

High flow nasal cannula in asthmatic children with suspected COVID-19

Cânula nasal de alto fluxo em crianças asmáticas com suspeita de COVID-19

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Date of first submission: November 24, 2020

Last received: May 3, 2021

Accepted: May 11, 2021

Associate editor: Ana Paula Cunha Loureiro

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Abstract

Introduction: The use of a high-flow nasal cannula as an alternative treatment for acute respiratory failure can reduce the need for invasive mechanical ventilation and the duration of hospital stays. **Objective:** The present study aimed to describe the use of a high-flow nasal cannula in pediatric asthmatic patients with acute respiratory failure and suspected COVID-19. **Methods:** To carry out this research, data were collected from medical records, including three patients with asthma diagnoses. The variables studied were: personal data (name, age in months, sex, weight, and color), clinical data (physical examination, PRAM score, respiratory rate, heart rate, and peripheral oxygen saturation), diagnosis, history of the current disease, chest, and laboratory radiography (arterial blood gases and reverse-transcriptase polymerase chain reaction). Clinical data were compared before and after using a high-flow nasal cannula. **Results:** After the application of the therapy, a gradual improvement in heart, respiratory rate, $\text{PaO}_2/\text{FiO}_2$ ratio, and the Pediatric Respiratory Assessment Measure score was observed. **Conclusion:** The simple and quick use of a high-flow nasal cannula in pediatric patients with asthma can be safe and efficient in improving their respiratory condition and reducing the need for intubation.

Keywords: Pediatrics. Oxygen therapy. Physiotherapy. Pediatric Intensive Care Units. Asthma.

Resumo

Introdução: A utilização da cânula nasal de alto fluxo como alternativa de tratamento para a insuficiência respiratória aguda pode diminuir a necessidade de utilização de ventilação mecânica invasiva e reduzir os dias de internamento. **Objetivo:** Descrever a utilização da cânula nasal de alto fluxo em pacientes pediátricos asmáticos com insuficiência respiratória aguda e suspeita de COVID-19. **Métodos:** Para a realização dessa pesquisa foram coletados dados de prontuários, sendo três pacientes com diagnóstico de asma incluídos. As variáveis estudadas foram: dados pessoais (nome, idade em meses, sexo, peso e cor) e clínicos (exame físico, PRAM Escore, frequência respiratória, frequência cardíaca, e saturação periférica de oxigênio), diagnóstico, história da moléstia atual, radiografia de tórax e exames laboratoriais (gasometria arterial e Reverse-Transcriptase Polymerase Chain Reaction). Foram comparados dados clínicos antes e após a utilização da cânula nasal de alto fluxo. **Resultados:** Após a aplicação da terapia foi possível observar melhora gradativa da frequência cardíaca e respiratória, relação $\text{PaO}_2/\text{FiO}_2$ e do escore Pediatric Respiratory Assessment Measure. **Conclusão:** A utilização simples e rápida da cânula nasal de alto fluxo em pacientes pediátricos com asma pode ser segura e eficiente para melhora do quadro respiratório, diminuindo a necessidade de intubação.

Palavras-chave: Pediatria. Oxigenoterapia. Fisioterapia. Unidades de Terapia Intensiva Pediátrica. Asma.

Introduction

Asthma affects all age groups, with a higher prevalence in pediatric patients. It has a high morbidity and mortality worldwide. Episodes of an exacerbation of this disease in children occur with respiratory manifestations, such as respiratory distress, dyspnea, and cough in different degrees of intensity.¹

In children, a high-flow nasal cannula (HFNC) for the treatment of acute respiratory failure (ARF) can decrease the need for invasive mechanical ventilation. It can also reduce hospital stays.^{2,3} The combination of heating and humidification of the inspired gas under higher flows, with control of the inspired fraction of oxygen (FiO_2), increases the acceptance of the cannula in patients of all age groups.⁴ Its installation is simple, fast, and offers moist and heated oxygen, promoting better tolerability and comfort for children.²⁻⁴

Due to the COVID-19 pandemic, the use of CNAF has been widely discussed. It was initially believed that its high potential for aerosolization in the hospital environment could lead to a decrease in safety for health professionals engaged in patient care. Recently, however, its use has proven to be safe. It has a low risk of aerosolization when used with the guidance of teams that care for pediatric patients.² For the biosafety of the multiprofessional team, it is recommended that patients wear a surgical mask while using CNAF to avoid aerosol dispersion.^{2,5}

The present case report describes the use of CNAF in three pediatric asthmatic patients with ARF and suspected COVID-19.

