An-Najah National University

Faculty of Graduate Studies

Comparing Adaptive Support Ventilation (ASV) and Synchronized Intermittent Mode of Ventilation (SIMV) in Patients Undergoing Coronary Artery Bypass Grafting Surgery

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Dedication

بسم الله الرحمن الرحيم

(وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنون) صدق الله العظيم

إلهي لا يطيب الليل إلا بشكرك ولا يطيب النهار إلى بطاعتك.. ولا تطيب اللحظات إلا بذكرك.. ولا تطيب الآخرة إلا بعفوك.. ولا تطيب الجنة إلا برؤيتك.

الله جل جلاله

إلى من بلغ الرسالة وأدى الأمانة.. ونصح الأمة.. إلى نبي الرحمة ونور العالمين.

سيدنا محمد صلى الله عليه وسلم

والدي العزيز

إلى من كلله الله بالهيبة والوقار، إلى من علمني العطاء بدون انتظار، إلى من أحمل أسمه بكل افتخار، أرجو من الله أن يمد في عمرك لترى ثماراً قد حان قطافها بعد طول انتظار، وستبقى كلماتك نجوم أهتدي بها اليوم وفي الغد وإلى الأبد

أمي الحبيبة

إلى ملاكي في الحياة، إلى معنى الحب والحنان والتفاني، إلى بسمة الحياة وسر الوجود، إلى من كان دعائها سر نجاحي وحنانها بلسم جراحي، إلى أغلى الحبايب.

زوجتي الغالية

بكل الحب، إلى رفيقة دربي التي جمعني بها القدر، وأضاءت ليالي السهر، وجسدت معاني العطاء والصبر وسارت معي خطوة بخطوة نحو العلم الذي بذرناه معا، وحصدناه معا، سنبقى معا بإذن الله.

إخواني وأخواتي الأحباء

إلى اللذين ظفرت بهم هدية من الله إخوة فعرفوا معنى الإخوة، إخوتي وأخواتي الأحباء حفظكم الله ورعاكم.

أصدقائي

إلى الأخوة الذين لم تلدهم أمي، إلى من تحلو بالإخاء، وتميزوا بالوفاء والعطاء، إلى ينابيع الصدق الصافي، إلى من معهم سعدت، وبرفقتهم في دروب الحياة الحلوة والحزينة سرت، إلى من كانوا معي على طريق النجاح والخير.

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الإقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Comparing Adaptive Support Ventilation (ASV) and Synchronized Intermittent Mode of Ventilation (SIMV) in Patients Undergoing Coronary Artery Bypass Grafting Surgery

أقر بأن ما اشتملت عليه هذه الرسالة انما هي نتاج جهدي الخاص، باستثناء ما تم الاشارة اليه حيثما ورد، وان هذه الرسالة ككل او اي جزء منها لم يتقدم لتنال اي درجة او لقب علمي او بحثي لدى اي مؤسسة تعليمية او بحثية أخرى

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work and has not been submitted elsewhere for any other degree or qualification.

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List of Abbreviations

Abbreviation	Meaning
ABGs	Arterial Blood Gases
ACV	Assist Control Ventilation
ANNU	An-Najah National University
ANOVA	Analysis of variance
ARDS	Acute Respiratory Distress Syndrome
ASV	Adaptive Support Ventilation
b/m	beats per minute
BMI	Body Mass Index
bpm	breath per minute
CABG	Coronary Artery Bypass Grafting Surgery
CAD	Coronary Artery Disease
Cc	Cubic centimeters
CCU	Cardiac Care Unit
CHD	Coronary Heart Disease
Cm	Centimeter
cmH2O	Centimeter Of Water
CO2	Carbon Dioxide
COPD	Chronic Obstructive Pulmonary Disease
CPAP	Continuous Positive Airway Pressure
CPB	Cardiopulmonary Bypass
DBP	Diastolic Blood Pressure
DM	Diabetes Mellitus
etc.	et cetera
EtCO2	End-Tidal Carbon Dioxide
ETS	Expiratory Trigger Sensitivity
FIO2	Fraction Of Inspired Oxygen
F-test	Repeated ANOVA measure
HR	Heart Rate
hr.	Hour
HTN	Hypertension
IAH	AL-Istishari Arab Hospital
IBW	Ideal Body Weight
ICU	Intensive Care Unit
IE ratio	Inspiration to expiration ratio
IHD	Ischemic Heart Disease
IRB	Institutional Review Board
Kg	Kilogram
L/min	Liter Per Minute
MAP	Mean Arterial Pressure
mcg/kg/hr.	Micrograms per kilograms per hour

