Improving Helmet CPAP Use During COVID-19 Pandemic

A Multidisciplinary Approach in the Emergency Department

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The aim of this article is to describe the importance of a multidisciplinary team dedicated to noninvasive ventilation training of the emergency department's staff. In our experience, the presence of a medical and nursing "noninvasive ventilation group" made it possible to quickly teach expertise on the management of noninvasive ventilation of COVID-19 patients among emergency department doctors and nurses. This allowed improving a standardized approach regarding the identification and ventilatory assistance of patients with SARS-CoV-2 pneumonia needing ventilatory support, the correct use of the devices, and quick identification and reduction of the complications associated with noninvasive ventilation.

In this article, we would like to encourage the formation of similar working groups in all situations where this is not yet present.

Keywords: Continuous positive airway pressure, COVID-19, Emergency department, Noninvasive ventilation, Nursing, Respiratory insufficiency

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PEER EDUCATION

In our emergency department (ED), there are many self-training multidisciplinary groups (eg, noninvasive ventilation, triage, trauma, emergency plan for massive casualties, vascular access), made up of both nurses and physicians. Among these, the "noninvasive ventilation group" (NG) is involved in updating and training medical and nursing staff through peer education meetings on noninvasive ventilation (NIV) to constantly provide a refresher on its use, setup, and clinical indications.

All members of the NG are experts in managing patients undergoing NIV. Because of the lack of recommendations for patients with respiratory failure due to COVID-19–related pneumonia, the NG developed a flowchart to standardize the approach in the ED (Figure 1).[1] Because of the large wave of patients presenting to the ED and requiring ventilatory support, it was necessary to train the largest number of emergency physicians and nurses as quickly as possible to spread the flowchart application and the use of the devices available.[2] Theoretical and practical peer educational meetings were organized to show how to fully manage patients during continuous positive airway pressure delivered through helmet (H-CPAP), previously not used in our hospital. Tutorials were filmed to show how to place the helmet, how to use different air flow generators, and how to use different fixing systems. Training on-the-job by expert nurses was implemented, organizing shifts to always guarantee the

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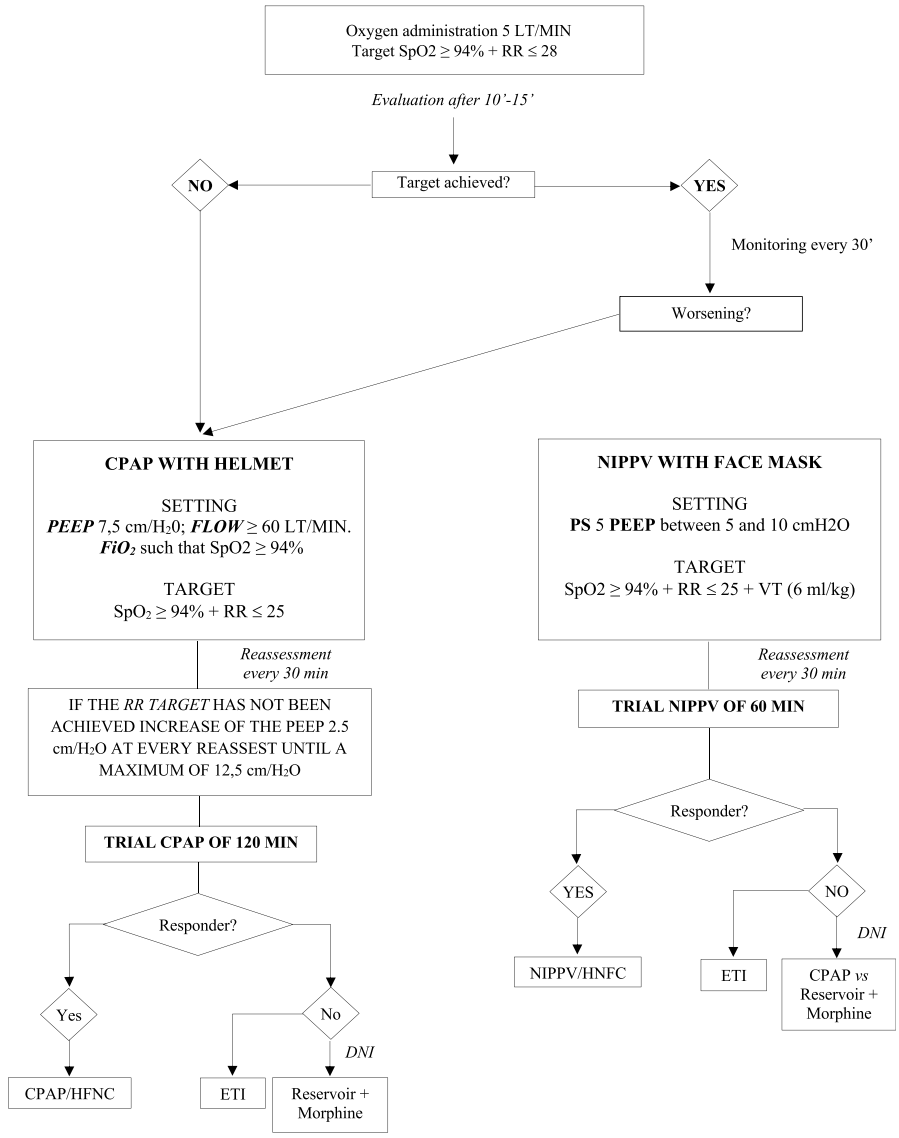

