Rethinking aerosol-generating procedures in COVID-19

Reconsidérer les procédures aérosolisantes au cours de la prise en charge de la COVID-19

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RÉSUMÉ

Objectif: La gestion de la pandémie de COVID-19 a soulevé plusieurs problèmes concernant les procédures aérosolisantes telles que l'oxygène à haut débit et la ventilation non invasive (VNI). La prise en charge adéquate des patients atteints de pneumonie COVID-19, tout en assurant la sécurité des soignants, est de la plus haute importance. Des recommandations concernant les procédures aérosolisantes sont certainement nécessaires pour guider les attitudes thérapeutiques dans ce contexte. Cependant, une peur excessive de la contamination pourrait interférer avec la prise en charge des patients.

Le présent article discute de la place des procédures aérosolisantes dans la gestion de la COVID-19 et si la seule peur de l'aérosolisation justifie l'éviction de ces méthodes.

Mot clés : COVID-19, aérosolisation, oxygène à haut-débit, ventilation non invasive.

SUMMARY

Objective: Dealing with COVID-19 pandemic raised several issues regarding aerosol generating procedures such High Flow Nasal Cannula (HFNC) and Non Invasive Ventilation (NIV). Adequately managing patients with COVID-19 pneumonia, while, ensuring caregivers' safety is of utmost importance. Recommendations regarding aerosol generating procedures are, certainly, required to guide therapeutic attitudes in this context. However, excessive fear of contamination could interfere with patients' management.

The present paper discusses the place of aerosol generating procedures such as HFNC and NIV in the management of COVID-19 and does fear of aerosolization, solely, justifies the avoidance of these methods.

Keywords : COVID-19, aerosolization, High Flow Nasal Cannula, Non Invasive Ventilation.

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BACKGROUND

Managing COVID-19 pneumonia raised a plethora of interrogations and challenges. Uncertainty surrounded the mechanisms of virus transmission and the risk of contamination incurred by exposed healthcare professionals. To prevent contamination, experts, initially, recommended to avoid procedures increasing risk of aerosolization such as High Flow Nasal Cannula (HFNC), Non-Invasive Ventilation (NIV), nebulizations and airway management in the absence of videolaryngoscope (1,2).

COVID-19 was considered as an Acute Respiratory Distress Syndrome (ARDS) requiring invasive mechanical ventilation (IMV) and protective ventilation, in addition to prone positioning and Extracorporeal Membrane Oxygenation (ECMO) when necessary (3). The benefit of NIV in hypoxemic acute respiratory failure especially ARDS is largely debated, yet not recommended (4). From this perspective, early reports of COVID-19 tended to prioritize IMV (1,5).

In this paper we want to discuss the place of aerosol generating procedures such as HFNC and NIV in the management of COVID-19 and does fear of aerosolization, solely, justifies the avoidance of these methods.

COVID-19 PNEUMONIA

Experts came to the conclusion that COVID-19 is not a typical ARDS. Discrepancies in clinical presentation were observed (6). From the Farhat Hached Intensive Care Unit (ICU) experience, these patients related a progressive dyspnea that was tolerated for several days before consultation, associated to polypnea > 30c/min with no evident struggle signs. A, seemingly, low work of breathing that contrasts with profound hypoxemia and extensive radiological images. Many suggested the concept of “happy hypoxemic” where lung compliance and resistance were reasonably normal, generating low expenditure of energy (7). Hypoxemia was tolerated leading to late consultation and exposed to misdiagnosis in terms of severity.

Gattinoni identified two phenotypes of COVID-19 pneumonia; L and H. Phenotype L is characterized by normal compliance, low ventilation-to-perfusion ratio, low lung weight with only ground glass densities on CT-Scan and low lung recruitability. Phenotype H presents low compliance, high right-to-left shunt, high lung weight with mostly severe ARDS and high lung recruitability. These phenotypes conditioned ventilatory strategies. Phenotype H, treated as ARDS, required low Vt at 6ml/kg, high PEEP, prone positioning and extracorporeal support. Phenotype L could be ventilated with higher Vt at 8ml/kg, lower PEEP as the normal compliance results in a low risk of VILI (8).

VENTILATORY STRATEGY

In the critical care setting, resorting to invasive mechanical ventilation, surely requires a careful clinical judgment of risk-benefit balance. In the context of COVID-19 pandemic, the initial incertitude regarding the comprehension of the disease led experts to excessively indicate rapid IMV and treating COVID-19 pneumonia as ARDS. However, once pathophysiological mechanisms were partially clarified, enquiries revolved around the eventual benefit of IMV in some patients, mainly phenotype L. Some patients would likely profit from HFNC or NIV as they reduce work of breathing while preventing complications related to IMV, such as Ventilator-Induced Lung Injury (VILI) and deleterious heart-lung interactions. Cheung *et al.* showed that NIV use prevented intubation in 14 (70%) patients with ARDS (9). The challenge is to, adequately, indicate the right ventilatory assistance to the right patient at the right time, taking into account patient’s physiological characteristics.

The Intensive Care Unit of Farhat Hached University Hospital admitted ten RT-PCR confirmed COVID-19 patients. Initially, four patients were rapidly invasively ventilated in front of low P/F ratio <150mmHg even though they seemed to tolerate their hypoxemia. All patients passed away, approximately, after two weeks of evolution. They, barely, responded to recruitment maneuvers and prone positioning. The apparent poor prognosis, once patients were invasively ventilated, led to favor HFNC and NIV when possible. Figure 1 displays clinical outcomes of four patients presenting with moderate to severe acute respiratory failure that received noninvasive ventilatory procedures in contrast to the remaining six patients. Only one patient failed and was invasively ventilated. Prone positioning was successfully performed in two conscious patients while under HFNC.