mcg/min	Micrograms per minute
mg	Milligram
MI	Myocardial Infarction
MinVol	Minute Volume
ml	Milliliter
ml/Kg	Milliliter per kilogram
mmHg	Millimetre of mercury
MOH	Ministry of Health
MV	Mechanical ventilation
n	Number of the subjects.
O2	Oxygen
P	P-value
P peak	peak inspiratory pressure
P/F ratio	Pao2/Fio2 ratio
Paco2	The partial pressure of carbon dioxide
Pao2	Partial pressure of oxygen
Pasv	Peak pressure delivered in ASV
PCI	Percutaneous Coronary Intervention
PCV	Pressure Control Ventilation
PEEP	Positive End Expiratory Pressure
pH	Potential of Hydrogen
Pinsp	Prussur Inspiration
P-peak	Peak Airway Pressure
P-ramp	Pressure ramp. Time required for inspiratory pressure to rise to the set (target) pressure
PRVCa	Pressure-Regulated Volume-Controlled Ventilation with automode
PS	Pressure Support
PSV	Pressure Support Ventilation
PVD	Peripheral Vascular Disease
RCT	Randomized Controlled Trial
RR	Respiratory Rate
RSBI	Rapid Shallow Breathing Index
SBP	Diastolic Blood Pressure
SD	Standard Deviation
SIMV	Synchronized Intermittent Mode of Ventilation
SPO2	Saturation Of Peripheral Oxygen
SPSS	Statistical Package for Social Sciences
T	Student t-test
TMV	Target Minute Volume
VAP	Ventilator-Associated Pneumonia
vs.	Versus
Vt	Tidal Volume
%	Percent

%MinVol	Adjustment of target minute ventilation
χ2	Chi-square test.
°C	Celsius
°F	Fahrenheit
µg	Microgram

Comparing Adaptive Support Ventilation (ASV) and Synchronized Intermittent Mode of Ventilation (SIMV) in Patients Undergoing Coronary Artery Bypass Grafting Surgery

By
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Dr. Hadeel Ghaith

Abstract

Background: Mechanical ventilation is used frequently to provide respiratory support in patient that go to Coronary artery bypass grafting surgery. One of the most common respiratory modes used for patients receiving CABG is Synchronized Intermittent Mandatory Ventilation. Other mode can be used is Adaptive Supportive Ventilation to decrease pulmonary complication.

Aim: The general aim of this research is to measure the effects of Adaptive Support Ventilation (ASV) on duration of mechanical ventilation and Hospital Stay in CCU compare with Synchronized Intermittent Mode of Ventilation (SIMV) as controls among patients undergoing CABG surgery.

Method: Randomized controlled trial design "single-blind controlled trial" was used in this study. 100 patients, was included and divided into two group, (1) patients on ASV mode; (2) patients on SIMV mode. The study carried out in the cardiac Care Unit at AL-Istishari Arab Hospital (IAH) in Palestine.

Results: The results showed that there is no statistically significant difference between ASV and SIMV regarding gender, age and BMI ($P>0.05$). The percentage of smokers' hookah among ASV was statistically significant differences compared with SIMV (18% vs. 42.0%, respectively,

P<0.05). The mean of mechanical ventilation duration was lower statically significant in ASV patients compared with SIMV (4.88±0.48 hr. vs. 5.98±0.77 hr. respectively and P < 0.005). By same away, the mean of length of stay in CCU was lower statically significant in ASV patients compared with to SIMV (3.66±0.56 vs. 6.02±0.84 days respectively and P < 0.005). The average number of ABGs in this study was lower statically significant in ASV patients compared with to SIMV (4.00±0.64 vs. 5.86±0.64 respectively and P < 0.005). Finally, the average respiratory rate, SPO_2, SBP, DBP, set rate, FIO_2, was higher statistically significantly different in ASV compared to SIMV during the first 12 hr. after CABG surgery. The mean of heart rate in ASV groups was lower statistically significant than SIMV groups. There are no statistically significant differences between SIMV and ASV regarding average FIO2, PEEP, IE ratio, SBP, DBP and minute volume.

Conclusion: ASV compared to SIMV were statistically significant differences regarding to mechanical ventilation duration, the length of stay in CCU, average number of ABGs, respiratory rate, heart rate, SPO2, SBP, DBP, set rate, and FIO2. In contrast, there is no association between the type of ventilation and socio-demographic characteristics.

Key words: Adaptive Support Ventilation (ASV), Synchronized Intermittent Mode of Ventilation (SIMV), Coronary Artery Bypass Grafting Surgery (CABG).

