two hours each, were performed within 24 hours. During the following five days the patient's clinical condition improved, EAA decreased from 0.92 to 0.62 EU, procalcitonin decreased from 3.6 to 2.9 ng/mL, C-reactive protein (CRP) decreased from 32.2 to 23.0 ng/mL, IL-6 decreased from 43.6 to 16.9 pg/mL. Hemodynamic parameters also improved; mean arterial pressure (MAP) increased from 60 to 77 mmHg and noradrenaline was suspended.

However, a week later the patient's conditions deteriorated. The second CCT scan showed a tendency of consolidation of bilateral pleural effusion (Figure 1B).

The patient became hypercapnic and in order to facilitate ultraprotective ventilation, extracorporeal CO₂ removal therapy was initiated. Extracorporeal CO₂ removal (ECCO₂R) was continued for six days. The partial pressure of carbon dioxide (PaCO₂) improved from 74 mmHg at baseline to 42 mmHg on the 7th day and pH increased from 7.17 to 7.41. The final CCT scan revealed a net reduction of ground glass opacities and pleural effusion (Figure 1C).

The patient was hospitalized in the ICU for 113 days and was then admitted to a rehabilitation facility.

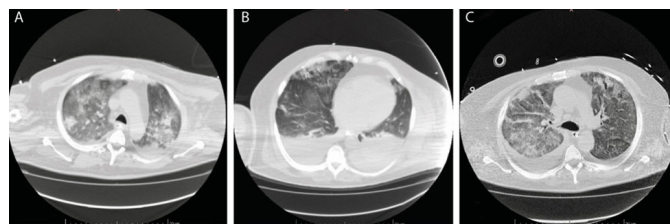


Figure 1: Chest CT scans. (A) Initial CT scan showing ground-glass opacities with interlobular septal thickening (crazy paving). (B) Second CT scan showing a tendency of consolidation of bilateral pleural effusion. (C) Third CT scan (follow-up) showing a net reduction of ground glass opacities and pleural effusion.

DISCUSSION

In this case report, we have presented a case of COVID-19 complicated with septic shock and ARDS. COVID-19 infection may lead to nosocomial infection potentially resulting in a long-term hospitalization and cause a worsening of the outcomes. In this case report, with a focus on a septic shock as secondary infection of the lower respiratory tract of a COVID-19 patient, *Acinetobacter baumannii* was the most common organism. In recent years, this species has become resistant to many types of antibiotics and they are responsible for the spread of septic shock [7, 8]. This clinical condition delays the process of treatment and recovery of COVID-19 patients but also increases the mortality rate.

Our local strategy is to identify as early as possible the outbreak of septic shock drugs using a combination therapy according to the pattern of antibiotic resistance. According to guidelines we routinely and as fast as possible try to perform polymyxin B hemoperfusion therapy to ease the cytokine storm, monitoring the endotoxin activity. In this study, combination therapy with meropenem and colistin was used for the treatment of infections caused by the resistant strains of *Acinetobacter*. Mechanical ventilation seems to be a key factor in the COVID-19 patient outcome, we are observing a progressive deterioration of blood gases exchange. Among several supportive measures including low tidal volume ventilation in those with H-type-COVID-19-pneumonia as proposed by Gattinoni et al. [9]. Prone positioning and inhaled vasodilators, extracorporeal lung assist is the most limited resource

in the treatment of ARDS. Extracorporeal membrane oxygenation (ECMO) is not generally recommended in severe ARDS. Several other options of extracorporeal support are of interest. Among those options is low blood flow extracorporeal CO₂-removal (ECCO₂R), and feasibility of ultra-protective ventilation we used (tidal volume 3 mL/kg instead of 6 mL/kg predicted bodyweight) as well as combination with continuous renal replacement therapy. Extracorporeal CO₂ removal (ECCO₂R) at lower blood flows in combination with very low tidal volume ventilation could be a therapeutic option.

