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REVIEW ARTICLE

A clinical review of using a high-flow nasal cannula for patients with COVID-19 infection

Mutia Ayu Pratiwi, Abi Muhlisin

Author information
Department of Nursing, Universitas Muhammadiyah Surakarta, Indonesia

mutiatiwi27@gmail.com

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Abstract
Coronavirus Disease 2019 (COVID-19) is caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV 2). The most common manifestations of COVID-19 include fever > 37.5˚C, cough, flu, anosmia, and respiratory distress—the virus cause Acute Respiratory Distress Syndrome (ARDS), which quickly turns into respiratory failure. Therefore COVID-19 patients with ARDS require intensive care in a hospital with oxygen support. One type of oxygen therapy used to treat COVID-19 with ARDS is a High Flow Nasal Cannula (HFNC) administration. This study aimed to determine the effectiveness of HFNC therapy in COVID-19 patients with ARDS. This study used a literature review research design. Sources of literature were carried out on Google Scholar, Science Direct, Pubmed, and Sage Journal, with the final results obtained from eight reviewed articles. The results of the eight articles stated that using HFNC positively impacted the decreased need for mechanical ventilation and increased gas exchange of COVID-19 patients with ARDS.

Keywords: COVID-19; oxygen therapy; nursing care; infectious diseases; prevention strategy

Introduction

Coronavirus Disease 2019 (COVID-19) is a disease caused by infection with a virus called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV 2) that was first discovered in Wuhan, China, in December 2019 (Annunziata et al., 2021). The number of COVID-19 cases continues to show an increasing trend in terms of prevalence and mortality. As of August 2021, there were 201 million confirmed cases globally, with a death rate of 4.27 million (2.1%) (WHO, 2021). Meanwhile, there were 3.61 million confirmed cases in Indonesia alone, with a death rate of 104 thousand people (2.6%) (RI Ministry of Health, 2021). In December 2020, a new SARS-CoV 2 virus was discovered in India, later named the SARS-CoV 2 Delta variant. The Delta variant is highly contagious, estimated to be twice as infectious and causes more severe disease than the previous variant (Alhasan et al., 2021).

On July 15, 2021, Indonesia recorded the highest record in increasing the number of daily cases of COVID-19, which reached 56.767 cases per day (Kemenkes, 2021). Vaccination coverage, which is still very low, is one factor driving the significant spike in cases associated with the Delta variant (Dyer, 2021). The impact is that hospitals have to struggle to cope with the sharp increase in COVID-19 cases in a very short time, and the government makes policies for the gas and oxygen production industry to prioritize the production and distribution of oxygen for medical needs over industrial needs (UN OCHA, 2021). The problem of fulfilling spiritual needs can lead to a lack of patient interest in seeking information about diabetic ulcer healing, a lack of adherence to wound care, and a lack of blood sugar control so that the patient's condition becomes severe (Subhannur et al., 2020). On the other hand, spiritual needs make psychological disorders calmer and more confident, with a sense of closeness to oneself, others, nature, and God. Rahman Subhannur et al. 2020 conducted a literature review on spiritual needs in patients with diabetic ulcers and got the results that spiritual fulfilment is the best coping because, subconsciously, it will create positive thinking, emotional, and motivational patterns that it can make healing process wounds more effective (Subhannur et al., 2020).

The most common manifestations of COVID-19 include fever > 37.5˚C, cough, flu, impaired sense of smell, taste, and shortness of breath (Parasher, 2021). In cases of COVID-19 with severe symptoms can cause Acute Respiratory Distress Syndrome (ARDS). ARDS is a rapidly progressive disorder that initially manifests clinically as shortness of breath (dyspnea and tachypnea), rapidly progressing to respiratory failure (Kashani et al., 2020). COVID-19 patients who experience ARDS have a mortality rate of 50% - 94%. In addition, the outcome of ARDS patients caused by COVID-19 is worse than ARDS patients caused by other diseases (Fatoni et al., 2021). Therefore COVID-19 patients with ARDS require intensive care in hospitals with oxygen support (Panadero et al., 2020).

One type of oxygen therapy used to treat COVID-19 with ARDS is the administration of High Flow Nasal Cannula (HFNC) (Rali et al., 2020). HFNC can produce high fractional inspired oxygen (FiO2) titrated up to 100%, even in patients with acute respiratory failure (Vianello et al., 2020). HFNC can also increase gas exchange, reduce respiratory rate, and improve the work of breathing (Drexler et al., 2021). Oxygen levels are given gradually, starting by providing oxygen with a high flow and then lowering it to a lower flow according to the severity of the patient (Wang et al., 2020). Patients with severe respiratory problems with SpO2 < 90% can be given high-flow oxygen up to 70L/per minute (García-Álvarez & García-Vigil, 2020). Patients with moderate respiratory distress SpO2 between 90% - 94% can be given high-flow oxygen up to 50L/minute. Meanwhile, SpO2 between 94% - 97% of patients with mild respiratory disorders can be given high-flow oxygen up to 30L/minute in the initial phase of the patient's admission to the hospital to reduce the need for intubation (Parasher, 2021). The Respiratory Rate Oxygenation Index (ROX) is an assessment used to predict the success of HFNC therapy (Rali et al., 2020). Given the high rate of increase in daily cases related to COVID-19 in Indonesia, followed by the high rate of patient dependence on oxygen therapy, it is therefore very important for researchers to raise the topic of the effectiveness of oxygen therapy, especially HFNC in COVID-19 patients with ARDS. Based on a literature review, this study aimed to determine the effectiveness of HFNC therapy in COVID-19 patients with ARDS.

