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.
Surviving 2019 novel coronavirus pneumonia: A successful critical case report

Lei Zou, MD, PHD a,*, Jiakui Sun, MD a, Ying Liu, MD, PHD a, Wenhao Zhang, MD a, Wei Jiang, MD, PHDb, Shoutao Yuan, MD a, Qiankun Shi, MD a

a Department of Critical Care Medicine, Nanjing First Hospital, Nanjing, Jiangsu Province, China
b Tongji Hospital, Wuhan, Hubei Province, China

ARTICLE INFO

Article History:
Received 12 July 2020
Accepted 17 August 2020
Available online 20 August 2020

Keywords:
COVID-19
ARDS
ACP
Prone position ventilation

ABSTRACT

Background: An outbreak of acute respiratory illness was proved to be infected by a novel coronavirus, officially named Coronavirus Disease 2019 (COVID-19) from World Health Organization (WHO), was confirmed first in Wuhan, China, and has become endemic worldwide, which was a serious threat to public health all over the world. Herein, we reported a successful critical case of COVID-19 and shared our experience of treatment, which would do a favor for other COVID-19 patients.

Case summary: A 65-year-old man, Wuhan citizen, was infected by COVID-19, and his pulmonary lesions progressed quickly in five days. On admission to Tongji Hospital, Wuhan, China, the immediate arterial blood gas(ABG) analysis showed the PaO2/FiO2(P/F) ratio was 134.4mmHg, moderate acute respiratory distress syndrome(ARDS) was diagnosed. Emergency tracheal intubation was performed, and the initial ventilator mode and parameters were set up based on the lung-protective ventilation strategy, but the P/F ratio could not be improved, and then the prone position ventilation was carried out for four consecutive days, as long as 16 hours every day, the P/F ratio rose to 180mmHg approximately, which still did not reach to the standard of extubation. And then we found that it was complicated with acute cor pulmonale(ACP) by ultrasound examination, dobutamine and diuretic were used for the treatment of ACP caused by ARDS successfully, and the P/F ratio went up to about 250mmHg. Seven days later after admission, the endotracheal intubation was successfully removed, after extubation, High-Flow nasal cannula(HFNC) oxygen therapy was used as a sequential strategy to prevent reintubation. Ultimately, he was discharged on day 34 after admission.

Conclusion: Our case presented the treatment process of a critical COVID-19. Effective therapy was crucial to heal COVID-19, and organ function support therapy, especially the cardiorespiratory function support therapy, was the core of treatment.

© 2020 Elsevier Inc. All rights reserved.

Keywords:
COVID-19
ARDS
ACP
Prone position ventilation

Introduction

Since December, 2019, an increasing number of cases of novel coronavirus (2019-nCoV) pneumonia (NCP) have been identified in Wuhan, Hubei Province, China,1–5 officially named Coronavirus Disease 2019 (COVID-19) from World Health Organization (WHO). The number of COVID-19 patients increased quickly in China and other countries in the world, including American, Italy, France, Iran and so on. Currently, more than 11,000,000 laboratory-confirmed cases in the world have been reported. The latest public health information from Chinese Centers for Disease Control(CDC) shows, under the great efforts of Chinese government, many effective strategies were made, and large numbers of COVID-19 patients in China have been cured. Unfortunately, in many other countries, the caseload of COVID-19 was still huge, and raised a global health emergency, and World Health Organization (WHO) has made the assessment that COVID-19 can be characterized as a pandemic. Therefore, COVID-19 has become the common enemy of all mankind. Herein, we reported a successful critical case of COVID-19 in Tongji Hospital, Wuhan, China, and shared our experience of treatment, which would do a favor for other COVID-19 patients.