Chapter One

Introduction

1.1. Research Overview:

The most popular form of open-heart surgical interventions to treat people at high stages of coronary artery disease (CAD) is coronary artery bypass grafting (CABG); it is performed to minimize cardiac-related mortality and enhance & increase quality of life in patients with coronary artery disease (Domburg, Kappetein, & Bogers, 2009). In details, in the 1960s coronary artery bypass grafting was first performed with the goal of relieving symptomatic, enhancing quality of life, and rise expectancy of life for patients with coronary artery disease (Konstantinov, 1997). By the 1970s, compared with medical therapy, coronary artery bypass grafting has been shown to raise the rates of survival in patients with multi-vessel disease and left main disease (Veterans Administration Coronary Artery Bypass Surgery Cooperative Study Group, 1984). The surgery is carried out when atherosclerosis of one or more of coronary arteries is sufficiently extreme to demonstrate a minimum 50 percent arterial lumen stenosis in angiographic image. Since 1980, the number of coronary artery bypass grafting surgeries performed to treat coronary artery disease has grown more than five times, and the general trend has been an almost constant increase in the number of surgeries carried out annually (National Heart, Lung and Blood Institue, 2021).

Mechanical ventilation is used frequently to provide respiratory support in most critical ill patient in intensive care unit and in patient undergoing to general anesthesia. Also, when the spontaneous breathing of the patient's is insufficient to sustain life, mechanical ventilation is indicated. Moreover, it

is indicated for ineffective gas exchange in the lungs, or as prophylaxis for imminent collapse of other physiologic functions (Tobin, 2012).

The main goal of mechanical ventilator is to optimize the levels of arterial blood gases (ABG) and promote acid-base balance by providing O_2 and eliminating CO_2 (ventilation). Mechanical ventilation can minimize the breathing work by taking effort from respiratory muscles and sustaining the long-term respiratory support for chronic diseases patients (Guillén & Gómez, 2020).

Synchronized Intermittent Mandatory Ventilation (SIMV) is one of the most often used respiratory modes for patients undergoing coronary artery bypass grafting (Arnal, et al., 2008). Regardless of being useful, there are documented defects in this respiratory mode; when the respirations number from ventilator is fallen during weaning patients from the device, reduction in ventilation, respiratory acidosis and carbon dioxide retention are experienced (Comer, 2004). As a result, during ventilation, intensive care unit nurses must provide constant, proper and careful care (Chen, Cheng, Shih, Chu, & Liu, 2008). Another significant issue is the requirement for performing blood tests and repeated analysis of arterial blood gases (ABGs) after any decrease in the mechanical respirations number (Urden, Stacy, & Lough, 2008). Such a prolonged and gradual decline in mechanical respirations leads to unwarranted prolongation when weaning patients from ventilation device (Urden, Stacy, & Lough, 2013). As a result, it is of utmost significance to use a respiratory mode for patient ventilation, which needs less involvement from intensive care unit nurses and can smartly screen the condition of the patients (Gruber, Gomersall, Leung, Ng, & Underwood, 2008).

With Synchronized Intermittent Mandatory Ventilation, breaths can be either spontaneous or mandatory ventilator controlled. The mandatory breaths are synchronized with patient effort (i.e., they are patient triggered). The mandatory breaths can be either pressure controlled or volume controlled. The patient's remaining inspiratory efforts result in spontaneous breaths which may be pressure-supported. The main purpose of Synchronized Intermittent Mandatory Ventilation was to utilize the respiratory muscles during the spontaneous breaths and to rest the muscles during the mandatory breaths. Weaning is accomplished by reducing the rate of mandatory breath, needing additional spontaneous breathing effort to sustain minute ventilation. It has been shown that during the mandatory breath delivery of Synchronized Intermittent Mandatory Ventilation, respiratory muscle rest does not occur. In actuality, respiratory muscle activity and respiratory center output are just as high during Synchronized Intermittent Obligatory Ventilation's mandatory breaths as they are during spontaneous breaths. To put it in another way, the respiratory center does not adjust its output in expectation of the next breath type provided by the ventilator. As a result, Synchronized Intermittent Mandatory Ventilation can cause respiratory muscles fatiguing load instead of alternating intervals of exercise and rest (Hess, 2002).

In addition, Adaptive Supportive Ventilation (ASV) is now one of the modes that are administered in recent mechanical ventilators (Rose, et al., 2011). Whereas in every respiratory cycle, this mode monitors patients smartly (Mireles-Cabodevila, Diaz-Guzman, Arroliga, & Chatburn, 2012). If spontaneous breathing does not presence, the ventilator provides controlled pressure ventilation on the patient, but in the presence of spontaneous breathing, it works smartly and automatically as a supportive pressure mode by supporting the breathing attempts of the patient (Hemant, Chacko, &

Singh, 2006). As a result, there would be no interference between the patient's breathing attempts and the ventilator's breathing supports (Rose, Nelson, Johnston, & Presneill, 2007).

