

A STUDY OF MECHANICAL VENTILATION ON CARDIOVASCULAR OUTPUT

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Abstract

Background: This study is measuring the impact of mechanical ventilation on cardiovascular output. Mechanical ventilation improves the gaseous exchange. According to, it also helps to modify the blood flow system.

Purpose of the study: A group of 30 patients was included in this study. Those patients are continuously assigned to either a control group or a mechanical ventilation group. The control group consists of conventional protective mechanical ventilation. serving 24 hours it is concluded that the control group received no c but the mechanical group received continuous mechanical ventilation. Before and after 24 hours cardiovascular output was measured.

Problem statement: It is observed that mechanical ventilation increased cardiac output significantly among the patient in the mechanical ventilation group in contrast to the control group. It is concluded that the paints that are suffered from cardiac disorders mechanical ventilation became a fruitful treatment for them.

Method materials: The data sources will include conference processing pre-reviewed journal articles and other relevant sources. Qualitative data analysis method has been used in this research. The output of this systematic review will be used to create a conclusion about the mechanical ventilation effect on cardiovascular output.

Major findings: The study is a discussion about the importance of closely monitoring patients who received mechanical ventilation ensuring to receive the required oxygen and ventilation. This study became a review of the available literature.

Novelty: This study became a review of the available literature. The strategy of searching will include mechanical ventilation-related keywords.

Keywords: Mechanical ventilation, Respiratory blockage, Invasive ventilation, Cost and operation efficiency

1. Introduction

In the healthcare research sector, the study of mechanical ventilation is treated as the most important area in cardiovascular output. When a person feels difficulties in breathing or is unable to breathe, mechanical ventilation treatment helps to breathe the person. In the process of Mechanical ventilation, extra oxygen is provided to the patient who using a ventilator. Mechanical ventilation is used in chronic respiratory diseases treatment those

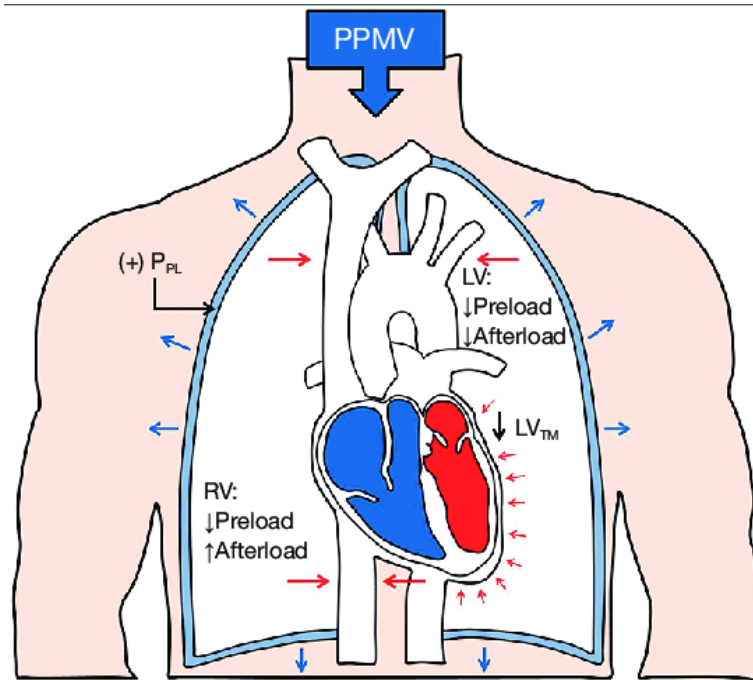
include like asthma, chronic obstructive pulmonary disease, lung cancer, bronchitis, and tuberculosis. Mechanical ventilation has a significant effect on the cardiovascular system. It can help to reduce myocardial oxygen demands and also improve cardiac output tissue perfusion. Mechanical ventilation treatment decreases blood pressure. Besides all these positive impacts it also has a negative side. sometimes blood pressure, oxygen demands, and heart rate are increased.

1.1 Definition of mechanical ventilation

Mechanical ventilation is an invention in the medical sector that involves artificial devices to regulate a patient's breathing, at that time when the patient fell difficulties in breathing. It gives support and helps to improve breathing. Mechanical ventilation can be used in short-term and long-term cases [2]. Invasive ventilation and Non-invasive ventilation are in practical use. Non-invasive ventilation can be treated at home. When a patient's lungs are not working properly Mechanical ventilation therapy is used.