Case report

On February 4th, 2020, a 65-year-old man, Wuhan citizen, began with low-grade fever, about 38°C, dry cough, shortness of breath, combined with chest CT scans finding and oropharyngeal swab real-time reverse-transcription–polymerase-chain-reaction (RT-PCR) assay for 2019-nCoV, he was diagnosed with COVID-19 and treated...
in a local community hospital. He got oxygen therapy, ganciclovir for antiviral treatment, cefamandole to prevent bacterial infection, nevertheless, he still had a fever, and shortness of breath was aggravating, even felt dyspnea, chest CT scans were rechecked on February 15th and February 20th, respectively (Figs. 1 and 2), which showed the localized patchy clouding opacity was increasing rapidly, on February 22th, he was transferred to Tongji hospital at one AM. He has no special medical history. After admission to Tongji hospital, the initial physical examination revealed axillary temperature was 36.4°C, blood pressure was 142/89 mmHg, pulse was 91 bpm, respiratory rate was 40 breath/min, and SpO2 was 95% when he was breathing supplement oxygen at 10L/min, and dyspnea was obvious. The arterial blood gas(ABG) analysis was carried out immediately and showed pH was 7.408, PCO2 32.6mmHg, PaO2/FiO2(P/F) ratio 134.4mmHg, and lactate 3.31mmol/L, which means acute respiratory failure, lung ultrasound was carried out at once, and severe lung edema and consolidation located in dorsal and basal segment of lower lobe were found, combined with the newest chest CT scans findings, moderate acute respiratory distress syndrome(ARDS) was diagnosed. Considering the rapid progressing pulmonary lesions, emergency tracheal intubation was performed, based on the lung-protective ventilation strategies, the initial ventilator mode was synchronized intermittent mandatory ventilation(SIMV), tidal volume 400ml, about 5ml/kilogram weight, positive end-expiratory pressure(PEEP) 10-12cmH2O, FiO2 80%, frequency 18 breath/min, and then, SpO2 was about 95%, respiratory rate was 18 to 22 breath/min. The laboratory results showed white blood cell count(WBC) was obvious high, 17.56*10^9/L, neutrophil ratio 93.3%, lymphocyte ratio 4.2%, and C-reactive protein (CRP) 56.3 mg/L and interleukin-6(IL-6) 39.21pg/ml, serum creatinine 65umol/L, aspartate aminotransferase (AST) 23 U/L, alanine aminotransferase (ALT) 35 U/L, and lactate dehydrogenase (LDH) 441 U/L, albumin 29.1g/L, NT-proBNP 626pg/ml. And the oropharyngeal swab tested still positive for 2019-nCoV by rRT-PCR assay. The IgM and IgG of 2019-nCoV were significantly high, 132.59AU/ml and 111.81AU/ml, respectively.

Under the treatment of mechanical ventilation(MV), the P/F ratio could not be improved and serum lactate was still high, therefore, on the day of admission, the prone position ventilation was performed from seventeen o’clock PM to eight o’clock AM next day for four consecutive days, as long as 16 hours every day (Fig. 3). Considering the influence of sedation and analgesia during the prone position ventilation, in order to maintain hemodynamic stability, bedside invasive hemodynamic monitoring was carried out, including central venous pressure(CVP) monitoring and arterial blood pressure(ABP) monitoring, at the same time, every day we used ultrasound to evaluate this patient’s cardiac function, effective circulatory blood volume, and pulmonary interstitial edema, rigid fluid management was implemented by recording urine volume per hour and fluid balance every 24 hours. At the second day after the prone position ventilation therapy, the P/F ratio went up to about 150mmHg at the supine position, while approximate 180mmHg at the prone position. However, to the fourth day, the P/F ratio did not increase more, by the ultrasound examination, we found that the inferior vena cava was filled with no obvious respiratory variability, the right ventricular was satiate, CVP was in a high level, 14mmHg to 15mmHg, which means circulatory blood volume was overload, and estimated pulmonary artery pressure(PAP) reached to 45-50mmHg by tricuspid regurgitation speed, which means it was complicated with acute cor pulmonale(ACP). Based on the findings of ultrasound scans, we adjusted this patient’s therapeutic regimen, diuretics were used to achieve the goal of being negative fluid balance, meanwhile, we used dobutamine to improve right ventricular function and optimize ventricular artery coupling at a dose of 2ug/(kg*min), and heart rate was below 90bpm with no arrhythmia. After that, the P/F ratio increased obviously, about 230mmHg at the supine position, while approximate 250mmHg at the prone position, and chest x ray presented that pulmonary lesions were clearly reduced compared to last time (Figs. 4 and 3), and bedside ultrasound scans found that PAP declined to about 30mmHg at the prone position, while PAP declined to about 30mmHg at the prone position, and chest x ray presented that pulmonary lesions were clearly reduced compared to last time (Figs. 4 and 3), and bedside ultrasound scans found that PAP declined to about 30mmHg at the prone position, while approximate 250mmHg at the prone position. However, to the fourth day, the P/F ratio did not increase more, by the ultrasound examination, we found that the inferior vena cava was filled with no obvious respiratory variability, the right ventricular was satiate, CVP was in a high level, 14mmHg to 15mmHg, which means circulatory blood volume was overload, and estimated pulmonary artery pressure(PAP) reached to 45-50mmHg by tricuspid regurgitation speed, which means it was complicated with acute cor pulmonale(ACP). Based on the findings of ultrasound scans, we adjusted this patient’s therapeutic regimen, diuretics were used to achieve the goal of being negative fluid balance, meanwhile, we used dobutamine to improve right ventricular function and optimize ventricular artery coupling at a dose of 2ug/(kg*min), and heart rate was below 90bpm with no arrhythmia. After that, the P/F ratio increased obviously, about 230mmHg at the supine position, while approximate 250mmHg at the prone position. However, to the fourth day, the P/F ratio did not increase more, by the ultrasound examination, we found that the inferior vena cava was filled with no obvious respiratory variability, the right ventricular was satiate, CVP was in a high level, 14mmHg to 15mmHg, which means circulatory blood volume was overload, and estimated pulmonary artery pressure(PAP) reached to 45-50mmHg by tricuspid regurgitation speed, which means it was complicated with acute cor pulmonale(ACP). Based on the findings of ultrasound scans, we adjusted this patient’s therapeutic regimen, diuretics were used to achieve the goal of being negative fluid balance, meanwhile, we used dobutamine to improve right ventricular function and optimize ventricular artery coupling at a dose of 2ug/(kg*min), and heart rate was below 90bpm with no arrhythmia. After that, the P/F ratio increased obviously, about 230mmHg at the supine position, while approximate 250mmHg at the prone position. After extubation, High-Flow nasal cannula(HFNC) oxygen therapy was used as sequential strategy to prevent reintubation. HFNC oxygen therapy was withdrawn on day 12 after admission, and supplemental oxygen was discontinued on day 29 after admission.
tion therapy has been demonstrated by large numbers of research.8,9

