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Research Article

Non-Invasive Mechanical Ventilation in Acute Respiratory Failure: Helmet Interface

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ABSTRACT

Background: Non-invasive mechanical ventilation is one of the most used organ support measures in critical care medicine. Hemet interface has been implemented in everyday practice at ICUs later than classic means of delivery for NIV including face mask. We used helmet interface for first time at ICU and recorded CPAP setting and outcome.
Methods: Helmet was used for 9 patients and any complication or side effects were recorded. Also nurses first experience of using the helmet has recorded in a survey.
Results: No skin lesion, vomiting, and air leaking were recorded. Also none of the patients complained about claustrophobia, dyspnea, pain, or feeling hot while the helmet was in use. In addition, nursing was easier while using a helmet than it was with face mask.
Conclusion: The overall first time use of helmet interface in our department gave us a positive feedback, but more data need to be collected for more effective way of applying NIV and specifically helmet interface.

Non-invasive mechanical ventilation (NIV) gained growing popularity among intensive care clinicians in the past three decades. The use of NIV among patients with acute exacerbation of COPD and acute cardiogenic pulmonary edema became the first line of therapy in ICU and emergency departments [1]. Even though the effect of NIV on cardiopulmonary system is not fully understood, most studies suggest it can significantly reduce intubation rate, infection rate and mortality. Also, some Covid-19 guidelines suggest NIV can be use in earlier stages of the disease. Lower complications could make NIV a great alternative to invasive mechanical ventilation in patients with acute respiratory failure [2]. Some suggested lower infection rate reduces mortality rate among immunocompromised patients. However, NIV can fail because of severity of the disease or technical issues at the interface. Different interfaces give a variety of options to meet each patient's need, but intolerance, gas leakage, and CO2 rebreathing remained the main problems among interfaces. Helmet is the newest version that has shown lower intolerance among patients with same effectiveness as face mask. The helmet was introduced in everyday practice later than masks to decrease the intolerance rate among patients. Helmet may benefit patients with decreasing the skin rashes, eye irritation, feeling of suffocation in comparison to masks interfaces. We reviewed few meta-analyses, reviews, and RCTs regarding NIV applications and comparison between different interfaces. Moreover, we used helmet at the Department of Anesthesiology and Intensive Therapy, University of Szeged, Hungary, and observed patient's tolerance, recorded CPAP setting and outcome, and asked about nurse's experience with helmet in a survey.

Methods

At Szeged department of Anesthesiology and Intensive care between September to December 2020 we used helmet for 9 patients and collected the setting used during helmet CPAP (flow, FiO2, PEEP) and the effects on oxygenation and CO2 removal (PaO2, PaCO2). In this

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clinical observation, six male and three female patients used the helmet interface. The mean age of patients was 58.32± 46.89 years. Helmets were used for an average of 4.5± 5.13 days. We recorded the patients experience and the side effects and complications. For some of the patients we used helmet as an alternative to face mask due to their intolerance to face masks. In addition, we were interested in the nurses' feedback on helmet placement and their overall experience with this newer method of NIV interface and for this we asked them to participate in a survey.

Results

Four patients had pneumonia leading to hypoxemic respiratory failure with a background of immunosuppressive diseases. Among these patients, all were initially put on helmet and could tolerate it, but three of them needed endotracheal intubations due to progressive hypoxemia. One of them refused intubation and put on end-life-support with helmet for 2 days without any complains. In total he used helmet for four days with no problem, later progressive hypoxia indicated intubation and he died one day later.

Three patients had acute heart failure. Helmet was used for two of them because of intolerance to the face mask. One patient with sever aortic regurgitation used helmet for 3 days before he needed endotracheal intubation due to cardiogenic shock. Later he underwent a successful heart surgery. The second patient used helmet for 7 days after complaining about face mask. He died supported by helmet during end-of-life care since surgery was not indicated. In the latter case, CPAP helmet therapy was successful, and the patient underwent successful heart surgery and later discharged from hospital.

From the remaining two patients one had thoracic trauma with multiple ribs fractures. He could not tolerate face mask, but helmet was effective and well-tolerated. He underwent chest stabilization surgery and he rapidly extubated and discharged to the ward after 2 days of NIV therapy with helmet.