A ventilator avoid collapsing small sacks of lungs and provide sufficient oxygen to breathe avoiding carbon dioxide from the lungs. The time required for Mechanical ventilation depends on the reason for the patient's disease. There are some risks in the treatment of mechanical ventilation. It can cause bacterial infections, lung damage, collapsed lungs, and blood flow changes [8].

Figure 1: Homodynamic effect of the mechanical ventilation (Pelosi, Paolo, et al. 2021, {3})



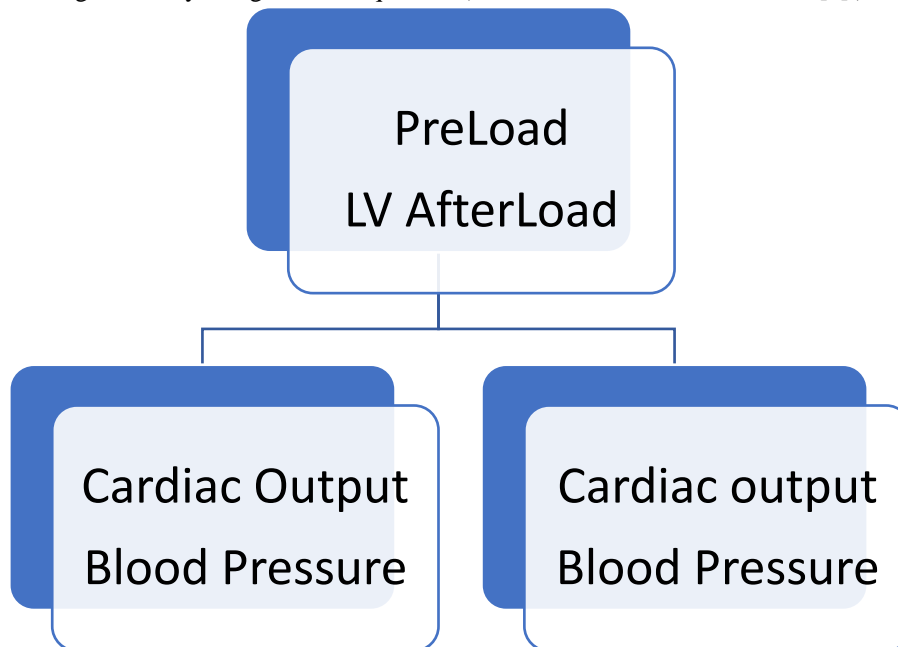
The trigger phase, inspiratory phase, cycling phase, and expiratory phase are the four phases of Mechanical ventilation. Invasive mechanical ventilation is used while the patient is suffering from critical condition it can be from different type of sources that include shock, respiratory disease. It provides the support for preventing breathing condition. In the critical condition of apnea in which they suffered from breathing issue can be helped by mechanical ventilation. In non-invasive care settings, Mechanical ventilation is used to provide extra oxygen support to a patient having breathing difficulties due to a chronic condition like Chronic obstructive pulmonary disease(COPD), kidney failure, etc [3]. In this chronic situation, the patient is unable to get sufficient oxygen of their own. Mechanical ventilation can improve this situation by providing a sufficient amount of oxygen to the patient. A neuromuscular disorder like muscular dystrophy can be cured by Mechanical ventilation.

Having all this positivity Mechanical ventilation is a partially dangerous invention in the medical sector. Mechanical ventilation should be used under the supervision of expert medical professionals and doctors. Before using Mechanical ventilation therapy a patient must have understood its risks and benefits [7].

1.2 History of Mechanical ventilation

Mechanical ventilation is a life-supporting form in the healthcare sector. It helps to facilitate the exchange of oxygen and carbon dioxide in the lungs artificially regulating the flow of air. When the body cannot breathe properly extra support of oxygen can be given by Mechanical ventilation. Galen, a Greek physician, and scientist plays a major role in the analysis of disease [4]. In his thought to maintain circulation breathing is mandatory. There is no understanding of ventilation for almost 1500 years ago. Mechanical ventilation was first used by Scottish physician John Hunter. He develops mechanical devices that would help to exchange oxygen and carbon dioxide in the lungs.