Method

The method used is a literature review by reviewing scientific literature on a topic and critically analyzing, evaluating, and synthesizing research findings, theories, and practices. Search for research articles using databases from Google Scholar, Science Direct, Pubmed, and Sage Journal using keywords, namely 'COVID-19' OR 'Coronavirus Disease 2019' AND 'SARS-CoV 2' OR 'Severe Acute Respiratory Syndrome Coronavirus 2' AND 'Oxygen' AND 'High Flow Nasal Cannula' OR 'HFNC' AND 'Acute Respiratory Distress Syndrome' OR 'ARDS'. The inclusion criteria are full-text articles in English or Indonesian published in 2020 – 2021, focusing on High Flow Nasal Cannula interventions, with the research sample being all COVID-19 sufferers from teenagers to the elderly. Meanwhile, the exclusion criteria were articles that did not discuss HFNC and COVID-19 infection. We used PRISMA flow steps for screening and selecting the article. All the authors contributed to this process of manuscript writing. The bias of the study finding has been prevented by reading and perusing the articles at times.

Results

The total number of articles obtained was screened first (n=654), then deleted articles that had multiple titles and titles that did not match the inclusion criteria (n=646) so that the final results were eight articles reviewed **(Table 1)**. All the articles have various research designs, such as observation and review studies. We did not focus on nursing studies as several healthcare professionals have written many articles.

Discussion

Of the eight articles that have been reviewed, it is explained that cases of COVID-19 with severe symptoms can cause Acute Respiratory Distress Syndrome (ARDS). ARDS is a rapidly progressive disorder that initially manifests clinically as shortness of breath (dyspnea and tachypnea), rapidly progressing to respiratory failure (Kashani et al., 2020). In conditions of respiratory failure, the supply of oxygen in the body will decrease, where oxygen is needed by cells for regeneration and metabolic processes. So that patients with respiratory failure need intervention to provide oxygen therapy to maintain oxygen levels within normal limits (97% - 100%) (Cannon et al., 2018). In addition to ARDS, oxygen therapy can be used for other respiratory diseases such as COPD (chronic obstructive pulmonary disease), asthma, end-stage heart failure, cystic fibrosis, and sleep apnea (Driscoll et al., 2017). Besides aiming to maintain oxygen levels in the body within normal limits, oxygen therapy using a nasal cannula also has many benefits, including

the installation is quite easy, does not interfere with the patient's eating and drinking activities, does not limit the patient when talking, and provides stable oxygen with tidal volume—and regular respiratory rate. However, using oxygen therapy using a nasal cannula for a long time can cause side effects by drying the nasal mucosa and irritation of the skin in contact with the nasal cannula such as the ears, cheeks, neck and neck and nose (Garnier, 2016).

Table 1. Study findings

No	Authors, years	Research design	Main finding
1	Annunziata et al., 2021	Observational study	HFNC improve the outcomes and prevent mortality
2	Andrea Vianello et al., 2020	Observational study	The positive response and improved the respiratory function
3	Kashani, 2020	Retrospective cohort study	HFNC increase oxygen saturation
4	Ke Wang et al., 2020	Retrospective observational study	HFNC supports another oxygen therapy
5	Carolina Panadero, 2020	Retrospective Observational Study	HFNC prevent intubation
6	Francesco Di Gennaro et al., 2020	Narrative review	HFNC improve the respiratory dysfunction
7	Jiang Xie et al., 2020	Retrospective Cohort Study	HFNC increase the opportunity to survive mortality
8	You Shang, 2020	Retrospective Observational Study	HFNC can be used in seniors having an infection