Figure 1. Local protocol for helmet CPAP trial. Abbreviations: CPAP, continuous positive airway pressure; PEEP, positive end-expiratory pressure; FiO_2, fraction of inspired oxygen; RR, respiratory rate; SpO_2, peripheral oxygen saturation; ETI, endotracheal intubation; DNI, do-not-intubate; HFNC, high flow nasal cannula. A full downloadable version of this image is available (see Supplemental Digital Content 1, http://links.lww.com/DCCN/A116) .

presence of an experienced nurse to support less experienced colleagues.

TRIAGE AND COVID AREA

In the last months, during the COVID-19 pandemic outbreak, EDs had to face a high number of patients seeking medical assistance. Organizing a path from triage identification to medical management of COVID-19 patients was a challenge for all the EDs.

The aim was both to avoid intrahospital viral spreading and to early identify COVID-19 patients requiring immediate O_2 therapy or ventilatory support. Our ED was therefore divided into 2 sections: a non-COVID area and a COVID one. A careful, methodological, and constantly updated triage was a key element to identifying patients at risk of COVID-19 infection and reducing the risk of wrong assignments to the 2 areas.

During the triage phase, 2 types of criteria were evaluated:

- Epidemiological criteria:

-close contact with a COVID-19 patient in the past 10 days;
-known recent positive swab

- Clinical criteria:

patient's complaining at arrival or in the previous 10 days of at least one of the following symptoms:

-fever without a specific organ recall;
-cough, rhinitis, sore throat even with or without fever;
-respiratory failure (SpO_2 < 95% or respiratory rate (RR) > 25);
-anosmia or dysgeusia.

Patients with at least one of these epidemiological or clinical criteria were assigned to the COVID-19 area. After the priority code was assigned, patients underwent nurses and emergency physician's evaluation. The number of nurses in the COVID area varied according to the workload. Shifts were organized to have at least 1 adequately NIV-trained nurse as a reference for less experienced colleagues in case a patient needed noninvasive ventilatory support.

STANDARDIZED PATIENT TREATMENT: CPAP TRIAL FLOWCHART

At ED arrival, supplemental oxygen administration was soon started when needed.

If the patient had an altered mental status (Kelly score ≥ 3),[3] unstable hemodynamics, and/or a state of shock or altered/ineffective respiratory mechanics, immediate endotracheal intubation was evaluated as soon as possible. For patients without immediate endotracheal intubation indication, we designed a step-by-step flowchart to standardize the first ventilatory approach. According to the local protocol, if the patient had a SpO_2 less than 94% and/or respiratory rate greater than 28, the first step was to perform an initial arterial blood gas and, at the same time, to administer 5 L/min of supplementary oxygen through nasal goggles or a simple facial mask, keeping, in any case, the surgical mask on the patient's face. Binks et al[4] suggested that the patients can wear the oxygen mask over the top of a surgical mask without compromising their fraction of inspired oxygen (FiO_2). It has been shown that wearing a mask reduces coronavirus detection in droplet and aerosol samples of symptomatic patients.[5] In case of failure to increase the SpO_2 and to reduce the RR after 15 minutes, the nursing staff, in agreement with the physician in charge, automatically started CPAP, according to the subsequent step of the flow chart. Delivered through high-flow generators, H-CPAP was begun as first choice. Noninvasive pressure support ventilation was alternatively reserved for patients with hypercapnic respiratory failure and for those at risk of muscular exhaustion (eg, history of chronic obstructive pulmonary disease and neuromuscular disease).