Figure 2: Physiological consequences (Gamberini, Lorenzo, et al.2019, [6])



In the 18th century, people were unconscious of the lack of stimulation. A German surgeon named Friedrich Maass invented an artificial respirator in the early 19th century which is a more sophisticated version compared to the previous one. To assist the flow of air this device used a rubber musk and it is the first device to allow sustained ventilation. Finally in 1774 Joseph Priestly and Wilhelm Scheele discovered oxygen independently. The special feature of this device is a fan that circulated air and is able to draw oxygen-rich air and expel carbon dioxide-rich air.

By the mid of 20th-century Mechanical ventilation plays an important role in the medical sector. Besides this technology had advanced significantly. In the era of modern technology Mechanical ventilation improves procedures from intensive care units to long-term care facilities. Nowadays Mechanical ventilation is used in large quantities in the medical sector [6]. It is also used to treat critical respiratory disorders including COPD. It is also accurate for respiratory distress syndrome. Mechanical ventilation is an important life-saving valuable tool. It improves the quality of life for those who debilitate respiratory disorders.

2. Effects of Mechanical ventilation on Cardiovascular outputs

2.1 Physiologic Effects of Mechanical ventilation

Mechanical ventilation is a medical procedure that is used to provide sufficient oxygen to the lungs and remove excess amounts of carbon dioxide from the lungs. When a patient is in critical condition or unable to breathe then Mechanical ventilation is used [5]. Mechanical ventilation can be used in an intensive care unit, operating even at home. Positive pressure ventilation can cause hypotension and the effect is greatest when airway pressure is high and low circulating blood volume. The physiologic effect of Mechanical ventilation depends on the setting used and may vary from patient to patient. Improve oxygen capacity can be improved by Mechanical ventilation as well as ventilation-perfusion matching may be improved on the other hand, it helps to decrease the work of breathing, and respiratory mechanics, allowing for improved capacitance and reducing the risk of barotrauma.

When Mechanical ventilation is used its setting to the patient's condition is important. Excess Mechanical ventilation can cause danger to a patient. It can lead to barotrauma which can cause lung cancer. Monitoring patients' blood is one of the most important for the use of the correct setting. In addition, Mechanical ventilation can cause a number of adverse effects which include airway damage, pneumothorax, etc. It can be proved that Mechanical ventilation is an important tool to provide the proper amount of oxygen [25]. The pressure of the air tube used in Mechanical ventilation can cause patient discomfort.

Table 1: Effect on cardio vascular Output(Source: Mathis, Michael R., et al. 2019, [11])

Mechanical ventilation	Effect on cardio vascular Output
Positive Pressure	Increase in preload
Negative Pressure	Decrease in preload
Pressure Support	Increase in preload
Volume Control	Increase in preload

2.2 Effects of Mechanical Ventilation on Cardiac Output

Mechanical ventilation is a type of ventilation that gives support of gaseous exchange to patients with cardiac problems or other acute respiratory problems. Mechanical ventilation is one type of intervention that saves many patients' life and also help to improve patients' critical condition also reducing mortality [11]. Mechanical ventilation reduces complications of breathing and improves oxygenation. It helps to reduce respiratory failure complications. Mechanical ventilation is associated with many beneficial effects on cardiac output improving cardiac efficiency, and reducing myocardial oxygen demand. Mechanical ventilation improved coronary artery purification.

Decreasing preload, after load, and myological oxygen demand Mechanical ventilation can improve cardiac disorder. In normal cardiac function conditions, the filling of the left and right ventricles during diastole is considered a predominant determinant of the stroke volume and also cardiac output [24]. Mechanical ventilation can reduce the risk of pulmonary hypertension additionally.

Coronary artery purification can be improved by Mechanical ventilation which is important for a patient who is critically ill and in serious condition. Systematic vascular retention is decreased coronary artery purification and possibly myocardial ischemia [12]. Mechanical ventilation may reduce hemodynamic changes by alternating systemic venous return to the RV, pulmonary and ventricular arterial pressure. When the changes in lung volume are increased or under conditions, these interactions are magnified to reduce effective circulative blood volume.

