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Use of high-flow nasal cannula in out-of-hospital setting

To the Editor,

Oxygen therapy via High-flow nasal cannula (HFNC) has been a major advance in the treatment of patients with hypoxemic lung disease for some years [1-3]. The current SARS-CoV-2 pandemic has resulted in an increased number of rapidly deteriorating critical patients in hospitals, and some of these patients have had to be transferred to higher acuity care facilities. However, until now, the apparent complexity of using HFNC has limited its use to in-hospital settings and prevented its routine use in out of hospital environments. In order to ensure safe inter-hospital transports while keeping initiated treatment, we tested HFNC in Advanced Life Support (ALS) ambulances. During the first months of 2021, 30 patients on HFNC were transported within a range of 30 miles. During transport, no adverse events were reported. To our knowledge, no HFNC use in out-of-hospital settings has been reported in the literature. The aim of this letter is to update the medical community on out-of-hospital HFNC feasibility and to provide solutions to overcome existing technical constraints.

HFNC allows the non-invasive administration of an Air/Oxygen (O_2) mixture with an adjustable FiO_2 via nasal cannula, in a continuous high-flow. It has therefore a number of technical constraints such as oxygen quantity and other equipment needed to warm and humidify the inspired gases. Additional constraints include the lack of electrical autonomy and the need for anchoring all equipment aboard an ALS. Finally, with regards to COVID patients, there is the issue of SARS-CoV-2 aerosolization in the confined space of an ALS, about 15 m^3.

Several studies have shown that HFNC does not increase the risk of contamination of health workers compared to other non-invasive respiratory support techniques [4-7]. During our trial period, the ALS air extraction system was systematically turned on and the ambulance staff wore full Personal Protective Equipment, whatever the respiratory support technique was.

The Fisher & Paykel MR 850® humidifier-heater was selected due to its ease of use, compatibility with available respirators (Air Liquide Medical System Monnal T60®), ability to maintain a constant gas flow even in case of power shortage, moderate device and consumables costs, and ease of cleaning and disinfection. Its main shortcoming was the lack of an internal battery. A one-hour training session was given to all ALS ambulances health care workers, providing detailed technical procedures involved with using HFNC and its indications and contra-indications.

O_2 flow rate was up to 60 L/min with FiO_2 values of up to 1. It led to higher oxygen consumption compared to more conventional ventilation modes. Average patient transportation time was 80 min in our setting. Thus, critical care patients requiring 60 L/min oxygen with an FiO2 of 1 would need a total of 4,800 L of O_2. The ALS autonomy of 8,000 L of O_2 largely met the needs of such a demand.

One special consideration in the use of HFNC in our ALS was the evaluation of the explosion risk due to possible accumulation of oxygen within the ambulance space. The threshold is typically known to be around 24% O_2 [8]. In theory, after 60 min without ventilation, O_2 concentrations inside the ALS should reach 36% if O_2 with an FiO_2 of 1 was delivered at a flow rate of 60 L/min in a 15 m^3 volume.

Each ambulance was equipped with a ventilation system including an air extractor that ensured the renewal of 20 volumes of air per hour. However, effective air renewal (ventilation system, leaks and "natural" aeration, etc.) was difficult to model theoretically; therefore 5 tests were carried out under real conditions in an ALS ambulance. For each test, the ambulance was initially aerated with room air to allow oxygen concentration to reach 21%. Doors and windows were then closed, and 60 L/min of oxygen was delivered under the monitoring of an oxygen detector (BW Clip O2 real time detector®). Two cases were experimented: In case 1, the ALS air extractor system remained turned off. In case 2, the ALS air extractor system was turned on. In case 1, the alarm threshold set at 23.5% was reached on average in 5:11 (SD: 0:49). In case 2, it never reached the alarm threshold and remained stable at 22.5% after 40 min of O_2 release. These findings showed the strong need of transporting patients under HFNC with the air extractor turned on and under the constant monitoring of an O_2 detector.

As HFNC is becoming a standard in the treatment of severe hypoxemic patients, it should also be used in out-of-hospital settings, especially during transport of patients already on HFNC. A thorough process made it possible to overcome existing constraints and to safely allow the transportation of 30 patients. Further studies will be needed to show benefits of HFNC transports compared to other respiratory support techniques.

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