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ROLE OF ELECTRICALLY DRIVEN CPAP MACHINE WITH OXYGEN ENRICHMENT FOR OXYGEN CONSERVATION IN COVID ICU

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ABSTRACT

INTRODUCTION: Acute respiratory distress syndrome (ARDS) is a major complication of COVID-19 that occurs in 20-41% of patients with severe disease. (7) SARS-CoV-2 patients present with a wide spectrum of clinical severity, ranging from asymptomatic to pneumonia to ARDS-like phenotypes. (8,9) During the early months of the COVID-19 pandemic unprecedented numbers of patients presented to hospitals with acute respiratory failure. With intensive care services at risk of being overwhelmed, strategies were soussght to reduce invasive mechanical ventilation (IMV). Whilst not previously a standard treatment for viral pneumonitis, early anecdotal accounts and preliminary data highlighted the use of continuous positive airway pressure (CPAP) in COVID-19. (7,10) Subsequently it gained traction as an intervention that could be delivered outside of the intensive therapy unit (ITU) and high-dependency unit (HDU) along with conservation of oxygen. Oxygen conservation posed a huge challenge in COVID ICU's. HFNO being the major cause of oxygen consumption. Electrically driven CPAP machines

- Use air to maintain Continuous positive airway pressure.
- Decrease atelectasis.
- Increase surface area of alveolus.
- Improves V/Q matching.

Thus, improving oxygenation and saving Oxygen with the use of electrically driven CPAP with oxygen supplement. CPAP has mostly been studied in relation to OSA and a lot is yet to be explored regarding its potential in COVID ICU's.

OBJECTIVES:

I. To note the change in Spo2
II. To note if CPAP delivery system can reduce oxygen consumption as to HFNO
III. To note if treatment is well tolerated
IV. To note if use of CPAP can avoid/delay the use of HFNO/NIV

METHOD: Patient's vitals were noted before shifting to electrically driven CPAP machine and monitored throughout. Properly fitted vented Bi-pap mask was attached with the electrically driven CPAP machine and the oxygen was supplemented with the help of tubing connecting the Bi-pap mask vent to the flow-meter. The flow of oxygen was titrated according to patients requirements ranging from 8-12 liters/min.The pressure was set as per patients need and titrated as per the condition of the patient. During meal times the patients were shifted to HFNO.

RESULT: Out of the total 30 patients in our study, 25 patients were successfully treated with the Electrically driven CPAP machine with O2 enrichment and did not require stepping up to further modalities of oxygen therapy. Around 1700 - 1900 L/hr of oxygen was being used by HFNO whereas only 600 - 720 L/hr of oxygen was used by use of CPAP which helped us to save about 29-80% of oxygen by the use of CPAP machine.

CONCLUSION: From our limited study we can only conclude that the CPAP when used with Oxygen enrichment in COVID ICU's can help in conservation of Oxygen by improving the respiratory mechanics of the COVID affected lung, which becomes an essential aim in a pandemic to serve maximum patients with limited resources.
KEYWORDS: CPAP, HFNO, Covid ICU, Oxygen Conservation

INTRODUCTION:

Corona virus disease 2019 (COVID-19), the very contagious viral illness caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2), resulting in more than 6 million deaths worldwide as of March 2022. The pathogenesis of SARS-CoV-2 induced pneumonia has two stages, an early and a late stage. In the early stage, there is viral replication resulting in direct virus-mediated tissue damage, which is followed by a late stage when the infected host cells trigger an immune response with the recruitment of T lymphocytes, monocytes, and neutrophil recruitment which releases cytokines such as tumor necrosis factor-α (TNF α), granulocyte - macrophage colony - stimulating factor (GM-CSF), interleukin-1 (IL-1), interleukin-6 (IL-6), IL-1β, IL-8, IL-12 and interferon (IFN)-γ. In severe COVID-19, the immune system's overactivation results in a 'cytokine storm', causing a local and systemic inflammatory response. There is increased vascular permeability and subsequent development of pulmonary edema in patients with severe COVID-19. Also, the patients are at a greater risk of silent hypoxia due to lack of dyspnea even with low oxygen saturation level. Several reports revealed that the prevalence of silent hypoxia in COVID-19 patients ranges from 20 to 40%. [11] Pneumonia is a major cause of silent hypoxia in COVID-19 patients. Instead of filling alveoli with pus and fluid, the SARS-CoV-2 induced pneumonia causes alveoli to collapse (also referred to as "atelectasis"), which results in low oxygen supply in the body. The alveoli collapse in covid 19 patients can be explained by a sequence of events initiated by alveolar epithelial cell damage to surfactant dysfunction and alveolar instability, all of which leads to micro-atelectasis. These collapsed alveoli and air sacs are sealed by proliferating alveolar epithelial cells, which results in the formation of thickened septa and subsequent loss of alveolar function. As the pulmonary system adapts for efficient oxygen transfer between pulmonary blood flow and alveolar ventilation even in differential oxygen pressure in different lung regions, COVID-19 associated silent hypoxia patients do not notice any vital signs of collapsed alveoli. [12]

