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Comparative Efficacy of SPONTANEOUS BREATHING TRIAL Techniques in Mechanically Ventilated Adult Patients: A Review

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Abstract:- Since the invention of mechanical ventilation and the development of critical care medicine, weaning literature and research have transformed daily patient treatment in intensive care units. More study on weaning trials has become important as our understanding of mechanical breathing with the use of mechanical ventilators has grown. Studies tended to concentrate on the length of mechanical ventilation utilizing different methods for conducting spontaneous breathing trials as a means of weaning patients from assisted ventilation.

This article review offers a comprehensive look at the effectiveness of weaning using spontaneous breathing trials with pressure support ventilation (PSV), synchronized intermittent mandatory ventilation (SIMV), and T-tube or T-piece trials.

Keywords:- *Weaning; Mechanical Ventilation Weaning; Mechanical Ventilation; Spontaneous Breathing Trial; SBT; Spontaneous Breathing Trial Techniques*

I. INTRODUCTION

Several ventilatory support techniques have been proposed to assist patients in gradually weaning themselves off mechanical ventilation. However, it is unknown how effective these techniques will be when used in a medical setting. Only a few of the identified ventilatory support techniques have passed as a theory.

By quickly identifying patients who are capable of spontaneous breathing, the duration of mechanical ventilation may be reduced, and complications related to artificial ventilation may also be reduced. [1] Weaning off artificial breathing is done in the intensive care unit (ICU) using a step-by-step procedure that is well recognized to all primary health workers who work closely with the mechanically ventilated patients. Despite the fact the intubation is required to protect the airways and stop central hypoventilation, the respiratory therapists face a problem while weaning patients off of mechanical ventilation because it is important to keep intubation times to a minimum. To reduce risk of tracheotomy and delayed weaning, prolonged mechanical breathing, defined as more than 14 days of intubation, is typically avoided unless absolutely required. [2] Early extubation has been proven to improve the patient's prognosis.

The researcher's objective is to compare the efficacy of spontaneous breathing trial techniques with the use of synchronized intermittent mandatory ventilation (SIMV), pressure support ventilation, and T-piece/T-tube trials for adult patients weaning from mechanical ventilation according to mortality, weaning failure, re-intubation, and weaning duration. [3]

II. METHODS

The researchers of this study conducted a systematic literature search on PubMed from their inception until February 28, 2023. No restriction on language was imposed. The search process employed several combinations of specific keywords based on the principle of combination of medical subject heading and text words: "ventilator weaning", spontaneous breathing trial", "mechanical ventilation", and other terms related to weaning modalities. Any disagreements about the study retrieval were solved based on the consensus between the 4 authors of this study.

III. LITERATURE SEARCH

- *Spontaneous Breathing Trials*

The spontaneous breathing trial (SBT) evaluates the likelihood that a patient can effectively wean off of invasive mechanical ventilation by using a T-tube or modest spontaneous breathing support. [2] If a patient is declared ready to breathe independently, this screening technique is routinely performed. Typically, a T-piece is affixed to the patient's endotracheal tube when the patient is taken off the ventilator to assume all of the work of breathing.

Trials of spontaneous breathing can be performed in a variety of ways, with varying levels and types of assistance provided during inhalation and exhalation. One strategy is using pressures that typically ranges from 5-7cmH20 of minimal pressure support, which some prefer to partially replace the mechanical ventilator. [1] [2]

- *Synchronized Intermittent Mandatory Ventilation (SIMV)*

Synchronized intermittent mandatory ventilation (SIMV) is type of ventilation where the ventilator must deliver a specified volume and predetermined number of breaths and permits spontaneous breathing during a certain window. Spontaneous breathing happens when the airway pressure drops below the end-expiratory pressure also known as trigger. The ventilator makes an effort to match the patient's spontaneous efforts with the delivery of necessary breaths. In contrast, SIMV can also supply spontaneous volumes that are entirely motivated by patient effort through assist control ventilation (ACV) [4]. One type of breath pattern used to categorize a mode of ventilation is intermittent mandatory ventilation (IMV). IMV is described as the capacity for patient-triggered and patient-cycled spontaneous breaths to exist in between obligatory breaths (machine triggered or machine cycled). [3] Patients who have undergone unsuccessful weaning methods can try a gradual withdrawal from assisted breathing while addressing the root cause of ventilatory reliance. The most effective method of weaning those who are deemed tough to wean has been proved to be SIMV.[5]