ASV is a new ventilation mode, a closed-loop control mode which can automatically switch from PCV-like behavior to SIMV-like or PSV-like behavior depending on the patient's condition. The principles of operating are depending on pressure-controlled Synchronized Intermittent Mandatory Ventilation with pressure levels and Synchronized Intermittent Mandatory Ventilation rate automatically adjusted based on lung mechanics that measured at each breath. Adaptive Support Ventilation offered effective and safe ventilation in patients with normal lungs, obstructive or restrictive diseases. In heart surgery tracheal extubating was quicker in Adaptive Support Ventilation patients than in Synchronized Intermittent Mandatory Ventilation. The need of resetting ventilator parameters decreased in the early weaning phase of acute ventilator insufficiency, indicating potential benefit for patient care (Brunner & Iotti, 2002).

The aim of this research is to measure the effects of Adaptive Support Ventilation (ASV) on duration of mechanical ventilation and Hospital Stay in CCU compare with Synchronized Intermittent Mode of Ventilation (SIMV) as controls among patients undergoing CABG surgery.

1.2. Research questions:

- What are the effects of Adaptive Support Ventilation (ASV) and Synchronized Intermittent Mode of Ventilation (SIMV) on duration of mechanical ventilation and hospital stay in CCU among patients undergoing CABG surgery?

- Is there any significant difference between ASV and SIMV regarding to (Age, gender, BMI, and past medical or surgical history) in patients undergoing CABG surgery?
- What is the number ABGs among ASV and SIMV?
- Is there any significant difference between ASV and SIMV regarding to hemodynamic changes (SBP, DBP RR, HR, SPO_2) in patients undergoing CABG surgery?
- Is there any significant difference between ASV and SIMV regarding to respiratory setting and mechanical ventilation management in patients undergoing CABG surgery?
- Is there any significant difference between ASV and SIMV regarding to total intake and output during first 12 hr. after operation in patients undergoing CABG surgery?

1.3. Problem Statement:

Statistics indicate that heart disease is one of the main causes of death in Palestine in 2018, reaching 30% of all deaths in the Palestinian community (Bethlehem Arab Society for Rehabilitation, 2018).

Also, according to a report issued by the Palestinian Ministry of Health in the last quarter of 2019, cardiovascular diseases continue to be the leading cause of death in Palestine, where the death rate from these diseases reached 29.9% of all deaths. The report stated that the cardiovascular diseases is the first and main cause of death around the world, accounting for 31% of the global death toll. It also demonstrated that cardiovascular diseases in Palestine often appear as a result of the accumulation of several causes, including: unhealthy lifestyle, physical inactivity, obesity, improper diet, and smoking (MOH, 2020).

In detail, the death rate from heart attacks in the year 2019 in Palestine was 11.7% of the total recorded deaths, with a rate of 32.4 deaths per 100,000 inhabitants, and the death rate from ischemic heart disease among the Palestinians was 12.7% of the total recorded deaths, with a rate of 35.1 deaths per 100,000 inhabitants (MOH, 2020).

Studies on the topic of comparison between synchronized intermittent mode of ventilation (SIMV) and adaptive support ventilation (ASV) are limited and the need more studies seems to be necessary in this regard.

The limited previous literature about topic reflects several research gaps and support the need for more research that explore comparison between ASV and SIMV.

Unfortunately, there are no research studies in Palestine that have conducted to compare between the adaptive support ventilation and synchronized intermittent mode in ventilation in Patients Undergoing Coronary Artery Bypass Grafting. Therefore, the researcher wants to focus on this topic.

1.4. Significant of the study:

The current study was conducted to provide the responsible persons, hospitals, health staff and those interested in the results of this study in Palestine with a dilated comparison between two of the most mechanical ventilation modes (ASV and SIMV modes) in coronary care unit (CCU) by different variables to take advantage of it and to improve hospitalization outcome, and to determine the most user friendly and easily ventilation mode, and can reduce health care expenses and the patient CCU hospital stay by reducing intubation time. In addition, the study encourages future research in the mechanical ventilation modes.

1.5. Objectives of the study:

1.5.1 General objective:

The general aim of this research is to measure the effects of Adaptive Support Ventilation (ASV) on duration of mechanical ventilation and Hospital Stay in CCU compare with Synchronized Intermittent Mode of Ventilation (SIMV) as controls among patients undergoing CABG surgery.