CONCLUSION

The concern of life-threatening bacterial infections in COVID-19 ICU patients due to antibiotic resistance is high. Secondary bacterial infections may develop during or following COVID-19 infection. It is important to limit infection at an early stage and the use of PMX-HP in COVID-19 patients with septic shock may be useful. Endotoxin is the primary driver of the septic cascade and there is reliable evidence that removing endotoxin by PMX-HP reduces circulating levels of cytokines and other inflammatory mediators. The use of PMX-HP in septic shock patients has resulted in decreased dependency of ventilators, which is a serious issue during this COVID-19 pandemic. In addition, our preliminary experience reveals that CO₂ removal could play a role in the stabilization and survival of selected critically ill patients with COVID-19. Additional gathering and analysis of data will inform appropriate selection of patients and provide guidance as to the best use of CO₂ removal in terms of timing, implementation, duration of support, and best criteria for discontinuation when treating patients with COVID-19.

REFERENCES

1. Fanelli V, Fiorentino M, Cantaluppi V, et al. Acute kidney injury in SARS-CoV-2 infected patients. *Crit Care* 2020 Apr;24(1):155.
2. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020;395(10223):497–506.
3. Klok FA, Kruip MJHA, van der Meer NJM, et al. Incidence of thrombotic complications in critically ill ICU patients with COVID-19. *Thromb Res* 2020;191:145–7.
4. Lin L, Jiang X, Zhang Z, et al. Gastrointestinal symptoms of 95 cases with SARS-CoV-2 infection. *Gut* 2020;69(6):997–1001.
5. Ronco C, Reis T. Kidney involvement in COVID-19 and rationale for extracorporeal therapies. *Nat Rev Nephrol* 2020;16(6):308–10.
6. Fink MP, Delude RL. Epithelial barrier dysfunction: A unifying theme to explain the pathogenesis of multiple organ dysfunction at the cellular level. *Crit Care Clin* 2005;21(2):177–96.
7. Paczosa MK, Meccas J. *Klebsiella pneumoniae*: Going on the Offense with a strong defense. *Microbiol Mol Biol Rev* 2016;80(3):629–61.
8. Sampedro GR, Bubeck Wardenburg J. *Staphylococcus aureus* in the intensive care unit: Are these golden grapes ripe for a new approach? *J Infect Dis* 2017;215(suppl_1):S64–70.
9. Gattinoni L, Chiumello D, Caironi P, et al. COVID-19 pneumonia: Different respiratory treatments for different phenotypes? *Intensive Care Med* 2020;46(6):1099–102.

Author Contributions

Monastra Luca – Conception of the work, Design of the work, Drafting the work, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Perrella Alessandro – Design of the work, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Garzia Raffaele – Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Fraganza Fiorentino – Conception of the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Guarantor of Submission

The corresponding author is the guarantor of submission.

Source of Support

None.

Consent Statement

Written informed consent was obtained from the patient for publication of this article.

Conflict of Interest

Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.

Copyright

© 2021 Monastra Luca et al. This article is distributed under the terms of Creative Commons Attribution License which permits unrestricted use, distribution

and reproduction in any medium provided the original author(s) and original publisher are properly credited. Please see the copyright policy on the journal website for more information.

Access full text article on
other devices



Access PDF of article on
other devices





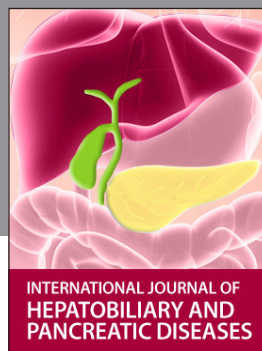
INTERNATIONAL JOURNAL OF
CASE REPORTS AND IMAGES



