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Selected Topics: Prehospital Care

Logistical Challenge With Prehospital Use of High-Flow Nasal Oxygen Therapy in COVID-19-Induced Respiratory Distress: A Case Report

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□ **Abstract— *Background* Although commonly used inside hospitals, no previous case report has been published on high-flow nasal oxygen (HFNO) therapy in an adult in the prehospital setting. *Case Report* A 46-year-old nonsmoking man presented with a cough and fever. He deteriorated suddenly 5 days later. When the basic life support team arrived, his peripheral oxygen saturation (SpO_2) in ambient air was 56% and respiratory rate was 46 breaths/min. The man was weak with thoracoabdominal asynchrony. An emergency medical team with a physician was dispatched. As France was still under lockdown for the SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) pandemic, COVID-19 (coronavirus disease 2019) was suspected. In spite of 15 L/min of oxygen delivered with a nonrebreathing mask, the patient's SpO_2 tended to drop below 90% at the slightest effort and during transport from home to the ambulance. It was therefore decided to start HFNO therapy. The patient was transferred to an intensive care unit, where HFNO was continued. *Why Should an Emergency Physician Be Aware of This?* As the trend in emergency medical services may move toward prehospital HFNO, this case report is an opportunity to question the feasibility of HFNO therapy in the prehospital setting. © 2021 Elsevier Inc. All rights reserved.**

□ **Keywords—adult respiratory distress syndrome; COVID-19; high-flow nasal oxygen therapy; prehospital**

Introduction

High-flow nasal oxygen (HFNO) therapy is an oxygenation supplementation technique that is currently being evaluated in many clinical situations, including the management of acute hypoxemic respiratory failure (AHRF). A clinical review discussed respiratory support for adults with COVID-19 (coronavirus disease 2019). This review recommended HFNO therapy as the second-line therapy of choice when it was not possible to maintain oxygen saturation (SpO_2) above 90% or when patients had increased work of breathing (1). This was in accordance with unpublished hospital guidelines in the area of case onset from the end of March 2020. Since then, several articles on the use of HFNO in COVID-19 have been published (2,3).

Prehospital use of this technique represents a logistical challenge due to the amount of oxygen available and power supply. Our emergency medical service (EMS) was discussing the feasibility of HFNO therapy in the prehospital setting when the SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) pandemic occurred. In regard to feedback from physicians working in the intensive care unit (ICU), it was decided to place one HFNO therapy device in a logistic vehicle that can be called on scene any time of the day.

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Case Report

A 46-year-old nonsmoking man (body mass index 24 kg/m^2) with only a history of glaucoma treated with dorzolamide had weakness accompanied by cough and fever. His treating physician prescribed an anti-inflammatory (diclofenac) and analgesic treatment (acetaminophen, codeine) for lower back pain. The patient's respiratory condition deteriorated suddenly 5 days later. On arrival of the basic life support team equipped according to the recommendations of the World Health Organization in case of suspicion of COVID-19, the patient was slightly confused (Glasgow Coma Scale score 14) and had mild thoracoabdominal asynchrony. His peripheral SpO_2 was 56% in ambient air, and his respiratory rate (RR) was 46 breaths/min. His temperature was 36.7°C (98°F), blood pressure was 122/80 mm Hg, and pulse rate was 100 beats/min. An EMS team including an emergency physician experienced in prehospital medicine was dispatched to the scene, as well as the vehicle equipped with an HFNO therapy device. Under 15 L/min of oxygen delivered with a nonrebreathing mask, SpO_2 increased very slowly, reaching, at best and only for a few minutes, 95%. When the medical team arrived, the RR was still elevated at 40 breaths/min and the patient was still a bit confused. He was able to speak a few words at a time. Thoracoabdominal asynchrony was still present. Lung auscultation found bilateral dry crackles. Each time the patient tried to make the slightest effort (during his repositioning for instance), SpO_2 dropped below 85%, in spite of 15 L/min of oxygen, with the greatest difficulty thereafter in rising again above 90%.

Given the SARS-CoV-2 pandemic, the large number of patients with COVID-19 at the time of care in the region, and the relatively typical evolution of the disease, and in spite of the absence of fever (which may have been absent at the scene due to the prior intake of nonsteroidal anti-inflammatory or acetaminophen), the most likely diagnosis was COVID-19, although it was not possible, at this stage, to rule out a pulmonary infection from another cause. The absence of cardiac history, relatively young age, and nonsmoking habit were not in favor of pulmonary edema or acute exacerbation of chronic obstructive pulmonary disease. Exacerbation of asthma was unlikely, as the patient had no history of such disease. Patient's rapid worsening could have been a pulmonary embolism complicating an inflammatory state in a lung infection.