1.5.2 Specific objectives:

- To evaluate patient's information (Age, gender, BMI and past medical or surgical history) among ASV and SIMV.
- To assess the number of ABGs among ASV and SIMV.
- To evaluate hemodynamic changes (SBP, DBP, RR, HR, SPO_2) among ASV and SIMV.
- To assess respiratory setting and mechanical ventilation management (Mode, FIO_2, Set rate, Tidal volume, PEEP, I:E ratio, and minute volume) among ASV and SIMV.
- To identify the total intake and output during first 12 hr. after operation among ASV and SIMV.

1.6. Research hypothesis:

There is no significant difference at a level of 0.05 related to patient's information (Age, gender, BMI and past medical or surgical history) between adaptive support ventilation (ASV) and synchronized intermittent mode of ventilation (SIMV) in patients undergoing Coronary artery bypass grafting surgery.

There is no significant difference at a level of 0.05 related to duration on mechanical ventilation between adaptive support ventilation (ASV) and

synchronized intermittent mode of ventilation (SIMV) in patients undergoing Coronary artery bypass grafting surgery.

There is no significant difference at a level of 0.05 related to length of stay in CCU between adaptive support ventilation (ASV) and synchronized intermittent mode of ventilation (SIMV) in patients undergoing Coronary artery bypass grafting surgery.

There is no significant difference at a level of 0.05 related to number of ABGs between adaptive support ventilation (ASV) and synchronized intermittent mode of ventilation (SIMV) in patients undergoing Coronary artery bypass grafting surgery.

There is no significant difference at a level of 0.05 related to hemodynamic changes between adaptive support ventilation (ASV) and synchronized intermittent mode of ventilation (SIMV) in patients undergoing Coronary artery bypass grafting surgery.

There is no significant difference at a level of 0.05 related to respiratory setting between adaptive support ventilation (ASV) and synchronized intermittent mode of ventilation (SIMV) in patients undergoing Coronary artery bypass grafting surgery.

There is no significant difference at a level of 0.05 related to intake & output between adaptive support ventilation (ASV) and synchronized intermittent mode of ventilation (SIMV) in patients undergoing Coronary artery bypass grafting surgery.

Chapter Two

Background

2.1. Coronary Artery Bypass Grafting (CABG) Surgery:

CABG is a form of cardiac surgery for people who have CHD, which considered a leading reason of mortality in Western countries. It's distinguished by the slow accumulation of fatty and calcium deposits (plaque) in the arteries that provide blood to the heart. This causes a reduction in the amount of blood flow to the heart, producing chest pain or, if the arteries become completely blocked, a heart attack can produce. The purposes of coronary artery bypass graft surgery include alleviating symptoms, lowering the risk of a heart attack, and enhancing survival (Harris, Croce, & Tian, 2013).

2.1.1 Definition of CABG:

It is a surgical procedure where a blood vessel from another body part is grafted onto the occluded coronary artery below the occlusion in such a way that blood flow bypasses the blockage (Smeltzer, Hinkle, Bare, & Cheever, 2010).

In which native vessels (conduits) are “harvested” and grafted into place to redirect blood flow past diseased sections of the coronary arteries. Coronary artery bypass grafting surgery has been shown to be effective in alleviating symptoms and extending life for patients with left main coronary heart disease and three-vessel disease with poor left ventricular function. In many cases, the increased usage of PCI techniques has reduced the necessity for coronary artery bypass grafting surgery. Patients who are selected for coronary artery bypass grafting surgery nowadays are older, have more

advanced coronary disease, have more impaired left ventricular function, and have had history of Coronary artery bypass grafting surgery in many cases. The most common grafts that are widely used are radial artery grafts, internal mammary artery grafts, and saphenous vein grafts (Morton & Fontaine, 2013).

2.1.2 Patient that undergoing to cardiac surgery

Prime candidates for CABG include patients who have any of the following: three-vessel disease with normal left ventricular function at rest but with inducible ischemia and poor exercise capacity, three-vessel disease with proximal stenoses or left ventricular dysfunction, severe proximal left anterior descending coronary artery stenosis, left main coronary artery stenosis and medically uncontrolled angina interfering with the patient's lifestyle (Malone, Mitchell, & Ratnatunga, 2011).

2.1.3 Stages to bypass surgery:

Bypass surgery is divided into two stages:

Stage (1) involves the removal of a graft (the healthy blood vessel) from the chest wall, arm, or leg. *Stage (2)* involves graft connecting to coronary artery, ‘bypassing’ the diseased part, and optimizing the blood flow to the heart (Malone, Mitchell, & Ratnatunga, 2011).