- *Pressure Support Ventilation*

Patients who can breathe on their own are usually given pressure support ventilation (PSV), also known as pressure support mode, to aid in ventilator release. Patients participating in weaning trials have shown to find pressure support ventilation to be comfortable. Furthermore, it is simple to titrate in order to regulate patient's respiration. Without intending to stop the ventilation, it may also be tried on a patient. For some patient populations who require long-term mechanical ventilation, pressure support mode may be useful. These patients include those who have chronic muscle weakness, chronic obstructive lung illness, and narrow artificial airways. Because pressure support increases ventilation and decreases blood carbon dioxide levels, it is a straightforward and logical concept. Although a rise in airway resistance or a decline in lung compliance might produce less-than-ideal outcomes, pressure support ventilation performs best in patients with compliant lungs who can breathe spontaneously. [6]

- *T-tube/T-piece Trial*

After extubation, spontaneous breathing trial aims to as nearly resemble the patient's breathing pattern as possible. One of the two main kinds of spontaneous breathing trial, SBT with pressure support or SBT with T-piece, is generally administered to critically ill patients. It is said that SBT using pressure support reduces pressure support to 10 cmH20 whether or not a positive end-expiratory pressure (PEEP) is applied.

In line to this, the SBT using T-piece entails withdrawing the patient from the ventilator and then connecting the endotracheal tube to a t-piece to provide oxygen, if necessary, without artificial breaths. In a worldwide observational study, the type of SBT employed was significantly diverse. It was recently proposed that the initial spontaneous breathing trial technique should be carried out using pressure support rather than a T-piece trial for hospitalized patient who are ventilated for longer than 24 hours based on evidence of only fair quality. In fact, a study analysis indicates that SBT using pressure support may have higher success rates than using T-piece trial. This is also because pressure support technique requires less labor to breathe than the use of spontaneous breathing trial using T-piece.[7]

Table 1: Comparative Efficacy of Spontaneous Breathing Trial Techniques in Mechanically Ventilated Adult Patients

Author & Year	Origin	Article Title	Results/Discussion
Ye Xiaomei, Waters David & Yu Hong-Jing (2022)	China	The Effectiveness of Pressure Support Ventilation and T-piece in differing duration among weaning patients: A systematic review and network meta-analysis	When all four results of the study were looked at together, those who were thought to be easy to wean did better after 30 minutes of pressure support ventilation. Also, a 120-minute T-piece trial and 120-minute pressure support ventilation are more likely to lead to a lower rate of reintubation. So, weaning time is thought to be more important for people who are more likely to need a breathing tube again. [8]

Li Yuting, Li Hongxiang & Zhang Dong (2020)	China	Comparison of T-piece and pressure support ventilation as spontaneous breathing trials in critically ill patients; a systematic review and meta-analysis	In patients who are very critical, T-piece trial and pressure support ventilation as spontaneous breathing trial technique are thought to have the same effect. The authors were firm that there were no clear difference between the rates of patient being reintubated, length of stay in the critical care unit and hospital, or rates of mortality in the critical care unit and hospital. [9]
Na Soo Jin, Ko Ryoung-Eun, Nam Jimyoung, Ko Myeong Gyun & Jeon Kyeongnam (2022)	Republic of Korea	Comparison Between Pressure Support Ventilation and T-piece in Spontaneous Breathing Trials	In critical patients, spontaneous breathing trial using pressure support was not linked to a higher rate of successful weaning than using T-piece trial. But it was decided that pressure support ventilation could speed up the weaning process without increasing the risk of having to put the tube back in. [10]
Subira Carles, Hernandez Gonzalo, Vazquez Antionia, et. al (2019)	Spain	Effect of Pressure Support vs T-piece Ventilation Strategies During Spontaneous Breathing Trials on Successful Extubation Among Patients Receiving Mechanical Ventilation: A Randomized Clinical Trial	A spontaneous breathing test with 30-minutes of pressure support ventilation compared to 2 hours of T-piece trial led to a huge increase in the number of patients who were able to get rid of the breathing machines. The results show that a less difficult way to breathe should be used when testing patients' ability to breathe on their own. [11]
Pellegrini Jose Augusto, Boniatti Marcio Manozzo, Boniatti Viviane Correa, et. al (2018)	Brazil	Pressure-support Ventilation or T-piece Spontaneous Breathing Trials for Patients with Chronic Obstructive Pulmonary Disease – A Randomized Controlled Trial	The study found that trying to breathe on your own using spontaneous breathing trial technique didn't change how long you had to use mechanical ventilation. The use of T-piece trial may make it longer to get hard-to-wean patients off of mechanical ventilators. [12]
Mancebo Jordi, Golgher Ewan & Borchard Laurent (2019)		Spontaneous Breathing Trials and Successful Extubation	The results of the clinical trial, which was randomized, compared to 30-minute spontaneous breathing trial using pressure support mode was less difficult. When spontaneous breathing trial was done with T-piece, the rate of successful extubation was higher. It is thought to be an easier method that doesn't increase the risk of reintubation. [13]
Zein Hossam, Baratloo Alireza, Negida Ahmed, Safari Saeed, et. al (2016)	Egypt	Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review	Spontaneous breathing trials evaluates the patient's ability to breathe on his or her own with minimal to no ventilatory support. The collective task force stated in 2001 that the process of breathing trials and weaning should begin with determining whether or not the patient's underlying cause of respiratory failure has been addressed and resolved. Weaning predictors are parameters introduced to assist clinicians in predicting whether or not weaning attempts will be successful. [14]

