

## Weaning from Ventilator and Effect of Blender-Humidifier on Outcome

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### **Abstract**

#### **Introduction**

The weaning procedure of mechanical ventilation in many patients is a difficult and long process and increases the time of mechanical ventilation. There are numerous ways to achieve this goal. One common way is using Continuous positive airway pressure (CPAP) ventilator. Considering the lower price of Blender-Humidifier compared to CPAP of ventilator and the limited number of studies in this field, this study was aimed to compare these two procedures.

#### **Materials and Methods**

102 patients in Pediatric intensive care unit (PICU) were allocated randomly in one group: CPAP-ventilator and Blender-Humidifier. Duration of hospital and PICU stay, the number of days of mechanical ventilation, the frequency of re-intubation, and the mortality of the patients were recorded.

#### **Results**

The study was conducted on 66 male and 36 female patients (64.7% and 35.3% respectively). The average age was (22.5 ± 4.5) months. The most frequent complaint of the patients at the time of visit was coughing (35%), hyperventilation and respiratory distress (21.6%). Hospital stay was (23±14) and (20±12) days in humidifier and cpap groups respectively (p=0.52). PICU stay was (15± 11) and (20±11) days in humidifier and cpap groups respectively (p=0.18). Re-intubation rate was 16.2% and 33.5% in humidifier and cpap groups respectively (p=0.15). Mortality rate 8.4% and 21.5% in humidifier and cpap groups respectively (p=0.06).

#### **Conclusion**

Although there was no statistically significant difference between two groups, considering the differences in mortality rate, the need for re-intubation, rate of hospital and PICU stay, and at the same time, with easy availability and low prices, using Blender- Humidifier is recommended.

**Key words:** Blender, CPAP ventilator, Humidifier, PICU, Weaning.

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## Introduction

Acute lung injury and acute respiratory failure are the main causes of applying mechanical ventilation to children. Therefore, weaning the patients from the mechanical ventilation has a significant importance in the treatment course and treatment outcome of these patients. Weaning is the procedure through which patients are separated from the mechanical ventilator gradually or suddenly. In fact, it is the phase in which the act of breathing is transferred from the ventilator to the patient themselves. Usually this procedure is not easily done in patients with an acute episode of respiratory failure and it is a long and difficult process in many patients and adds to time needed for the mechanical ventilation and consumes a considerable amount of health system resources. This process includes around 40% of the total mechanical ventilation (1 and 2). One of methods for weaning is spontaneous breathing trial (3). These trials are usually conducted with positive pressure (CPAP) and some time with T-piece. T-piece requires a high gas pressure while other applied instrument is a machine which combines the temperature and humidity with air. The problem with this instrument is the lack of an effective and reliable filter for prevention of infection by virus and other pathogens and for this reason, there is risk of transmission of infections to personnel and other patients (4). Currently, there are two hospital machines used for making patients' inhalation warm and humid during endotracheal intubation and for compensating nasal function (bypass intubation): warm humidifiers and warmth and humidity interchange machines (5). In the last few years numerous studies have

been conducted to limit the ventilation time by early identification of patients eligible being weaned from the ventilator (6-9). In recent years, the physicians' main concern was the way for separating patients from the mechanical ventilations and reducing this period with the least possible side effects. It has been clearly recognized that when the patient is intubated, the interchange process of warmth and humidity of breathing gases, which are done by upper airways, is bypassed because of the omission of the respiratory airways from the respiration course. Similarly, intubated patients, may need suction of the endotracheal tube and airways, which, in turn, will cause changes in natural warmth and humidity of airways and increasing the risk of infection. The lack of enough humidity may cause a decrease in coughing reflex, an increase in bronchial discharges (and as a consequence, an increase in the number and duration of suction time), a decrease in mucociliary clearance, the destruction of respiratory cilia, mucous glands, alterations in lung functions, temperature loss and a decrease in body central temperature are among the other side effects of the lack of enough humidity and warmth in airways (11-14). In order to assess the patients' respiratory system and evaluating their ability at the time of weaning from the mechanical ventilation, the process of spontaneous breathing trial is often used which is usually done with the use of a T-piece Humidifier-blender (15). In a study by Jones et al., the two procedures of Humidifier-blender T-piece and CPAP in weaning adult patients from the mechanical ventilation were compared. 106 patients were assigned randomly in one of the two study groups after being weaned from the mechanical ventilation. The assessment of the patients