The surgeon will utilize one of two methods to operate on the heart. (a) A heart-lung machine is used for circulating the blood throughout the body, enabling the surgeon to do cardiac surgery. Alternatively, (b) the technique of ‘beating heart' is used, in which the operation is done while the heart is still working and beating. This is known as ‘off pump’ surgery. It normally takes 3 to 6 hours (Malone, Mitchell, & Ratnatunga, 2011).

2.1.4 Procedure

After the patient has received general anesthesia, surgery begins with graft harvesting; many incisions are made in the patient's calf or thigh by the surgeon and removes a saphenous vein segment for grafting. Most surgeons prefer using a segment of the internal mammary artery because this provides an artery doing the job of an artery. The surgeon performs a medial sternotomy and exposes the heart once the autografts have been obtained. He then initiates cardiopulmonary bypass. To reduce myocardial oxygen demands during surgery and to protect the heart, the surgeon induces cardiac hypothermia and standstill through injecting a cold cardioplegic solution (potassium-enriched saline solution) into the aortic root. Once the patient has been fully & properly prepped, the surgeon stitches one end of the venous graft to the ascending aorta and the other end to a patent coronary artery distal to the occlusion. The surgeon sutures the graft in a reversed position to promote proper blood flow. He repeats this procedure for each artery he bypasses. Once the grafts are in place, he flushes the cardioplegic solution from the heart and discontinues cardiopulmonary bypass. He then implants epicardial pacing electrodes, inserts a chest tube, closes the incision, and applies a sterile dressing (Mills, 2006).

2.1.5 Understanding cardiopulmonary bypass

Open-heart surgery often involves cardiopulmonary bypass, a technique that's used to divert blood from the heart and lungs to an extracorporeal circuit with a minimum of hemolysis and trauma. The cardiopulmonary bypass (or “heart-lung”) machine uses a mechanical pump to provide ventricular pumping action, an oxygenator to perform gas exchange, and a heat exchanger to cool the blood and lower the metabolic rate during surgery. To perform this procedure, the surgeon inserts catheters into the right atrium

or the inferior or superior vena cava for blood removal and into the ascending aorta for blood return. Then, after heparinizing the patient and priming the pump with fluid to replace diverted venous blood, the surgeon switches on the machine. The pump draws blood from the vena cava catheters into the machine, where it passes through a filter, oxygenator, heat exchanger, and another filter and bubble trap before being returned to arterial circulation. During cardiopulmonary bypass, an anesthesiologist or perfusionist maintains mean arterial pressure by adjusting the rate of perfusion or by infusing fluids or vasopressor drugs (Mills, 2006).

2.1.6 Risks of Coronary Artery Bypass Grafting

like any other surgery, coronary Artery Bypass Grafting surgery has the risks of complications. These risks differ from individual to individual and it depend on many factors, including:

- Sex and age.
- Having renal damage, lung problems, diabetes mellitus or any major health conditions.
- Urgency of the operation.
- Having another surgery at the same time as CABG.
- Weight.
- Smoking.

(Malone, Mitchell, & Ratnatunga, 2011).

2.1.7 Complications

CABG can cause many postoperative complications, including arrhythmias, hypertension or hypotension, cardiac tamponade, thromboembolism, hemorrhage, post pericardiotomy syndrome, and MI. Noncardiac complications include cerebral vascular accident, postoperative depression

or emotional instability, pulmonary embolism, decreased renal function, and infection. Also, such problems as graft rupture or closure or the development of atherosclerosis in other coronary arteries may require repeat surgery (Mills, 2006).

2.1.8 Alternatives to CABG

The CABG's alternatives are:

- Angioplasty – it is a procedure in which a tiny balloon was used by the doctor to open up the narrowed parts of arteries, which may be supported by placing a stent within the coronary artery.
- Medical treatment.

  (Malone, Mitchell, & Ratnatunga, 2011).

2.1.9 Postoperative Care:

Postoperative Care Patients are transported immediately to the CCU, where they recover from anesthesia and often stay at least 24 hours post operation. Patients are admitted to the CCU with a slew of lines and tubes attached to them. Certain individuals will have had temporary pacing electrodes putted on the heart's epicardial surface during operation and brought out through the chest wall on either side of the median sternotomy incision. Chest tubes inserted into the mediastinum and pericardial space for drainage are brought out through stab wounds just under the median sternotomy. Pleural tubes will be present if the pleural space has been entered. Immediate postoperative interventions include monitoring the heart and maintenance of oxygenation and stability of hemodynamic. Cardiopulmonary bypass has profound physiological impacts, because it produces altered blood flow patterns and abnormal blood interface. Constant care entails hypothermia prevention, pain management, and complications monitoring and prevention. In order to

stabilize patients who have just undergone heart surgery, vigilant monitoring, accurate evaluations, and appropriate interventions are essential and critical. (Morton & Fontaine, 2013).