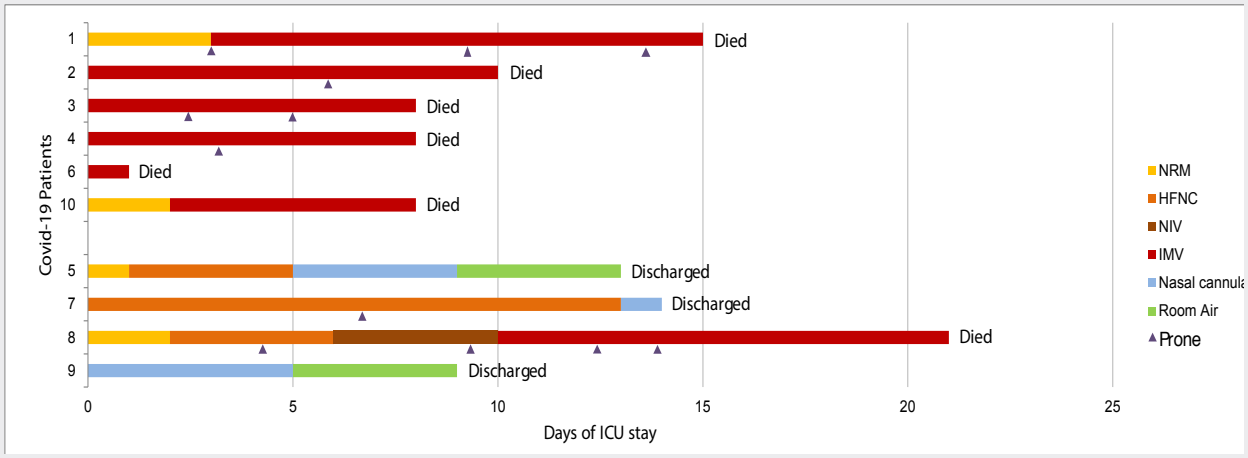

Figure 1. Non-invasive ventilatory strategies and outcomes in four (patients, 5, 7, 8 and 9) out of the 10 managed critically ill COVID-19 patients.

NRM, Non-Rebreathing Mask; HFNC, Heated Humidified High Flow Nasal Cannula; NIV, Noninvasive Ventilation; IMV, Invasive Mechanical Ventilation; Prone, Prone positioning.

NIV AND AEROSOLIZATION

At the start of the pandemic, enigma surrounded the disease, especially, the subtlety surrounding the rapid transmission of the virus. Experts were concerned regarding the high possibility of contamination when exposed to certain procedures that generate aerosols. These doubts led to categorize HFNC and NIV as procedures at high risk of contamination. The initial opinions of experts recommended avoiding such procedures (1,2).

A shift in perceptions was needed. In these circumstances, to ensure healthcare workers protection, one key element is the adequate wear of Personal Protective Equipment (PPE) (5). Concentration and mental preparation help avoid manipulation errors. On a second level, some ingenious ideas help minimize contamination, namely, the use of (1,5):

- A surgical mask over a nasal cannula.
- A Non-Rebreathing Mask over HFNC.
- Antibacterial filters placed at the outlets of a dual limbs ventilator.
- A Heat-Moisture Exchanger (HME) placed between exhalation port and mask on single limb ventilator or on Y piece on dual limb ventilator
- A Heat-Moisture Exchanger (HME) on impedance valve (Boussignac)
- Precautions when initiating NIV sessions: the ventilator is activated once connected to the mask already secured on the patient, and disconnected after the ventilator is put on standby mode.
- An easy breath decathlon full-face mask adjusted to be compatible with NIV but also suitable for healthcare professionals as a protective mask/ shield by adding a filter.
- When IMV is needed, rapid sequence induction helps minimize aerosolization, in addition to immediate balloon inflation before initiating ventilation.

These simple methods were adopted in the ICU of Farhat Hached University Hospital, since the start of the epidemic. No medical or paramedical staff was affected by SARS Cov-2.

AIRWAY MANAGEMENT

Fear of contamination not only impeded adequate ventilatory assistance but also hindered timely airway management, as it is considered as one of the most exposing procedure to aerosol contamination. Experts debated prioritizing videolaryngoscope use without being mandatory (1). However, many misinterpreted experts' opinion to be binding thus, sometimes, delaying IMV for lack of videolaryngoscope.

BETA2-AGONISTS NEBULIZATIONS

Through a COVID-19 influenced perspective, other common causes of acute respiratory failure were eclipsed such as acute exacerbation of asthma where simple therapeutics such as beta2-agonists nebulizations could drastically change patients' clinical outcomes. Many seemed to improperly approach nebulizations as aerosol-generating procedure, although no significant evidence supports this supposition (10).

CONCLUSIONS

Being aware of contamination risks is necessary in the context of a pandemic, to avoid rapid virus transmission. However, this should not interfere with rational thinking when managing patients. Healthcare professionals must invest in proper use of PPE, elaborate alternatives to ensure protection while using eventual procedures that might generate aerosols but could be lifesaving.

Competing interests

The authors declare no competing interest.

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