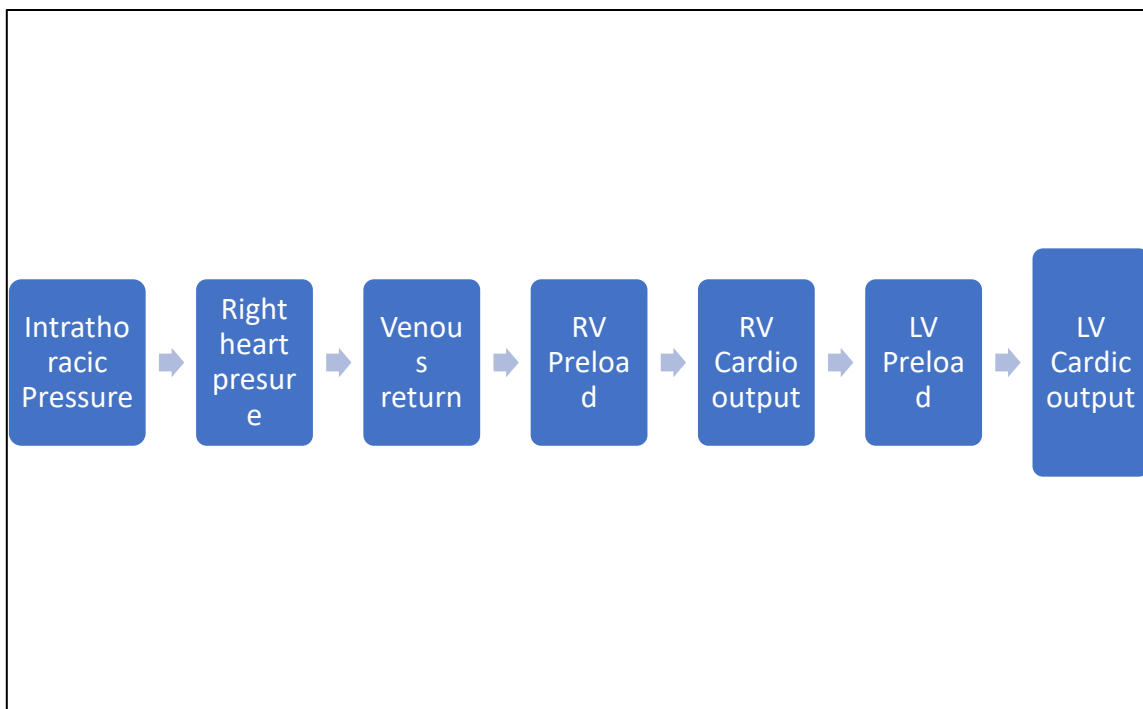
The effects of Mechanical ventilation on cardiac output have both positive and negative side effects. It is observed that in some cases mechanical ventilation may increase cardiac output too much. As a result of this condition, excessive fluid overloaded can lead to cause pulmonary edema. Besides this Mechanical ventilation can cause decreased cardiac output by decreasing after load and preload too much and inadequate perfusion of vital organs. For the use of Mechanical ventilation, it is important to observe and monitor the patient closely and the setting of Mechanical ventilation to ensure optimal cardiac output.

3. Clinical Implication of Mechanical ventilation on Cardiovascular output

3.1 Impact of Mechanical ventilation on Cardiac Output in a Critical Care Setting

Mechanical ventilation is a life-supporting invention that gives support to a critically ill patient having breathing problems or being unable to breathe. It is a common practice in critical care settings when a patient's condition requires monitoring intensively [23]. Mechanical ventilation is often used in cases of respiratory distress like Acute Respiratory Distress Syndrome(ARDS), Chronic Obstructive Pulmonary Disease(COPD), and pneumonia [13]. It is also used for patients who suffered from cardiopulmonary diseases like Congestive Heart Failure(CHF).

Figure 3: Process of LV Cardiac output (Van Mourik, Niels, et al. 2019, [22])