The prone position ventilation had the ability to correct non-
uniformity of lung injury, facilitate the alveolar recruitment in the
gravity-dependent lung region, which had been verified by ultra-
sound, and then improve hypoxemia and hypercapnia.10 Early
research showed that it would achieve optimal clinical effects when
the prone position ventilation therapy lasted for above 12 hours
every times,11 therefore, in this case, the prone position ventilation
therapy was performed for 16 hours every times.

HFNC, a novel device, could deliver fully humidified, high-flow
oxygen (up to 60 L/min) through a nasal cannula. By delivering the
gas at given flow rates in excess of the patient’s peak inspiratory flow
rate, HFNC provides a constant FiO2. In addition, a flow-dependent
effect of continuous positive airway pressure has been observed,
which is similar to PEEP. Last, the high gas flow may provide an upper
airways deadspace washout effect, create an oxygen reservoir within
the upper airways, reduce inspiratory resistance and work of breath-
ing.12 Compared with noninvasive ventilator, HFNC could provide
greater comfort for patients, avoid excessive tidal volume, which
would lead to worse outcome in patients with ARDS. After extuba-
tion, HFNC oxygen therapy had presented the ability to reduce the
risk of reintubation and postextubation respiratory failure.13,14 and
there was research showed that HFNC was safe enough during the
current COVID-19 outbreak.15

ARDS often was complicated with ACP, characterized by acute
pulmonary arterial hypertension and right ventricular dysfunction,
even failure,16 these clinical features also were observed in this case.
Possible mechanisms included pulmonary vasoconstriction caused
by hypoxemia and hypercapnia, vascular collapse between alveoli
after numbers of alveolar collapse. Prone position ventilation therapy
could facilitate the alveolar recruitment, improve hypoxemia and
hypercapnia, as a result, reduced PAP and protected right ventricular
function.17 Meanwhile, dobutamine, a β1 adrenoceptor agonist, has
been demonstrated to be able to optimize ventricular artery coupling
and improve right ventricular function by increasing heart rate and
myocardial contractility.18 In our case, the prone position ventilation
therapy, combining with dobutamine and diuretic, reduced acute
pulmonary arterial hypertension caused by COVID-19 successfully.