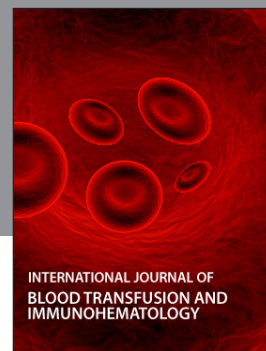
VIDEO JOURNAL OF
CLINICAL RESEARCH



VIDEO JOURNAL OF
BIOMEDICAL SCIENCE



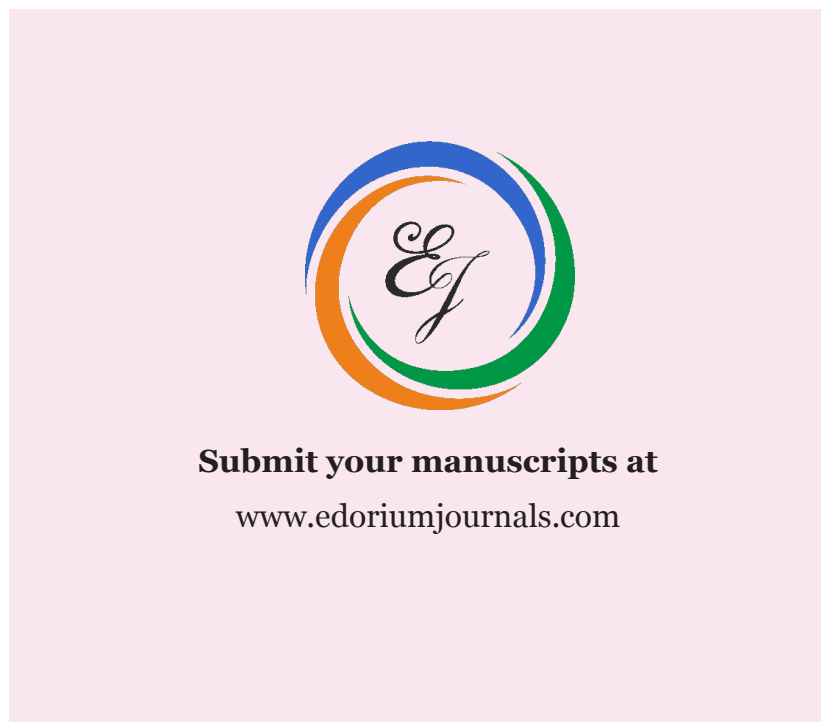
INTERNATIONAL JOURNAL OF
HEPATOBIILIARY AND
PANCREATIC DISEASES



INTERNATIONAL JOURNAL OF
BLOOD TRANSFUSION AND
IMMUNOHEMATOLOGY



EDORIUM JOURNAL OF
OPHTHALMOLOGY



EDORIUM JOURNAL OF
MEDICINE



EDORIUM JOURNAL OF
CARDIOTHORACIC AND
VASCULAR SURGERY



JOURNAL OF CASE REPORTS
AND IMAGES IN ORTHOPEDICS
AND RHEUMATOLOGY



EDORIUM JOURNAL OF
PSYCHOLOGY



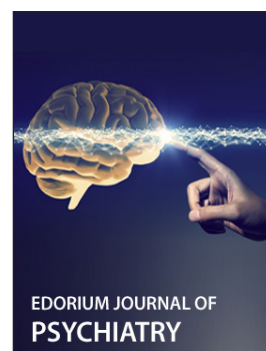
EDORIUM JOURNAL OF
CELL BIOLOGY



JOURNAL OF CASE REPORTS AND IMAGES IN
DENTISTRY



EDORIUM JOURNAL OF
CANCER



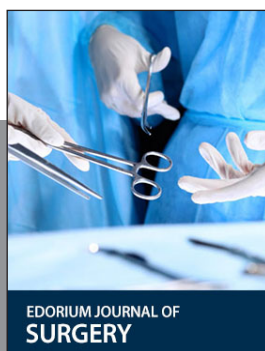
EDORIUM JOURNAL OF
PSYCHIATRY



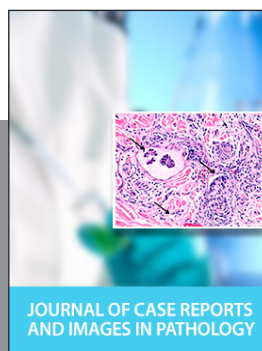
JOURNAL OF CASE REPORTS AND
IMAGES IN INFECTIOUS DISEASES



EDORIUM JOURNAL OF
ANATOMY AND EMBRYOLOGY



EDORIUM JOURNAL OF
SURGERY



JOURNAL OF CASE REPORTS
AND IMAGES IN PATHOLOGY



EDORIUM JOURNAL OF
ANESTHESIA