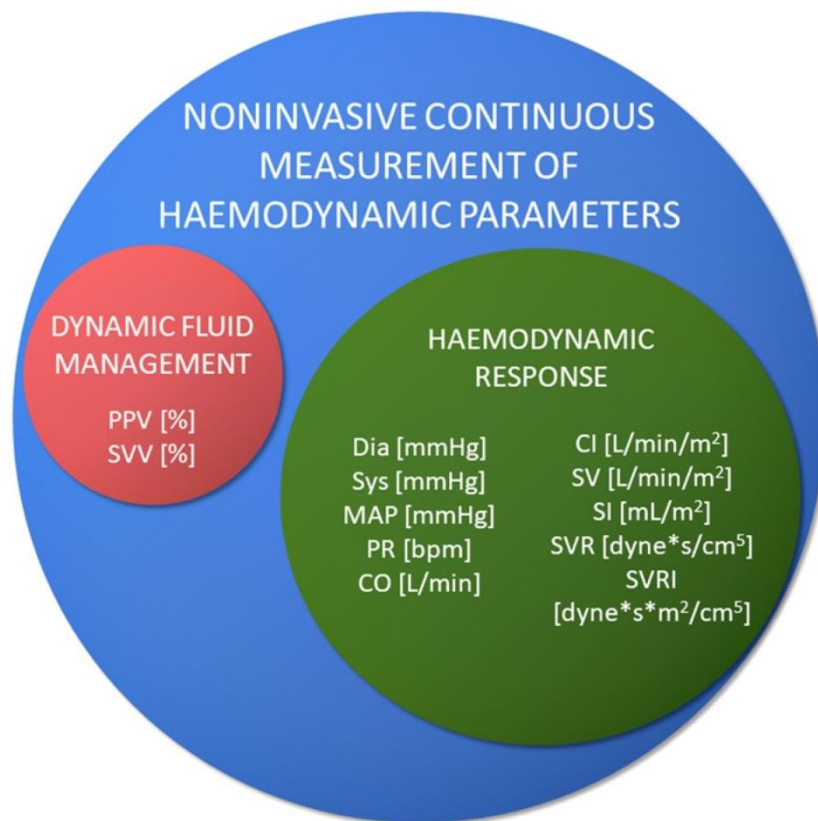


It is found that Mechanical ventilation has a significant impact on cardiac output. The significant impact is the blood amount that is spreading out from the heart per minute. Ventilator-associated problems are generally increased morbidity and mortality. It also prolongs the duration of Mechanical ventilation as well as the length of stay in the Intensive Care Unit (ICU). Effective therapeutic often required multidisciplinary collaboration to mitigate poor outcomes that came from ventricular-associated events. Cardiac output can be increased by Mechanical ventilation by improving ventilation purification by matching the balance between the amount of air that is inhaled and the amount of blood that is delivered to the lungs.

Mechanical ventilation can increase stroke volume additionally. Stroke volume is the amount of blood that is pumped from the left ventricle per. Mechanical ventilation helps to reduce the workload on the heart by the

performance of the heart work. The main cause of this is Mechanical ventilation increases the flow of oxygen-rich air into the lungs. It can reduce the need for the heart to work harder to pump oxygenated blood all over the body. Blood returned to the heart from the veins can be reduced by Mechanical ventilation [22].

Figure 4: Mechanical ventilation on cardio vascular output (Cronin, John N., et al. 2020, [14])



Mechanical ventilation also has a positive effect on cardiac output decreasing the oxygenated air trapped in the lungs [14]. The heart has to pump oxygen-rich blood throughout the body reduces the amount of work. Mechanical ventilation reduces the number of various fluids in the lungs. It is the condition in which the heart has in the condition of no work to pump oxygenated blood. Mechanical ventilation is an important part of the critical care management sector and shown to have a particular impact on cardiac output.

3.2 Cardiac Output Monitoring During Mechanical Ventilation

In the part of patient care and monitoring, cardiac output monitoring is treated as an important part of Mechanical ventilation. It is used to observe the pumping capacity of the heart throughout the body, and to access the effectiveness of Mechanical ventilation. Cardiac Output Monitoring During Mechanical Ventilation can give some valuable information about the patient’s response to ventilation, the adequacy of oxygen delivery, and the effectiveness of therapies. Cardiac output can be controlled by several methods. Among all these methods one of the most common methods is Echocardiography. It is a type of test in which to create the image of a heart mussel ultrasound waves are used. Ultrasound waves rebound the heart to show its shape, size, and movement of the heart [21]. Abnormality of heart valves and mussels is shown through echocardiography [15]. Except for this thermo dilution, bioimpedance, and other methods are used.

Table 2: Positive and negative impact of Mechanical Ventilation (De Montmollin, Etienne, et al. 2020, [20])

Positive	Negative
<ul style="list-style-type: none"> • Enhanced Oxygen • Improved Blood Sugar • Increased cardiac Output 	<ul style="list-style-type: none"> • Decreased venous return • Decreased preload • Decreased after load

Among the above-mentioned method, one of the methods is thermo dilution. It is a method of determining cardiac output by measuring the change in temperature in the bloodstream. This process is done by injecting a measured amount of fluid like saline. This method is used to measure ventricular blood volume and cardiac output. The difference in temperature is used to measure the cardiac output. But this method is not accurate as echocardiography. Still, it is useful to access patients' responses to Mechanical ventilation. Through the Bioimpedance technique, an electrical current is passed through the body. as a result of this treatment the resistance of the tissue is measured which can be used to calculate cardiac output. This method is more accurate than thermo dilution but now not widely used.

