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Case Report

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The use of Respiration-Oxygenation (ROX) index in determining high-flow nasal cannula outcome in COVID-19 pneumonia

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Abstract

In this pandemic, the high-flow nasal cannula (HFNC) gained popularity for managing hypoxemia. However, failure of HFNC is thought to delay the intubation. We report a 53-year-old male with COVID-19 pneumonia with hypoxemic respiratory failure. HFNC was given, but the respiration-oxygenation (ROX) index was below the target. The patient was declared as having failed HFNC and was intubated after 12 hours. After intubation, the clinical condition was improved. The patient survived and was discharged from the hospital two weeks later with a negative swab result. This case highlights that HFNC failure does not affect the intubation outcome in severe COVID-19 pneumonia.

Keywords: COVID-19, High-flow nasal oxygen, HFNC, ROX index, ventilation

INTRODUCTION

The clinical presentation of COVID-19 ranges from asymptomatic infection to severe pneumonia. About 5% of the cases can progress to hypoxemic respiratory failure requiring advanced respiratory support [1]. The increasing number of COVID-19 patients with respiratory failure is burdening hospitals in providing intensive-care unit (ICU) and ventilators. This necessitates the need for alternative respiratory support methods that might benefit the patient [2]. The high-flow nasal cannula (HFNC) has gained popularity as a non-invasive oxygen therapy that can delay or even prevent intubation mechanical ventilation. However, the decision to switch from HFNC to the mechanical ventilator remains a challenge. On the one hand, HFNC may delay or prevent intubation. However, the delay in administering the ventilator can also worsen the patient's condition [3].

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CASE REPORT

A 56-year-old man came to the hospital complaining of shortness of breath for the last three days. Other complaints were cough and fever. The peripheral saturation with room oxygen was only 74%. Blood gas analysis showed moderate respiratory distress syndrome (ARDS) with a PaO_2/FiO_2 ratio of only 123. The liver enzyme, D-dimer, and neutrophil to lymphocyte ratio (NLR) were elevated. The procalcitonin level was normal. Radiological examination revealed bilateral ground-glass opacities (Figure 1). The result of the polymerase chain reaction (PCR) swab was SARS-CoV-2 detected. The patient was given a non-rebreathing oxygen mask of 15 liters per minute. However, the respiratory rate was still 28 times per minute, with a peripheral saturation of 90%.