With millions of people being affected by Covid 19, the main challenge was how to manage space in hospitals and increase the capacity of intensive care units to parallel the increasing need. Previous studies have shown better outcomes in patients who were treated with HFNO (high-flow nasal oxygen therapy) than ordinary oxygen treatment. HFNO is a technique whereby heated and humidified oxygen is delivered to the nose by using small nasal prongs. HFNC (high-flow nasal cannula) generates positive pressure in the upper airways, increasing the minute ventilation and decreasing physiological dead space by flushing expired carbon dioxide from the upper airway, which potentially decrease the work of breathing and enhance oxygenation in patients with ARDS, when compared to traditional oxygen therapy. However, HFNO used a huge amount of oxygen which was not very rational in view of ongoing shortage of oxygen in the ICU. Oxygen conservation posed a huge challenge in COVID ICU's. HFNO being the major cause of oxygen consumption as conventional ventilators use large amounts of oxygen and air to generate pressures in a patient's airway.

Electrically driven CPAP machines uses air to maintain Continuous positive airway pressure, decrease atelectasis, increase surface area of alveoli and improves V/Q matching. Thus improving oxygenation and saving Oxygen used with the use of electrically driven CPAP

with oxygen supplement. CPAP has mostly been studied in relation to OSA and a lot of its potential is yet to be explored in COVID ICU's.

Objectives of the study

I. To note the change in spo2
II. To note if CPAP delivery system can reduce oxygen consumption as to HFNO
III. To note if treatment is well tolerated
IV. To note if use of CPAP can avoid/delay the use of HFNO/NIV

METHOD:

Patient selection:

30 Patients with antigen confirmed COVID-19 disease admitted in COVID ICU requiring HFNO were selected, informed consent was obtained about the procedure and proper counselling was done.

Patient's vitals were noted before shifting to electrically driven CPAP machine and monitored throughout. Properly fitted vented Bi-pap mask was attached with the electrically driven CPAP machine and the oxygen was supplemented with the help of tubing connecting the Bi-pap mask vent to the flow-meter. The flow of oxygen was titrated according to patients requirements ranging from 8-12 liters/min.The pressure was set as per patients need and titrated as per the condition of the patient. During meal times the patients were shifted to HFNO.

The Patients who were

1. Desaturating on maximum CPAP support
2. Non compliant
3. Drowsy
4. Having severe nausea or vomiting
5. Having disease progression
6. Feeling of claustrophobia
7. Fatigue of respiratory muscles

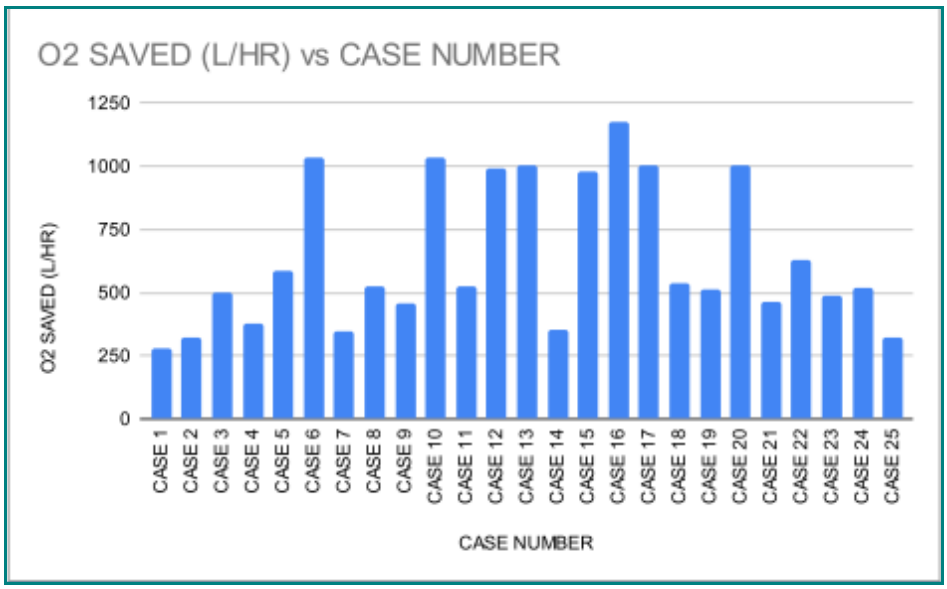
were shifted to other modes of oxygen therapy.