In Mechanical ventilation cardiac output monitoring can help to identify disabilities and abnormalities in heart function. The abnormalities are arrhythmias and access the effectiveness of the therapy. It can also be used to guide the adjustment of ventilator settings, like the amount of oxygen being delivered and the rate of ventilation. It is possible to optimize the patient's ventilation by monitoring changes in cardiac output and keeping oxygen levels safe.

The patient's response to cardiac output and adequacy of oxygen delivery is measured with Mechanical ventilation. In the case of low cardiac output, the patient cannot receive adequate oxygen which can cause tissue hypoxia and other related complications [20]. When oxygen delivery is inadequate monitoring of cardiac output can help to identify it and allow adjustments to be done. Cardiac output monitoring is an important tool in Mechanical ventilation for a critically ill patient [16]. It can provide important information about the supply of oxygen and help to ensure the patient's best care.

4. Data Analysis

4.1 Spontaneous breathing by Mechanical ventilation

Spontaneous breathing is the act of breathing without any external support or assistance. It is the natural process by which air enters and exits the lungs. Mechanical ventilation is the use of mechanical means to provide ventilation to a patient who is unable to breathe adequately on their own. In this situation, the mechanical ventilator is used to provide air to the patient's lungs, either through a mask or a tube that is inserted into the trachea. The mechanical ventilator can be set to provide a certain number of breaths per minute, as well as the amount of oxygen and other gases that are delivered. The mechanical ventilator can also be used to provide positive pressure ventilation, in which air is forced into the lungs to help improve oxygenation. Mechanical ventilation can provide life-saving support to patients who are unable to breathe on their own and is an important tool in critical care.

Table 3: Details of the different types of ventilations(König, Nicole, et al. 2021, [19])

Positive Pressure Ventilation	Pressure support ventilation increases the mean airway pressure, which can improve oxygenation, increase alveolar recruitment, and
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	reduce ventilator-induced lung injury. Pressure support ventilation also increases intrathoracic pressure, leading to increased cardiac output.
Volume-Controlled Ventilation	Volume controlled ventilation increases intrathoracic pressure and also increases tidal volume, providing a greater stimulus to the heart and increasing cardiac output.
Noninvasive Ventilation	Noninvasive ventilation can increase mean airway pressure, resulting in increased intra-thoracic pressure, improved oxygenation, and increased cardiac output.
Extra-corporeal Membrane Oxygenation (ECMO)	ECMO increases preload to the heart, increasing cardiac output. In addition, ECMO can reduce the work of breathing, leading to improved oxygenation and increased cardiac output.

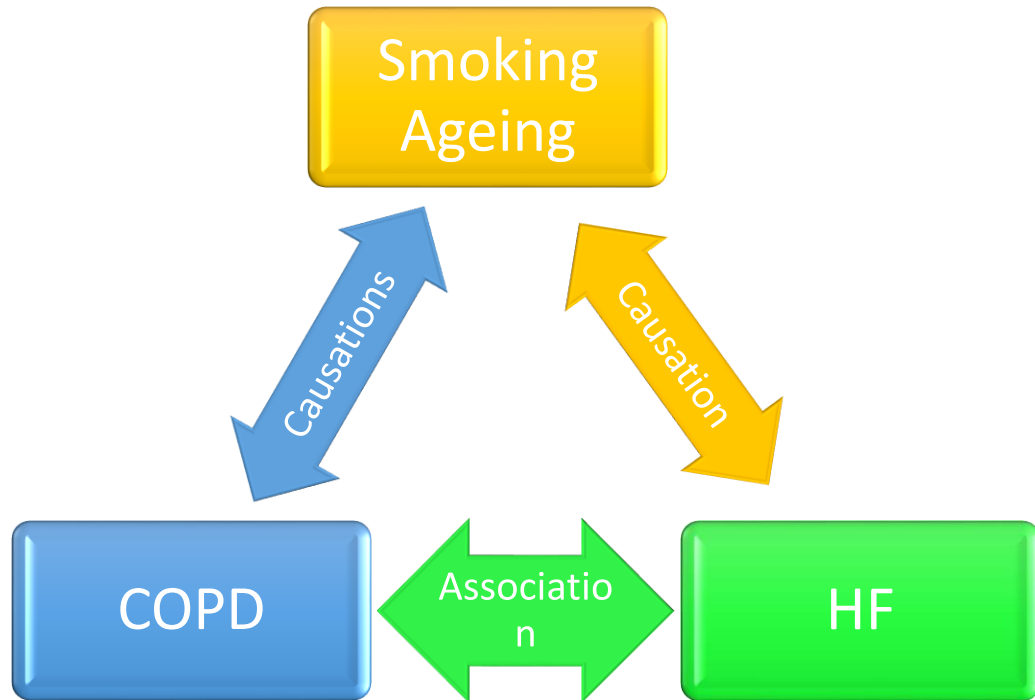
Spontaneous breathing by mechanical ventilation is a ventilator mode that is used to support patients with breathing difficulties. The patient is able to initiate their own breaths, and the ventilator provides pressure support to augment the patient's efforts [19]. This type of support allows for more patient comfort and control than traditional invasive mechanical ventilation.