2.2. Adaptive Support Ventilation (ASV):

2.2.1 Overview

ASV is an intelligent mode of ventilation designed to make mechanical ventilation safer, easier to use for the caregiver and more comfortable for the patient (Hamilton Medical, 2017).

The operator sets the %MinVol, PEEP, and Oxygen: %MinVol defines the percent of the patient's minute volume calculated according to its IBW and is a combination of Pinsp, Rate, Tidal volume (Vt), and I:E ratio. Adaptive Supportive Ventilation maintains an operator-preset, minimal minute ventilation independent of the patient's breathing activity. The ventilator calculates the target breathing pattern (tidal volume and inspiratory rate), based on the assumption that if the ideal breath pattern results in the least work of breathing, and the minimal force of breathing also results in the least amount of ventilator-applied inspiratory pressure when there is no patient breathing effort (Hamilton Medical, 2017).

ASV adjusts inspiratory pressure and machine rate on a breath-by-breath basis taking into account the changing patient condition (resistance, compliance) and applying lung-protective strategies to meet the targets. A decrease in pressure limitation will follow with a reduction in tidal volume and a rise in rate. It also encourages the patient to breathe spontaneously thus promoting an early extubation and shortening ventilation time (Hamilton Medical, 2017).

Adaptive Supportive Ventilation tries to steer the patient using a favorable pattern of breathing and avoids potentially pernicious patterns such as excessively large breaths, breath stacking (inadvertent PEEP), excessive dead space ventilation and rapid shallow breathing. Adaptive Supportive Ventilation doesn't replace the necessity for a clinician or physician and it doesn't conduct clinical decisions. Adaptive Supportive Ventilation executes a general command from the physician and the physician can alter it (Hamilton Medical, 2017).

This instruction is being summarized, by highlighting the modifiable parts. Maintain a preset minimum minute ventilation:

- Take into consideration spontaneous respiration.
- Tachypnea, Auto PEEP and excessive ventilation of dead space should be prevented.
- Fully ventilate the patient in the case of low respiratory drive or apnea.
- In the event that the patient can breathe unassisted
- All of this without exceeding a 10 cmH_2O Pinsp pressure beneath the upper pressure limit.
  (Hamilton Medical, 2017).

2.2.2 Indications for use

ASV is indicated for passively breathing and spontaneously breathing adult and pediatric patients (Hamilton Medical, 2017).

2.2.3 Contraindications for use

ASV is NOT indicated for: Neonates and for patients with a high leakage (noninvasive ventilation or bronchopleural fistula) (Hamilton Medical, 2017).

2.2.4 Setting up ASV

To set up the ventilator before connecting a patient

1. Prepare the device for clinical use.
2. In the Standby window, do either of the following:
   - Select patient group, Adult/pediatrics, or Last patient, and one of the three quick set up buttons.
   - Select patient gender and enter patient height.
3. Carry out preoperational checks and calibrations.
4. Set the high-Pressure alarm limit to an appropriate value.

The maximum peak pressure delivered in ASV (Pasv) is 10 cmH2O below high-pressure alarm or equal to Pasv limit. The maximum peak pressure for ASV can be also set using the Pasv control in the Controls window. Changing the Pasv value also changes the high-Pressure limit.

5. In the Modes window, select ASV and touch Confirm. The Controls window automatically opens.
6. Specify the following control settings:
   - %MinVol. Setting a %MinVol value is a logical starting point that will result in the same minute volume as a prior mode, if viable. Add 20 percent if body temperature exceeds 38.5°C (101.3°F) and five percent per 1640 Feet (500 Meters) higher than sea level.
   - PEEP. Set according to clinical requirements.
   - Oxygen. Set according to clinical requirements.
   - Set Trigger, ETS, P-ramp according to patient condition.
7. Touch Confirm to accept the settings.
8. Connect the patient to the ventilator and start ventilation. This initiates three test breaths.

(Hamilton Medical, 2017).

2.2.5 Clinical use of ASV

Figure (2.1) provides an overview of the ASV clinical workflow.