was done an hour after the weaning from the mechanical ventilation. The age and gender combination of the two groups, as well as their etiological need to mechanical intubation in the two groups were identical. No difference was observed in the heart beat and the systolic and diastolic blood pressure between the two groups. The incidence of conditions like infection and pneumonia in the two groups was not of tangible difference. Similarly, the average PaCO<sub>2</sub> between the two groups was not of significant difference. The average of initiatory Partial pressure of carbon dioxide (PaCO<sub>2</sub>) in the Humidifier- blender T-piece group was higher than the CPAP-ventilator group ( $47.23 \pm 16.103$  mm/Hg against  $40.21 \pm 93.92$  mm/Hg). Nonetheless, the amount of PaCO<sub>2</sub> in the Humidifier- blender T-piece group one hour before extubation had a more decrease (8.3% against 2.5%). Extubation failure occurred in 5 patients of the total patients and the difference of this case in the two groups was not significant (3 patients in CPAP-ventilator and 2 patients in Humidifier- blender T-piece group). Jones et al., concluded that the use of Humidifier-blender T-piece will not cause disturbance in arterial oxygenation and in fact may be preferred to using CPAP ventilator (16). In another study by Molina-Saldarriaga et al., the use of T-piece and CPAP ventilator in weaning patients from T-piece Humidifier-blender was compared. In this study, as well, CPAP ventilator and the use of Humidifier-blender T-piece were compared. Among 25 patients in Humidifier- blender T-piece group, 18 patients were successfully extubated of which 3 patients were re-intubated. Among 25 patients in CPAP-ventilator group, 19 were extubated of which none needed re-intubation. Finally, the rate of successful weaning of patients from mechanical ventilation in the two groups of

Humidifier- blender T-piece and CPAP ventilator was 60% and 76% respectively. Contrary to the results obtained from previous study, Molina-Saldarriaga et al., reported that the use of CPAP will cause more satisfactory results although for confirming this result there is a need for more studies (17). In a similar study, Vats et al., among the 20 patients in Humidifier-blender T-piece group, 15 patients were extubated of which 5 patients needed re-intubation, while among the 20 patients in CPAP-ventilator, 17 patients were successfully extubated of which only 3 patients were re-intubated. Even with this difference, Vats et al., concluded that the importance and the effectiveness of these two methods in weaning patients from mechanical ventilation is equal (18). In a study by Estaban et al., these two methods were of equal importance and ability in weaning the patients. Of 246 patients in T-piece group 192 patients and of 238 patients in CPAP-ventilator group 205 patients were finally extubed. The percentage of the patients who were not extubated was higher in Humidifier- blender T-piece group (22% against 14%). 36 patients in Humidifier-blender T-piece group and 38 patients in CPAP-ventilator group were re-entubated. Nevertheless, the percentage of the patients who remained entubated for 48 hours was not of significant difference in two groups (63% in Humidifier- blender T-piece group and 70% in CPAP-ventilator group,  $P = 0.14\%$ ). The incidence rate for mortality in ICU units in patients who were re-intubated was higher than the patients who were successfully extubated (275 against 2.6%) (8). In other studies, the effects of using different warming and humidifying machines in noninvasive ventilation was compared. In one of these studies, Lellouche et al., compared the effects of warmth and

humidity interchange using the two methods of end-tidal positive pressure and T-piece. The members of the two groups were selected by cross assignment. The basic amount for pH, PaCO<sub>2</sub>, and Pulmonary arterial oxygen tension (PaO<sub>2</sub>) were 7.37 ± 0.04; 15 ± 60; and 11 ± 64 mm/Hg respectively.

The amount of PaO<sub>2</sub> in all groups was almost reached 74. The amount of PaCO<sub>2</sub> and pH had remained around 57-60 and 7.38-7.39. Although there was no significant difference in findings of arterial blood gases analysis, it was clear that the use of warm humidifiers in comparison with warmth and humidity exchanger will cause an additional decrease in respiratory effort at the time of noninvasive ventilation (19). In a similar study of 24 patients with acute respiratory failure, Jaber et al., showed that PaCO<sub>2</sub> at the time of using warmth and humidity exchanger in comparison to warm humidifiers was higher while the ration of PaO<sub>2</sub> to Fraction of inspired oxygen (FiO<sub>2</sub>) was not of tangible difference. The opposite of this was true for pH Jaber et al., also recommended using warm humidifiers at the time of noninvasive ventilation. One easy way for prescribing oxygen in patients is using warm and humid making machines along Humidifier- blender T-piece (20). Numerous studies have been conducted on the effects of making the air flow warm or humid during treatment, the prognosis and prevention of colonization of bacteria in entubated patients but most of these cases were related to warming and humidifying the exchanged air during mechniac ventilation and the number of the studies on the warming and humidifying the exchanged air during the spontaneous respiration in patients is very limited. In some studies, only the comparison of Humidifier- blender T-

piece and CPAP-ventilator has been addressed. In addition, it must be noted that there has been no study on the above mentioned methods in PICU centers and all of the studies were about the adult age group. Considering the heavy cost of hospitalization and Neonatal intensive-care unit (NICU) and PICU, and also, of using CPAP ventilator, and also the lack of enough ventilation apparatus and the absence of studies about comparing these two methods in weaning patients from the ventilator, we decided to conduct this study.