Two different types of high flow generators were used: compressed air/O_2 flow meters or Venturi systems. Both are able to guarantee at least a 60 L/min flow,[6] which is considered the minimum flow required to perform CPAP in patients with hypoxemic respiratory failure. These high gas flows are required for 2 main reasons: first, to exceed the patient's peak inspiratory flow, ensuring a stable continuous positive airway pressure throughout the entire respiratory cycle; second, to avoid carbon dioxide (CO_2) rebreathing.[7] Two filters were usually placed along the helmet circuit: a heat and moisture exchanger filter at the air flow inlet to reduce the noise and improve the patient comfort[8] and a second electrostatic filter at the air flow outlet to filter the patient's breath and reduce external environment contamination.[9]

We used mainly mechanical positive end-expiratory pressure (PEEP) valves, both fixed and adjustable. We preferred adjustable valves to better titrate the PEEP inside the helmet. Because of PEEP increase due to the electrostatic filter on the out-flow, we recommend checking the PEEP value inside the helmet using the manometer attached to it.

Fraction of inspired oxygen was set to reach a SpO_2 greater than or equal to 94%. Evidence showed that a liberal oxygen strategy is associated with an increased risk of hospital mortality in acutely ill patients.[10] Positive end-expiratory pressure was initially set at 7.5 cm/H_2O and then titrated to a maximum of 12.5 cm/H_2O. Axillary bands were used as a fixing system in the beginning because they are simple and quick to use in the ED setting, whereas counterweights were applied at a later time.[11,12] The CPAP trial lasted 2 hours, during which nurses monitored vital signs every 30 minutes, modifying PEEP and FiO_2 according to SpO_2 or RR variations.[13] This guarantees a constant evaluation of the clinical picture of the patients, allowing the possibility to intervene if they get worse, avoiding the delay in intubation. If a SpO2 greater than or equal to 94% and a RR less than 25 bpm were reached at the end of the trial, H-CPAP was continued. Once the trial was over, the patient was transferred to the short-stay observation room awaiting admission to the ward if not immediately available. In this area of the ED with 8 monitored beds, 1 or 2 trained nurses continued regular monitoring of vital signs, alternating H-CPAP with high-flow nasal cannula (HFNC).[1] During patient transfers, H-CPAP treatment was not stopped but was continued using a Venturi flow generator compatible with oxygen cylinders (Figure 2). This kind of Venturi system flow generator can only be used with oxygen flow meters capable of delivering appropriate flows at the desired therapy settings. The oxygen cylinder must be adjusted to a pressure approximately between 3 and 3.5 bar, adequate for the correct functioning of the flow generators. Duprez et al[14] demonstrated that oxygen flow delivered by oxygen gas cylinders is accurate. The nursing staff should calculate the autonomy of the oxygen cylinder, dividing the remaining oxygen volume by the administered flow rate before its use.

When using oxygen cylinder with digital autonomy display, the minutes of oxygen remaining (min) are equal to liters of oxygen remaining in the tank (L) per oxygen flow delivered (L/min). When the oxygen cylinder does not have a digital autonomy display but only a manometer gauge,

Figure 2. Venturi flow generator devices for patient transport compatible with oxygen cylinders. A full downloadable colored version of this image is available (see Supplemental Digital Content 2, http://links.lww.com/DCCN/A117) .

then the remaining gas volume can be estimated by applying Mariotte's law, with the formula:

$$V = P \times n$$

V is the residual gas volume, P is the pressure in bars indicated by the manometer, and n is the water volume of the cylinder under air pressure.

In conclusion, we wanted to underline the importance of continuous peer training for ED's nursing and medical staff to manage patients undergoing NIV. Dedicated theoretical and practical training courses are essential to spread this skill and ensure the highest quality of care to a high number of patients. A standardized approach is useful when treating a large number of patients, and the presence of an expert nurse is important to guarantee support to health care personnel when NIV is provided.

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