Methods

Data were collected from the medical records. The three patients studied were admitted to the pediatric intensive care unit (PICU) of the Hospital de Clínicas Complex of Curitiba, PR, between July and August 2020.

The variables studied were: personal data (name, age in months, sex, weight, and color) and clinical (physical examination, PRAM score, respiratory rate, heart rate, and peripheral oxygen saturation), diagnosis, history of the current disease, chest radiography, and laboratory tests (arterial blood gas analysis and reverse-transcriptase polymerase chain reaction [PCR-RT]). The nutritional status of the patients was assessed at the time of admission using the Z-score (normal values for nutritional status between -2 and +2). In addition, ventilatory care parameters and medications used throughout the hospital stay were recorded.

The collected data were stored in an Excel Microsoft® spreadsheet for comparison and documentation of the results. The data were stored under the guardianship of the researchers for comparison at a later stage.

All patients had a confirmed asthma diagnosis and underwent a PCR-RT exam for COVID-19. A sample was collected from the nasopharynx at hospital admission and between the second and seventh day of the onset of respiratory symptoms.

Respiratory distress was assessed using the Pediatric Respiratory Assessment Measure (PRAM) score. This is a validated clinical tool that assesses the severity of respiratory effort in pediatric patients diagnosed with asthma. This score has a minimum level of 0 and a maximum level of 12 points. Scores from 1 to 3 indicate

mild discomfort, 4 to 7 indicate moderate discomfort, and 8 to 12 indicate severe discomfort. A change of \geq three points is indicative of a clinically significant change, either as an improvement or a worsening of the clinical picture. The score includes evaluation of signs of respiratory effort, air intake, and peripheral oxygen saturation (SpO_2).⁶

Bronchodilator therapy prescribed by the medical team and physiotherapeutic evaluation and care were performed twice a day. The objective was to clear the upper airways. The clinical decision of the medical and physiotherapeutic team to place a HFNC was based on the physical, laboratory results, and the PaO_2/FiO_2 ratio of the three patients.

Results

On admission the physical examination showed all three patients were tachypneic and had moderate to severe respiratory distress and significant psychomotor agitation, irritability, and upper airway obstruction due to a large amount of secretions. All patients used a low-flow oxygen nasal catheter. However, within 24 hours after hospitalization, clinical worsening was observed.

The three patients were transferred from the emergency care unit to the PICU with ARF and suspected COVID-19. Despite the clinical symptoms of COVID-19, the patients tested negative for COVID-19 on the PCR-RT exam. Patients 1 and 2 had a positive rhinovirus result on a virology test. The general characteristics of the patients are shown in Table 1.

On the day of admission, two of the patients (patients 1 and 3) had a score of 8. This indicated moderate respiratory effort. One of the patients had a score of 9 which indicated severe effort. During hospitalization, with the application of HFNC, the scores of all three patients gradually decreased. This indicated an improvement in their respiratory condition. At hospital discharge, patients 1 and 2 had a score of 3, indicating mild discomfort, and patient 3 showed no signs of discomfort. This assessment was according to their Z-scores (Figure 1).

On admission, the three patients presented with tachypnea when using low-flow oxygen therapy. From the time of the placement of the HFNC (D1), a decrease in respiratory rate was observed in patients 1 and 2. On the second day of hospitalization the gas flow was reduced, as an improvement in respiratory distress was observed (Figure 2).

Table 1 - Characteristics of patients

	Age (m)	Gender	Weight (kg)	Z Score	Color	Comorbidities
P1	22	F	10	-0,95	White	Asthma
P2	25	M	13	1,0	White	Asthma
P3	39	M	15	0,03	White	Asthma

Note: m = months; P = patient; F = female; M = male; Z = nutritional status. Source: data collected by the authors.

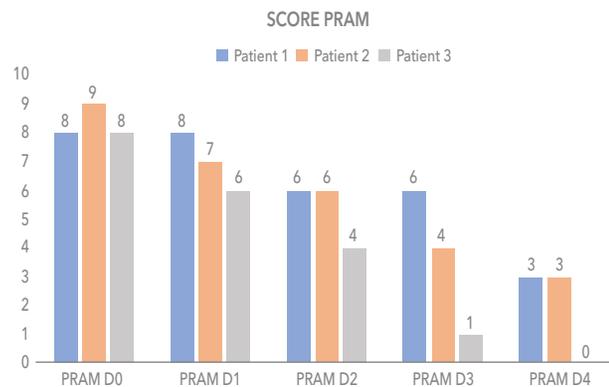


Figure 1 - Evaluation by the Pediatric Respiratory Assessment Measure (PRAM SCORE) from the day of admission until D4.