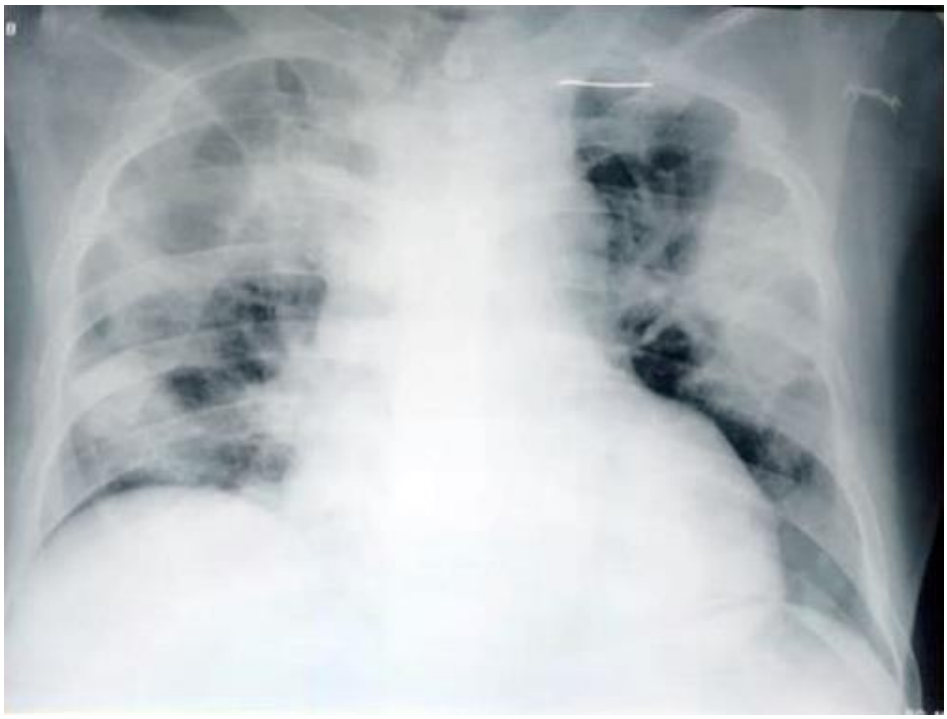
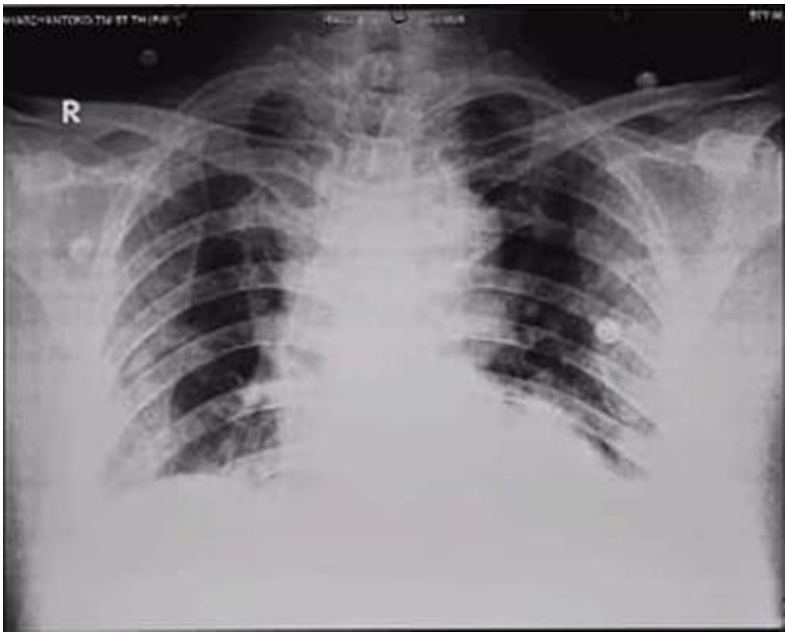


Figure 1. Chest x-ray of the patient on the first admission to the hospital showed bilateral ground-glass opacities

HFNC was given to patients with an initial set of 30 L/min airflows and an inspired oxygen fraction of 60%. We also attempted awake prone positioning, but it was ineffective as the patient was restless. On the second hour, the ROX index was 2.75, and the flow was increased to 40 L/min with a fraction of 80%. ROX index at the fourth hour was 3.01. The flow was then increased to 60 L/min with 100% oxygen fraction. At the 12^{th} hour of observation, the ROX index was still 3.70. The patient's saturation decreased, and he became increasingly restless. We decided to sedate and intubate the patient after 12 hours of failed HFNC use. After 2 hours of observation on the ventilator, there was an improvement in the PaO_2 / FiO_2 ratio to 165. The work of breathing improved, and peripheral saturation reached 99%. The PaO_2 / FiO_2 ratio increased to 261 in the next 24 hours. Post-intubation chest x-ray evaluation showed reduced bilateral infiltrates (Figure 2).

Figure 2. Chest x-ray of the patient after being intubated and using a mechanical ventilator, it appears that the bilateral infiltrates were reduced

The patient was decided to be weaned from the ventilator on the third day. He was successfully switched to HFNC again. The ROX index after 12 hours was 7.2, so the usage of HFNC was being continued. Weaning of HFNC was performed when the flow was 30 L/min, and the fraction was 50% to the conventional nasal cannula. Post-extubation chest X-ray showed improvement with reduced infiltrates (Figure 3). The other therapy for the patient were antiviral, anticoagulant, and dexamethasone injection. The patient was then transferred to the low-care room on the ninth day and was discharged four days later with a negative swab result.



Ffigure 3. Chest x-ray of the patient after moving to the low care room, the bilateral infiltrate was reduced

DISCUSSION

COVID-19 is an acute respiratory infection that can cause aggravate acute respiratory failure or death due to hypoxemia. Oxygen therapy is essential in the management of COVID-19. However, it is debatable whether ventilator management or non-invasive ventilation is better for patients [4]. However, amidst the limited intensive care and the increased need for ventilators, non-invasive ventilation is needed as an alternative treatment [5]. Surviving Sepsis/Society of Critical Care Medicine recommends HFNC as non-invasive oxygen therapy [1].