In spite of the patient's relatively precarious clinical condition, it was decided not to intubate him immediately. It seemed, however, that his oxygenation profile remained, even with oxygen therapy, intermediate with a tendency to improve slowly in the absence of mobilization, but to worsen rapidly with the slightest effort or added stressor. As the prehospital phase necessarily involves moving the patient and can be a major stressor, it was decided to start a session of HFNO while the patient was being transferred to the ICU (direct admission to an ICU from the field is a standard practice in France for the most serious cases). The available HFNO device (AIRVO^{TM} 2; Fisher & Paykel Healthcare, Auckland, New Zealand) was not dedicated to prehospital practice and operated only on main power (no internal battery). The patient was quickly transferred half-seated from the apartment to the resuscitation ambulance under 15 L/min of oxygen. In the meantime, the HFNO therapy kit was prepared and connected to a dedicated 15-L 200-bar oxygen cylinder (Figure 1). The HFNO device was powered via a plug in the ambulance. Once in the ambulance, as the patient's SpO_2 level was below 90%, HFNO was started with a 60 L/min flow rate. The fraction of oxygen in inspired air (FiO_2) was titrated to maintain $SpO_2 > 94\%$. A surgical mask was applied on top of high-flow nasal cannula and the window of the ambulance was opened to allow ventilation. The patient was transferred to the closest ICU and had a total of 18 min of HFNO therapy during the prehospital phase. Patient's SpO_2 rapidly increased to > 94% during transport, but this improvement in oxygenation was only partially associated with clinical improvement; he was still weak and unable to speak without pause, but his RR had decreased to 31 breaths/min. When the ambulance arrived at the hospital, as the HFNO device used did not run on battery power (it was powered via a plug in the ambulance), it was necessary to put the patient back on a nonrebreathing mask at 15 L/min of oxygen during the transfer on a wheeled stretcher to the ICU. As the patient was no longer receiving HFNO, SpO_2 dropped just below 90% for a few minutes when he

Figure 1. High-flow nasal oxygen therapy device being used in a resuscitation ambulance.

arrived in the ICU. Upon arrival at the ICU, HFNO therapy was reinstated; SpO_2 improved to > 90% in less than 10 min.

Discussion

Ten years after the first published use of HFNO in AHRF, this case report presents, for the first time, logistical challenges with the prehospital use of HFNO in an adult with COVID-19–induced respiratory distress (4).

The heating and humidification of gases seem to be particularly energy consuming. As the HFNO device used does not have internal batteries, its use is only possible where it can be plugged in. This raises the question of transfer phases (from the patient's home to the ambulance and from the ambulance to the definitive bed). As noted previously, the patient's saturation and dyspnea worsened during the transfer phase from the ambulance to the ICU. The explanation is probably multimodal, partly related to the need to put the patient back under a nonrebreathing mask at 15 L/min of oxygen instead of HFNO, but also related to the fact that the transfer phases can be long, uncomfortable, and can increase patients' respiratory work (this is even more true concerning the transfer phase between home and ambulance). We have tried to anticipate this problem by aiming for a high target of SpO_2 during ambulance transport in the hope that the patient would not desaturate to < 90% on arrival at the hospital during the transfer phase from the ambulance to the ICU bed, but we were not successful. Therefore, to overcome this problem in the future, we have decided to acquire an external and portable battery to power the HFNO device (lithium power cases; TECSUP, Annecy-le-Vieux, France).

Although HFNO therapy has been used in interhospital transport of critically ill children for several years, there is less constraint in terms of oxygen consumption in children than in adults. In the worst-case scenario, a 4.5-L (277-in^3) ME36 cylinder at 207 bar (3000 psi) can be emptied in < 16 min at 60 L/min and FiO_2 1. Therefore, it is necessary to have large-capacity cylinders in the ambulance permanently in case of prolonged field care and transport. In our EMS, there is currently only one HFNO device for six resuscitation ambulances. Therefore, it was decided to put the HFNO device in a logistics support vehicle, in which there are usually six 15-L 200-bar oxygen cylinders permanently. This organization overcomes the oxygen consumption problem but still requires good anticipation as soon as the call to the dispatch center is made and potential use of HFNO identified in order not to lose time during the prehospital care phase. To simplify this organization, one HFNO device and increased oxygen capacity could be available in every EMS ambulance.

In the context of the SARS-CoV-2 pandemic, one concern has been the risk of spreading the virus and contaminating health care workers. The risk of aerosolization with HFNO appeared to be only slightly higher than with a nonrebreather mask and much lower than with Venturi devices or noninvasive ventilation (5). Caregivers must wear personal protective equipment (including gown, gloves, FFP2/FFP3 masks, and goggles). As air volume in the ambulance is limited, the ambulance window can be opened to facilitate ventilation. As mentioned in the case report, a surgical mask was placed on the face of the patient, on top of the cannula. Since this case occurred, several studies have shown that this strategy can reduce the risk of aerosolization (6,7). An additional mask on top of the cannula even seems to improve the oxygenation of the patient without any clinically significant adverse effect (8).

HFNO could also be of interest for pre-apneic oxygenation during orotracheal intubation, or for some patients with "do-not-intubate" orders when orotracheal intubation seems too aggressive.

This case report describes the first prehospital use of HFNO therapy on an adult with AHRF. It allows the discussion of strategies to manage the risk of aerosolization in patients with COVID-19 treated with HFNO in an ambulance. It proposes solutions, such as the use of external batteries to power the HFNO device, to apprehend logistical challenges.

Why Should an Emergency Physician Be Award of This?

As the trend in EMS may move toward prehospital HFNO, this case report is an opportunity to question the feasibility of HFNO therapy in the prehospital setting.

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