Note: D0 = first day of hospitalization; D1 = placement of the high-flow nasal cannula (HFNC); D2-4 = days using HFNC. Source: data collected by the authors.

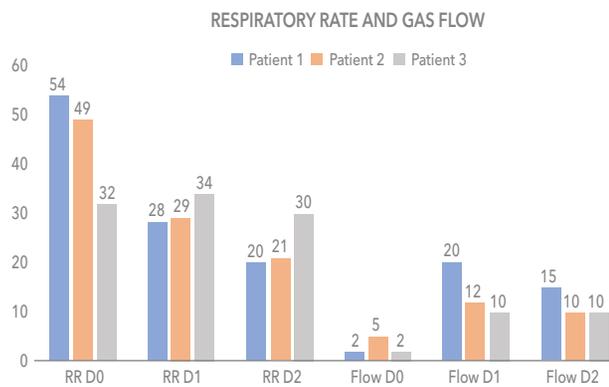


Figure 2 - Respiratory rate and gas flow.

Note: RR = respiratory rate; D0 = first day of hospitalization; D1-2 = D1-2 = days using high-flow nasal cannula (HFNC). Source: data collected by the authors.

Patients 1 and 2 had tachycardia on D0. However, all three patients showed a decrease in HR with the application of HFNC. All patients had HR values within the normal range at hospital discharge (Figure 3).

The supply of FiO_2 was higher on D1 due to the patient's requirements. FiO_2 was gradually reduced with the improvement in hypoxemia. Patient 1 required HFNC for four days, while patients 2 and 3 used HFNC for three days. This therapy proved to be effective in improving oxygenation and the clinical conditions of all three patients (Figure 4A). The PaO_2/FiO_2 ratio demonstrated hypoxemia between 172 and 250 at the initiation of therapy. From D2 on, the relationship gradually improved until all three patients were discharged from the hospital (Figure 4B).

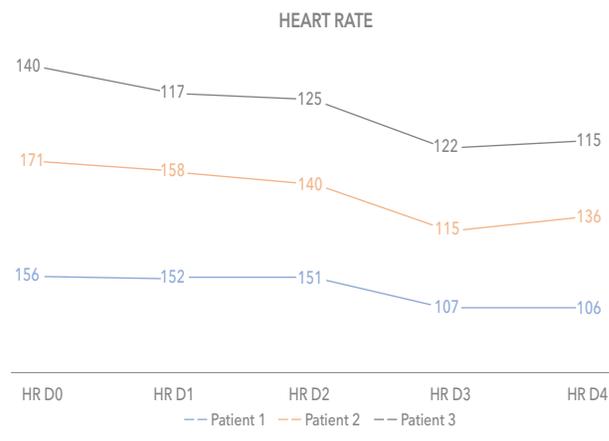


Figure 3 - Heart rate of the three patients evaluated.

Note: HR = Heart rate; D0 = first day of hospitalization; D1 = placement of the high-flow nasal cannula (HFNC); D2-4 = days using HFNC. Source: data collected by the authors.

Discussion

Three patients were admitted with suspected symptoms of COVID-19 (fever, moderate respiratory effort, and hypoxemia). This was in addition to asthma exacerbation, assessed using the PRAM score. The use of HFNC in patients diagnosed with COVID-19 at the beginning of the pandemic was contraindicated. It was believed that there would be a high risk of aerosol generation during its use. Thus, this would reduce the safety of the healthcare professionals who would provide

The HFNC weaning was conducted using a gradual decrease in the flow of gas as the patient presented a decrease in HR, RR, and an improvement in blood oxygenation. The termination of the HFNC therapy was performed when the FiO_2 was less than 40% and the flow of gas was less than 50% of the initial flow.⁷