Previous studies have found stated that HFNC could reduce intubation rates than other conventional oxygen therapies [6]. There are many clinical benefits of HFNC for patients: improved oxygenation, lower dilution, positive expiratory pressure, dead space wash-out, improved mucociliary movement, and improved comfort [7]. However, the failure of HFNC can lead to delayed intubation and increased mortality [8]. Determining when a patient is transferred from HFNC to a mechanical ventilator is still a challenge. In 2016 Roca et al. assessed a ROX index, namely the SpO_2/FiO_2 ratio divided by respiratory rate. This assessment is relatively easy because it does not require laboratory data, instead of bedside monitoring only.

The ROX index can assess the indicator for the success of HFNC. It has been validated to predict the early outcome of HFNC use in pneumonia. In the observation of HFNC, the ROX index is measured at 2 hours, 6 hours, 12 hours, and above 12 hours. The ROX index target value is ≥4.88 in every monitoring hours. If the ROX index measured is <2.85 at 2 hours <3.47 at 6 hours, or <3.85 at 12 hours, intubation should be considered. In this case, the patient is known to have HFNC failure assessed from the ROX index evaluation at 12 hours, which was <3.85 despite the maximum of HFNC have been given. There are many conditions associated with HFNC failures, such as high respiratory rate, low peripheral saturation, and residents' decision-making [9]. David et al. stated that HFNC failure was associated with increased mortality compared with NIV failure. The increase in mortality occurred mainly in patients who had the decision to intubate after more than 48 hours, compared to those intubated before 48 hours [10]. At presentation our patient had significant hypoxaemia and according to our hospital guidelines, HFNC was administered first to treat hypoxemia. Then we decided to intubate the patient after 12 hours declared a failure. After the patient got intubated, tachypnea, PaO_2/FiO_2 ratio, and chest x-ray were improved. The patient recovered well after his hypoxemia was treated. In this case, there were no confounding factors since the patient did not receive tocilizumab or IVIG. We also did not give antibiotics because the procalcitonin level was normal, and there were no features of bacterial infection. We used steroids in this patient, as standard of care for all COVID-19 patients with hypoxemia and needing oxygen therapy. Roca et al. reported that the relative risk of death for a patient with HFNC failure at 6 to 12 hours is 1.0, which means that 12 hours of observation on HFNC did not increase the risk of death than the patient who intubated in 6 hours after HFNC observation. This case similarly showed that ROX index observation can still be safe and may not hamper patient treatment with mechanical ventilator or worsen the outcome in HFNC failure [5].

CONCLUSION

HFNC is one of the modalities in dealing with hypoxemic COVID-19 patients. It can be used safely and effectively in the pandemic situation with highly limited availability of invasive ventilation and ICU care. Assessment of the success and failure of HFNC can be assessed using the ROX index. In keeping with current literature this case illustrates observation 12 hours using the ROX index in HFNC failure can be safe and may not hamper intubation and outcome of invasive ventilation in severe COVID-19 patients.

Author declaration

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Author Contributions
Those who have participated sufficiently in the intellectual content, conception, and design of this work or the analysis and interpretation of the data and the writing of the manuscript, to take public responsibility have been listed as follows.

1. Nur Prasetyo Nugroho: Treated the patient and wrote up the case report
2. Irmi Syafa'ah: Treated the patient and designing a case report
3. Isnin Anang Marhana:Treated the patient

Nature of work	1 A	2 A	3A
Concepts	√	√	√
Design	√	√	√
Definition of intellectual content	√	√	
Literature search	√	√	
Clinical studies	N/A	N/A	N/A
Experimental studies	N/A	N/A	N/A
Data acquisition	N/A	N/A	N/A
Data analysis	N/A	N/A	N/A
Statistical analysis	N/A	N/A	N/A
Manuscript preparation	√	√	√
Manuscript editing	√	√	√
Manuscript review	√	√	√
Guarantor	√	√	√

A = Author
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Competing interests
There is no conflict of interest in this article

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