Thille, A. W., Coudroy, R., Gacouin, A., Ehrmann, S., Contou, D., Dangers, L., Frat, J.-P. (2020)	France	T-piece versus pressure-support ventilation for spontaneous breathing trials before extubation in patients at high risk of reintubation: protocol for a multicentre, randomized controlled trial (TIP-EX)	The experiment was started by the researches to see if pressure support ventilation could speed up the extubation and reduce the number of high-risk patients who needed to be re-intubated faster than T-piece. Both of the techniques mentioned in the experiment have never been tested on patients who are at a high risk for re-intubation which makes the study very important for making good decisions and everyday recommendations about extubation in the intensive care unit. [15]
Chatburn Robert, Lui Ping-Hui, et. al (2022)	Cleveland, Ohio	The Evolution of Intermittent Mandatory Ventilation	Over time, intermittent mandatory ventilation has changed into four different types with each of the technique to have its own pros and cons for achieving the intended objectives of mechanical ventilation, which are mostly to keep the patient safe and comfortable. [16]
Dadam, M. M., Gonçalves, A. R. R., Mortari, G. L., Klamt, A. P., Hippler, A., Lago, J. U., … Westphal, G. A. (2021)	Brazil	The Effect of Reconnection to Mechanical Ventilation for 1 Hour After Spontaneous Breathing Trial on Reintubation Among Patients Ventilated for More Than 12 Hours.	The research shows that hooking up the patient to the mechanical ventilator for one hour after a successful spontaneous breathing test didn't have any statistically significant results or a big effect on the main goal of the proponents. The results were good for reintubation within the first 48 hours when the patient had been on mechanical ventilation for more than 72 hours before being taken off the ventilator. So, it is possible that people who have been using mechanical ventilation for a long time may benefit more from this. But this action needs to be checked with follow-up research that is the right size and focuses on the right people. [17]
Thille, A. W., Coudroy, R., Nay, M.-A., Gacouin, A., Demoule, A., Sonneville, R., Frat, J.-P. (2020)	France	Pressure-support ventilation versus T-piece during spontaneous breathing trials before extubation among patients at high-risk of extubation failure: a post-hoc analysis of a clinical trial.	The study showed that the first spontaneous breathing trial using pressure support mode in critical patients who are at high risk for extubation failures went by a lot. Using pressure support mode, weaning could speed up extubation without increasing the risk of having to put the tube back in. This is another important result that could happen in the future but more study needs to be done to confirm these results in high-risk groups before this can be used as part of the plan to wean all mechanically ventilated patients in the intensive care unit. [18]

IV. CONCLUSION

In individuals who are simple to wean from mechanical ventilation, spontaneous breathing trials employing the use pressure support ventilation reduces weaning failure rates. SBT employing T-tube/T-piece trial also lowers reintubation rates in patients when compared to pressure support ventilation, although it takes longer for patients to be removed from the mechanical ventilator. This is especially true to patients who are difficult to wean. On the other hand, synchronized intermittent mandatory ventilation has its own benefits and drawbacks in terms of patients' security, comfort and freedom from mechanical ventilation. Future research should therefore contrast pressure support ventilation and T-

piece and T-tube trials with spontaneous breathing trial techniques using synchronized intermittent mandatory ventilation.

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CONFLICT OF INTEREST

No conflict of interest among the authors.

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