One type of oxygen therapy used to treat COVID-19 with ARDS is the administration of High Flow Nasal Cannula (HFNC) (Rali et al., 2020). HFNC can produce a high fraction of inspired oxygen (FiO2), titrated up to 100%, in patients with acute respiratory failure (Vianello et al., 2020). Oxygen levels are given gradually, starting by providing oxygen with a high flow and then lowering it to a lower flow according to the severity of the patient (Wang et al., 2020). There is three respiratory distress that might need consideration in using HFNC as follows: first, Severe respiratory distress High Flow Nasal Cannula (HFNC) has an important role in correcting hypoxemia in around two-thirds of patients with COVID-19 with severe hypoxemic respiratory failure who cannot achieve SatO2 ≥ 90% with standard oxygen therapy. Patients with severe respiratory distress can be given high-flow oxygen up to 70L/per minute (García-Álvarez & García-Vigil, 2020). COVID-19 patients with severe respiratory distress who have been given HFNC for six days and have SpO2 values > 90% show a very high probability of survival. Whereas in patients with SpO2 values < 90%, even though they have been given HFNC, the possibility of death is very high (Xie et al., 2020). Second, Moderate respiratory distress, as COVID-19 patients with moderate hypoxemic respiratory failure with SatO2 values between 90% - 94% can be given high-flow oxygen up to 50L/minute (Parasher, 2021). Third, Mild respiratory problems in COVID-19 patients with mild hypoxemic respiratory failure with SatO2 values between 94% - 97% can be given high-flow oxygen up to 30L/minute (Parasher, 2021). They consider that COVID-19 patients who experience ARDS have a mortality rate of up to 50% - 94% (Fatoni et al., 2021). Therefore, installing a High Flow Nasal Cannula (HFNC) is very important (Rali et al., 2020). According to (Arofah & Sudaryanto, 2020), HFNC installation has several benefits, including getting adequate oxygen and ventilation, reducing the need for mechanical ventilation, efficient delivery of supplemental oxygen, reducing the work of breathing, increasing lung volume and improving gas exchange.

Even though HFNC has many benefits, not all patients can have HFNC installed. According to (Di Gennaro et al., 2020), several clinical conditions not allowed to be installed with HFNC include hypercapnia, hemodynamically unstable, multiple organ failure, decreased consciousness, and nosebleeds due to varicose veins or mucosal lesions. Management of HNFC in COVID-19 patients with ARDS is not without risks. HFNC can generate aerosols, so its treatment must be carried out in a negative-pressure room (Gürün Kaya et al., 2020). In addition, using surgical masks in COVID-19 patients who are using HFNC can reduce the risk of spreading droplets. The duration of treatment is between 1 – 11 days, with an average length of treatment of 6 days (Xu et al., 2020). According to a study that around 67.8% of patients with HFNC improved and could be moved to a normal room. This is supported by research from (Karamouzos et al., 2020), which describes a 44-year-old male patient treated in the Emergency Room (ER) due to fever and mild respiratory distress. He complained of an unproductive cough accompanied by mild dyspnea on exertion. On auscultation of the chest, crackles were found in the lower lobe of the right lung. From the anamnesis, it is known that

the patient had just returned from the pilgrimage to the Middle East, where a case of COVID-19 was reported. The SARS-CoV-2 test result is positive. On day six, the patient's respiratory function suddenly worsened. Due to a significant decrease in the patient's respiratory function, he was transferred to the negative pressure isolation ICU and underwent HFNC oxygen therapy. The patient responded well to treatment. Her PaO2/FiO2 ratio was 150, and she decided to continue HFNC therapy under close supervision. Her PaO2/FiO2 ratio progressively increased above 250, and after ten days, she was successfully weaned from HFNC and transferred to the internal medicine ward.

Whereas 32.2% of patients failed to use HFNC. Patients who experience failure during their treatment period with HFNC must proceed with invasive measures in the form of endotracheal intubation with the help of mechanical ventilation (Fatoni et al., 2021). According to (Xu et al., 2020), conditions that allow patients to fail HFNC therapy include the severity of hypoxaemia, high levels of reactive protein C (>0.3 mg/L), low PaO2/FiO2 (< 200), age > 60 years, ROX index < 5.31 in the first 4 hours of HFNC initiation and Interleukin 6 (IL-6) >7.0 pg/mL. The explanation of HFNC therapy failure above follows a clinical study conducted by (Kim et al., 2017) at Asan Medical Center Seoul, Korea, on hypoxemic respiratory failure patients using HFNC, divided into two groups, HFNC success and HFNC failure. The mortality rate was significantly higher in the HFNC failure group (52%) than in the HFNC success group (13%). The increased mortality rate occurs because of the initial severity of the disease, organ dysfunction, and a decrease in the PaO2/FiO2 ratio.

Conclusion

Our finding indicates that HFNC helps improve respiratory function among patients with COVID-19 infection. Nurses and healthcare professionals working in the COVID-19 ward should work in tandem to evaluate the patient's respiratory condition. Further study is needed to assess the effectiveness of HFNC in other respiratory distress syndromes in hospitals.

Author's declaration

The authors made substantial contributions to the conception and design of the study and took responsibility for data analysis, interpretation, and discussion of results. For manuscript preparation, all the authors read and approved the final version of the paper.

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Availability of data and materials

All data are available from the authors.

Competing interests

The authors have declared that no conflict of interest exists.

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