The Arterial Blood Gas Analysis (ABGA) was done with patient's consent as and when required. For the rest of the time pulse, respiratory rate, SPO2 were continuously monitored. Gradual titration of oxygen flow and the continuous positive airway pressure was done to achieve a stable oxygen saturation of 92-95% and Respiratory rate of 18-20/min with an aim to conserve maximum amount of oxygen.

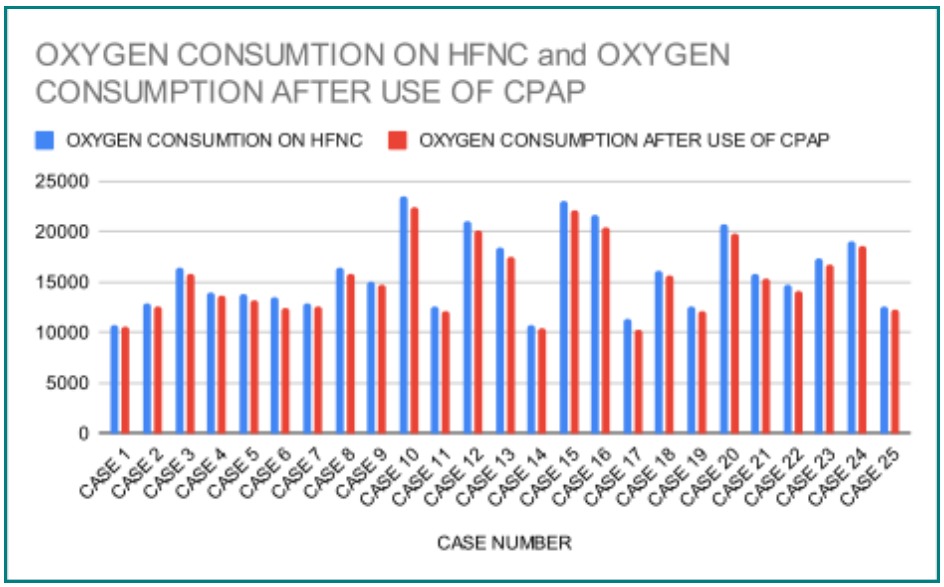
RESULT:

Out of the total 30 patients in our study, 25 patients were successfully treated with the Electrically driven CPAP machine with O2 enrichment and did not require stepping up to further modalities of oxygen therapy.

Around 1700 - 1900 L/hr of oxygen was being used by HFNO whereas only 600 - 720 L/hr of oxygen was used by use of CPAP which helped us to save about 29-80% of oxygen by the use of CPAP machine. As all the patients were different in characteristics of Age, Sex, Co-morbidities and compliance to the protocols such variation was seen. The patients treated with this method had increased comfort level as well for the therapy as compared to HFNO.



Graph 1 Oxygen saved per case



Graph 2 Oxygen utilization comparison between HFNO and CPAP

STATISTICAL ANALYSIS:

The statistical analysis was done by using Paired t-test with confidence limit of 95% and p-value <0.01. The mean oxygen consumption in HFNO group was found to be 15901.20 L/hr were as in CPAP group was found to be 15262.31 L/hr.

DISCUSSION:

Continuous positive airway pressure (CPAP) is a type of positive airway pressure that delivers a set pressure to the airway which is maintained throughout the entire respiratory cycle. Positive end-expiratory pressure (PEEP) is the pressure in the alveoli above atmospheric pressure at the end of expiration. It is measured in centimeters of water pressure (cm H2O).

In CPAP,

- No additional pressure above the set level is provided
- All breaths must be initiated by the patient
- The PEEP delivered by CPAP helps to keep the airways patent and prevents collapse.

In this single center observational study, 25 (83.33%) patients improved with electrically driven CPAP, though they were very hypoxemic who required 30-40 l/min oxygen flow on HFNO. Existing evidence for CPAP in severe acute respiratory distress is conflicting, and much of it was initially based on non-Covid-19 pathology. A study examining CPAP use in SARS found that CPAP avoided IMV in 70% of patients. Conversely, a study of non-invasive ventilation in critically ill patients with MERS found that over 90% of patients initially treated with non-invasive ventilation required intubation.

LIMITATIONS:

Very less sample size (n=30)
Could not included varied age groups

CONCLUSION:

Electrically driven CPAP was used for an average of 10-12 hours per day, along with oxygen supplementation of 8-12 litre/min. From our limited study we can only conclude that the CPAP when used with Oxygen enrichment in COVID ICU's can help in conservation of Oxygen by improving the respiratory mechanics of the COVID affected lung, which becomes an essential aim in a pandemic to serve maximum patients with limited resources. This can be of immense help in peripheral centers if the staff is adequately trained for the same.

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