Last patient had post-extubation hypoxemia, we switched to helmet due to intolerance to face mask and used helmet for 8 days which was effective.

All patients were comfortable using helmets except one who complained about excessive noise. The acute physiology and chronic health evaluation (APACHE II) score was calculated for each patient to show the severity of the disease. The APACHE2 score and the setting used in CPAP is summarized in (Table1).

In a survey, 18 nurses participated and answered questions regarding their first few experiences with the helmet. From the nurse's point of view, 80% thought the helmet was easy and straightforward to apply. Also, nursing was easier while using a helmet than it was with a face mask. They said enteral feeding, nebulization, giving oral medications, and mouth cleaning was more manageable with a helmet. According to our nurse's observation patients could communicate, rest, and sleep while using the helmet interface. They did not record any skin lesion, vomiting, and air leaking. None of the patients complained about claustrophobia, dyspnea, pain, and feeling hot while the helmet was in use. Only one patient complained about noise.

Table 1- Helmet CPAP settings of all cases

Case Number	APACHE II	days on CPAP helmet	Flow (l/min)	FiO2	PEEP (mH2O)	need for intubation	days of invasive mechanical ventilation	Any complain
1	19	6	80-100	0.6-0.8	8-10	NO	0	-
2	14	3	80-110	0.6-0.8	8-10	NO	1	-
3	17	7	60-100	0.6-0.8	8-10	NO: ELC*	0	-
4	29	3	60-120	0.8-1.0	8-10	NO: ELC*	0	-
5	18	5	60-120	0.8-1.0	6-12	NO: ELC*	0	-
6	34	<1	80-120	0.8-1.0	6-12	YEs	1	-
7	19	6	60-120	0.5-0.7	6-12	Yes	1	-
8	9	2	60-80	0.4-0.7	6-8	NO	0	-
9	21	8	60-80	0.4-0.8	8-10	NO	0	noise

*End of Life Care

Discussion

Recently, NIV and especially helmet CPAP become popular for Covid-19 pneumonias. NIV application has been controversial, and more studies need to be done to evaluate its effectiveness in these patients, but many countries and societies including the Italian thoracic society, National Health Care System guideline of UK, and the Chinese National Health Commission, recommended NIV for certain Covid-19 patients. The Irish Thoracic Society specifically suggested helmet interface use in Covid19 patients. European Respiratory Society/European Society of Intensive Care Medicine suggests helmet to contain Corona virus spread among personnel [3]. In contrary, American National Institute of Health (NIH) guideline for Covid-19 recommend high flow nasal cannula (HFNC) over NIV in critically ill adult patients with Covid-19. US department of defense suggests early intubation is superior to NIV, and the Austrian ICU Therapy guideline contraindicates NIV for

Covid-19 patients. Moreover, in one randomized control study in China, they compared the helmet with face mask in acute exacerbation of COPD [4]. They documented NIV tolerance, blood gas analysis, heart rate, respiratory rate of patients, the incidence of endotracheal intubation, and in-hospital mortality. The PaO2/FiO2 ratio was significantly higher in the helmet group at the end of NIV application. There was no significant difference in improvement of pH value, the PaCO2 level, arterial partial pressure, and heart rate. The tolerance was higher in the helmet group. Also, the complications from intubation after the helmet were lower than the mask group. They concluded in the helmet group CO2 clearance in not inferior compared to the mask group. The use of helmet over face mask is still controversial and more studies need to be done, but higher tolerance in helmet shows it can be a more comfortable way to deliver flow in acute respiratory failure patients [5].

Conclusion

In this study, cases were varied from immunocompromised, heart failure, ribs fracture, and post-extubation hypoxia. They did not record any skin lesion, vomiting, and air leaking. None of the patients complained about claustrophobia, dyspnea, pain, and feeling hot while the helmet was in use. Also, nursing was easier while using a helmet than it was with a face mask. Our first experience with helmet was successful since patients and nurses were both satisfied with this new interface, but to use helmet more effectively more data needs to be collected.

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