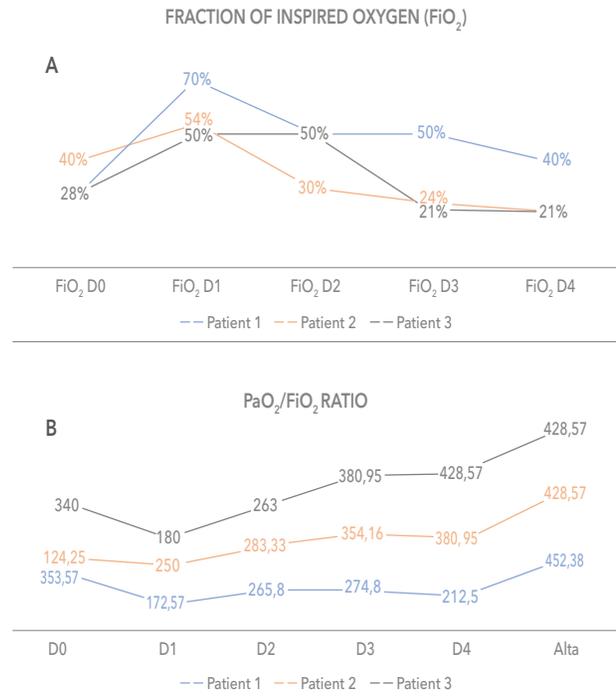


Figure 4 - Fraction of inspired oxygen (A) and PaO_2/FiO_2 ratio (B).

Note: PaO_2 = partial pressure of oxygen; FiO_2 = fraction of inspired oxygen; D0 = first day of hospitalization; D1 = placement of the high-flow nasal cannula (HFNC); D2-4 = days using HFNC. Source: data collected by the authors.

direct patient care. However, HFNC has been used to treat and improve the clinical conditions of patients with COVID-19. The risk of contamination was similar to that of other oxygen therapy devices. In addition, the use of a surgical mask under the interface can add another layer of protection for the healthcare team.⁸

The choice and administration of HFNC must be made with constant observation of the patient's vital signs and assessment of the patient's clinical condition. Studies have recommended constant monitoring of the patient's respiratory status. If their condition worsens,

tracheal intubation should be performed in a controlled environment.⁹

In North American studies, asthma is listed as a risk factor for severe COVID-19. In studies conducted in China among patients with the new coronavirus, asthma and respiratory allergies were not identified as risk factors for severe COVID-19.^{10,11}

The three patients in the present study showed RR and HR reduction during the use of HFNC. Geng et al.¹² evaluated the improvement of physiological variables (RR and HR) in patients with acute asthma using HFNC. Their research showed that during the use of this therapy, the evaluated variables gradually decreased until hospital discharge. Teng et al.¹³ compared the efficacy of HFNC with orotracheal intubation in children with COVID-19. The authors observed that the HR, RR, and PaO₂/FiO₂ ratio significantly improved 6, 24, and 72 h after the installation of HFNC when compared to orotracheal intubation.

In the present study, it was observed that the administration of a higher gas flow and FiO₂ during acute hypoxemic respiratory failure can lead to SpO₂, RR, and HR improvement. These findings are similar to those found by Pilar et al.¹⁴

The role of physiotherapy in these patients was not only in the management of ventilatory assistance, but also in the maintenance of airway permeability. In patients with acute hypoxemic respiratory failure, the presence of respiratory secretions may limit the application of certain techniques, such as noninvasive ventilation.¹⁵ The use of HFNC ensures greater comfort for these patients. In addition, this allows not only the ability to expel secretions without the need for interruption of the application, but also to assist in the excretion of secretions due to its humidification and heating system.^{4,16} Despite HFNC benefits, it must be administered carefully to avoid injury due to the excessive and prolonged use of oxygen therapy. In this study the use of HFNC resulted in a positive effect on the patients' treatment. Consequently, there was an improvement in the respiratory condition of the three pediatric patients.¹⁶

Conclusion

This study showed the safe use of HFNC in patients with acute hypoxemic respiratory failure with a potential risk for intubation. Considering the literature, this study contributes to the rationale for physical therapy

treatment in pediatric patients. It also provided benefits to the studied patients. To contribute to these results, it is suggested that further studies be conducted with a larger number of participants and additional methodologies.

Authors' contributions

VCN: conception and design of the study, data acquisition, data analysis and interpretation, article writing or critical review of relevant intellectual content, final approval of the version to be submitted. JOS: data acquisition, data analysis and interpretation, and article writing. AK: interpretation and critical review of relevant intellectual content, final approval of the version to be submitted. BSM: data acquisition and data analysis and interpretation. DCCS: interpretation and critical review of relevant intellectual content, final approval of the version to be submitted.

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