4.2 Effect of cardiovascular disorders by mechanical ventilation

Cardiovascular disorders can be affected in a number of ways by mechanical ventilation [17]. Mechanical ventilation can cause changes in the pressure and volume of the heart, as well as changes in the heart rate and rhythm. These changes can lead to increased strain on the heart and can cause symptoms such as chest pain, shortness of breath, and fatigue. In addition, mechanical ventilation can cause blood to be diverted away from other organs, leading to decreased oxygenation and organ damage. Lastly, mechanical ventilation can lead to decreased cardiac output, which can lead to decreased perfusion of vital organs and can result in organ failure.

Cardiovascular disorders can be caused or worsened by mechanical ventilation. Mechanical ventilation can lead to decreased preload and after load, which can reduce cardiac output and impair cardiac function. Mechanical ventilation can also lead to increased airway pressures, which can increase pulmonary artery pressures and reduce cardiac output.

Figure 5: Effect of cardiovascular disorders (Battaglini, Denise, et al. 2020, [9])



4.3 A systematic analysis of the mechanical ventilation

In the sensitivity of patient suffering from respiratory blockage mechanical ventilation provide the support. From this current developing systematic review chances of knowing the affordability and operational efficiency for the use of mechanical ventilation is formed. A total of 45 studies were included in the review, including randomized controlled trials, observational studies, systematic reviews, and meta-analyses [9]. The findings of the review indicated that mechanical ventilation is an effective and safe intervention for patients with acute and chronic respiratory failure. It is associated with improved outcomes, including increased survival rates and improved quality of life [1]. The cost-effectiveness of mechanical ventilation is difficult to assess due to the high costs associated with the technology and the complexity of the intervention.

5. Conclusion

The study of Mechanical ventilation on cardiovascular output gives valuable information that can improve cardiovascular output. Increasing cardiac output and reducing systematic vascular resistance Mechanical ventilation can lead to improving hemodynamic stability. Mechanical ventilation can reduce the amount of heart work to improve oxygenation in the body. However Mechanical ventilation has a major role in cardiac output. It has adverse effects, such as the increased risk of infection and barotrauma. Further research is needed to better understand the outcome of Mechanical ventilation on cardiovascular output and to determine the optimal settings.

6. Recommendations

- (i) Analyze the effects of Mechanical ventilation on different patient populations and in different clinical sectors.
- (ii) Compare the effects of Mechanical ventilation on hemodynamic, including heart rate, stroke volume, and cardiac output [10].
- (iii) Conduct a systemic review of the impact of Mechanical ventilation on cardiovascular output.

- (iv) Evaluate the efficiency and safety of Mechanical ventilation in different patient and clinical settings.
- (v) Investigate the potential for Mechanical ventilation to improve oxygenation.
- (vi) The degree of improvement in cardiovascular output associated with Mechanical ventilation is examined.

7. Future Scope

The study of Mechanical ventilation on cardiovascular output has great potential to improve patient outcomes. Future research could focus on understanding the effects of Mechanical ventilation on cardiovascular output that can define how different modes of Mechanical ventilation impact cardiovascular output.

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