In summary, this case presented the treatment process of a critical
COVID-19. Effective therapy was crucial to reduce the mortality of
COVID-19, and organ function support therapy, especially the cardio-
respiratory function support therapy, was the core of treatment.

Additional contributions

We thank the patient for providing permission to share his infor-
mation.

Declaration of Competing Interest

The authors declare no conflicts of interest relevant to this article.

References

1. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospi-
talized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA.
2020;323:1061–1069.
2. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical
characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a
descriptive study. Lancet. 2020;395:507–513.
3. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from
Patients with Pneumonia in China, 2019. New Engl J Med. 2020;382:727–733.
4. Petrucci N, De Feo C. Lung protective ventilation strategy for the acute respiratory
distress syndrome. Cochrane Database Syst Rev. 2013;2013(2):CD003844.
5. Yoon SH, Lee KH, Kim JY, Lee YK, Ko H, Kim KH, et al. Chest radiographic and CT
findings of the 2019 novel coronavirus disease (COVID-19): analysis of nine patients
treated in Korea. Korean J Radiol. 2020;21:494–500.
6. Wei J, Xu H, Xiong J, Shen Q, Fan B, Ye C, et al. 2019 Novel coronavirus (COVID-19)
pneumonia: serial computed tomography findings. Korean J Radiol. 2020;21:501–
504.
7. Chen L, Del Sorbo L, Grieco DL, Junhasavasdikut D, Rittayamai N, Soliman I, et al.
Potential for lung recruitment estimated by the recruitment-to-inflation ratio in acute
respiratory distress syndrome. A clinical trial. Am J Respir Crit Care Med. 2020;
201:178–187.
8. Scholten EL, Beiter JR, Prisk GK, Malhotra A. Treatment of ARDS with prone posi-
tioning. Chest. 2017;151:215–224.
9. Kallet RH. A comprehensive review of prone position in ARDS. Respir Care.
2015;60:1600–1687.
10. Guerin C, Gattinoni L. Assessment of oxygenation response to prone position venti-
lation in ARDS by lung ultrasonography. Intensiv Care Med. 2016;42:1601–1603.
11. Hu SL, He HL, Pan C, Liu AR, Liu SQ, Liu L, et al. The effect of prone positioning on mortality in patients with acute respiratory distress syndrome: a meta-analysis of randomized controlled trials. Crit Care. 2014;18:R109.

12. Maggiore SM, Idone FA, Vaschetto R, Festa R, Cataldo A, Antonicelli F, et al. Nasal high-flow versus Venturi mask oxygen therapy after extubation. Effects on oxygenation, comfort, and clinical outcome. Am J Respir Crit Care Med. 2014;190:282–288.

13. Hernandez G, Vaquero C, Gonzalez P, Subira C, Frutos-Vivar F, Rialp G, et al. Effect of postextubation high-flow nasal cannula vs conventional oxygen therapy on reintubation in low-risk patients: a randomized clinical trial. JAMA. 2016;315:1354–1361.

14. Hernandez G, Vaquero C, Colinas L, Cuena R, Gonzalez P, Canabal A, et al. Effect of postextubation high-flow nasal cannula vs noninvasive ventilation on reintubation and postextubation respiratory failure in high-risk patients: a randomized clinical trial. JAMA. 2016;316:1565–1574.

15. Loh NW, Tan Y, Taculod J, Gorospe B, Teope AS, Somani J, et al. The impact of high-flow nasal cannula (HFNC) on coughing distance: implications on its use during the novel coronavirus disease outbreak. Can J Anaesth. 2020;67:893–894.

16. Fougeres E, Teboul JL, Richard C, Osman D, Chemla D, Monnet X. Hemodynamic impact of a positive end-expiratory pressure setting in acute respiratory distress syndrome: importance of the volume status. Crit Care Med. 2010;38:802–807.

17. Jozwiak M, Teboul JL, Anguel N, Persichini R, Silva S, Chemla D, et al. Beneficial hemodynamic effects of prone positioning in patients with acute respiratory distress syndrome. Am J Respir Crit Care Med. 2013;188:1428–1433.

18. Acosta F, Sansano T, Palenciano CG, Falcon L, Domenech P, Robles R, et al. Effects of dobutamine on right ventricular function and pulmonary circulation in pulmonary hypertension during liver transplantation. Transpl Proc. 2005;37:3869–3870.