### **Materials and Methods**

The study is RCT which was conducted during two years. 102 patients who were hospitalized for different reason in PICU underwent the study. Patients' information was totally confidential and all of the parents read and signed an informed consent form. They were reassured that they can withdraw from the study at any time. At the time of weaning; the patients were randomly assigned in one of the CPAP and Blender-Humidifier groups. Patients who had spontaneous respiration and received FiO<sub>2</sub> less than 40 percent with PaO<sub>2</sub> more than 60 percent, were considered candidates for weaning from ventilator. Duration of hospitalization, the number of days being under mechanical ventilation, the need for re-intubation, the number of day being hospitalized, the number of day being in the PICU were recorded. For statistical investigation, descriptive statistics (frequency, percentage, and average ± normal deviation) were used. For comparing the qualitative findings, the statistical test of chi-square; and for comparing quantitative findings between groups the statistical test of independent t-test was used. The study

was done using SPSS16 statistical software. The pvalue<0.05 was significant.

## Results

In this study, 66 patients were male (64.7%) and 36 were female (35.3%). The average age of the patients was  $22.5 \pm 4.5$  months. The minimum and maximum age of the patients was 1.5 and 164 months respectively. The median and the mode were 10 and 48 months respectively.

The most frequent complaint of the patients at the time of visit were coughing (35.3%), hyperventilation and respiratory distress (21.6%), seizures or spasms (9.8%), Other cases involved cardiopulmonary arrest in 6 patients (11.8%), reduction in consciousness level in 4 patients (7.8%), respiratory acidosis and metabolic acidosis in 3 patients (5.9).

The main indication of intubation was impending to respiratory failure (52.9%).

Hospital stay was  $22 \pm 15$  and  $21 \pm 13$  days in humidifier and cpap groups respectively ( $p=0/48$ ).

PICU stay was  $13 \pm 11$  and  $21 \pm 13$  days in humidifier and cpap groups respectively ( $p=0/16$ ).

Re- intubation rate was 17/2% and 45/5% in humidifier and cpap groups respectively ( $p=0/1$ ).

Mortality rate 3/4% and 22.5% in humidifier and cpap groups respectively ( $p=0/07$ ).

All of the death cases occurred in patients who needed re-intubation, and in this respect, there was a significant difference between patients who were re-intubated and those who did not need re-intubation ( $p < 0.01$ )

## Discussion

Weaning patients from mechanical ventilation is a vital and important part of caring for patients who are intubated. Regarding the best method for doing this process there is no global agreement. This process in children is more important than in adults because these patients do properly cooperate. In addition, considering the lack of studies comparing different methods for weaning child patients, the need for conducting studies in this domain in the form of clinical trial is felt more strongly. In this research, the effectiveness of Blender-Humidifier in weaning patients from mechanical ventilation was studied, while in the previous studies focused either on the comparison of Humidifier- blender T-piece and CPAP ventilator without accompanying warm and humid exchange machines, or only two types of warm and humid exchange machines were compared.

In this study 102 patients who were under mechanical ventilation and had the indication of weaning from mechanical ventilation were randomly assigned in two study groups. As it was expected, in our study, like other studies, pneumonia was the main cause of acute respiratory failure (10). As mentioned before, there is no study in which children age group was considered. For this reason, it is not possible to compare the results of the basic study with other studies. The cause of the respiratory failure is different in different age groups. Extensive respiratory distress was the hospitalization indication in PICU in a considerable number of patients (60.8%). The main cause for patient intubation was impending to respiratory failure (52.9%). What is clear is the considerable difference in the causes of respiratory failure in children and their need for mechanical ventilation compared to adults (16-20),

which is a reminder of the importance to study them separately. In comparing the two groups, it was observed that the need for re-intubation in CPAP ventilator group was higher than Humidifier- blender T-piece . Although this difference was evident, it was not statistically significant. Based on these findings, it should be said that the critical period for patients who are weaned from the ventilator with Humidifier- blender T-piece method is shorter and in other words, the amount of time in which the patient's need for mechanical ventilation is determined is shorter, and considering the higher success rate of Humidifier- blender T-piece, this device can have a considerable effect in reducing hospitalization time, treatment costs, and also, increasing the percentage of patients in less amount of time compared to CPAP ventilator.

To confirm this result, we should take a look at the results obtained from comparing the number of hospitalization days in hospital and the number of days spent in PICU in the study groups .Contrary to the results of our study, in the study of Molina-Saldarriga and al., (17), Vats et al., (18) the rate of intubation failure in the Humidifier- blender T-piece was higher. In the study by Jones et al., (16), and Esteban et al., (8), as well, there was no considerable difference between two groups. Similar to the results announced by Esteban et al., (8), in our study, as well, there was a significant difference in the incidence rate of mortality between patients who were re-intubated and those who were not re-intubated (27% against 2.6%).

Considering this fact, the presence of considerable effects of T- piece- Humidifier- blender in reducing the number of re-intubation cases can be promising in reducing the rate of mortality in patients

with acute respiratory failure. Similar to our study, in the study of Jones et al., (16) and Esteban et al., (8), there was not a considerable difference in Arterial blood gas (ABG) results between the two groups.

### **Conclusion**

There was not statistically significant difference between two groups, however, the observable difference immortality rate, the need for re-intubation, the rate of hospital and PICU stay and easy and affordable availability, the use of Blender-Humidifier is recommended. Conducting similar studies with higher sample and patients with common type of pulmonary pathology can considerably increase the power of study.

**Conflict of interest:** None

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