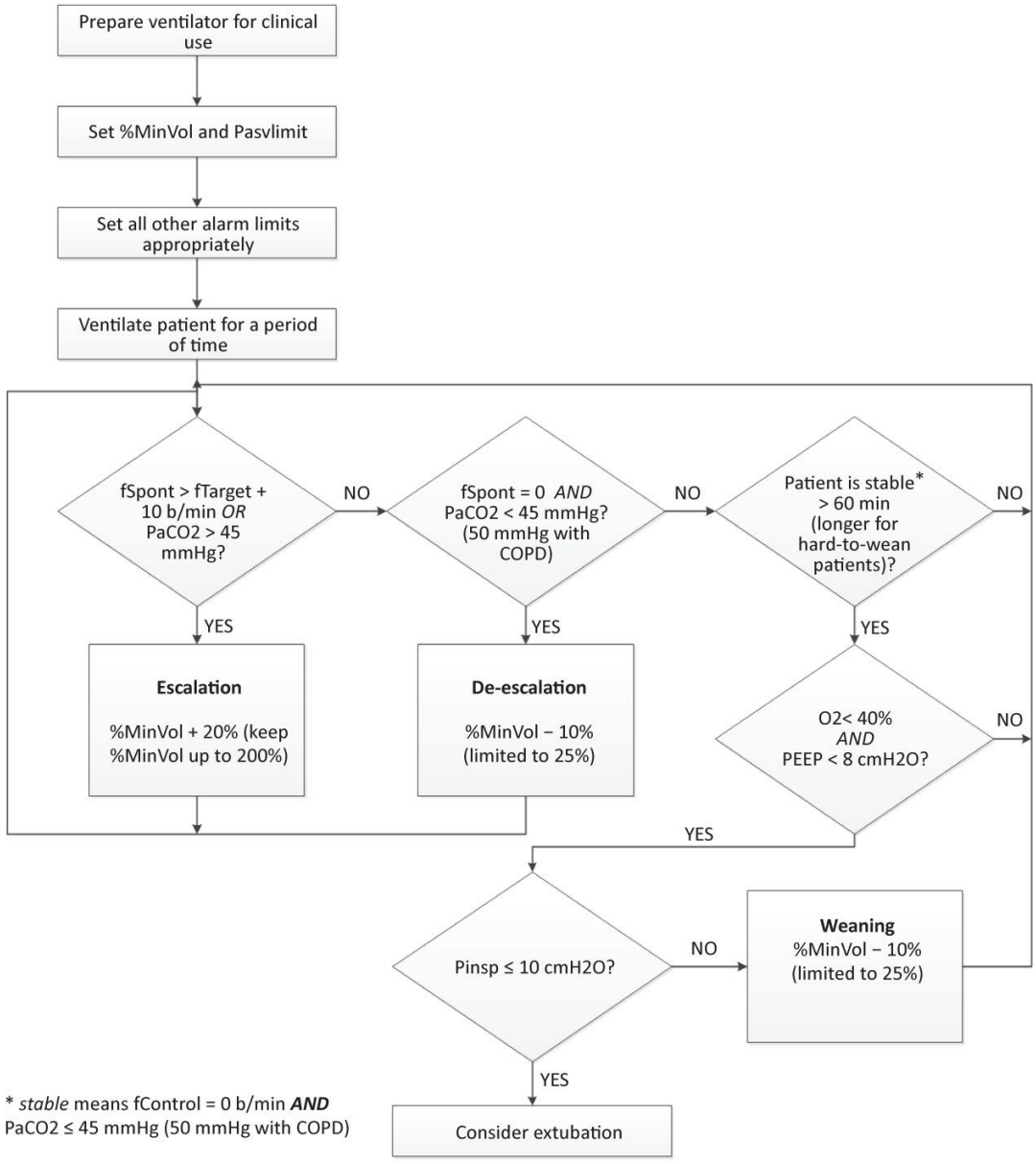

Figure (2.1): Clinical use of ASV, (Hamilton Medical, 2017).

2.3. Synchronized Intermittent Mode of Ventilation (SIMV):

2.3.1 Definition of SIMV:

It is s a type of volume control mode of ventilation. In which, the ventilator will give a mandatory number of breaths with a set volume while at the same time allowing spontaneous breaths. When the airway pressure falls below the end expiratory pressure (trigger), spontaneous breaths are delivered. As much as possible, the ventilator tries to synchronize the delivery of mandatory breaths with the patient's spontaneous efforts. On the other hand, to assist control ventilation (ACV), synchronized intermittent mandatory ventilation will deliver spontaneous volumes which entirely driven by patient effort. To enhance the volumes of spontaneous breaths, pressure support (PS) may be added (Lazoff & Bird, 2020).

2.3.2 Indications:

SIMV is generally used to assist patients weaning from the ventilator (Ghodrati, et al., 2016). Physiologically, synchronized intermittent mandatory ventilation offers the benefit of preventing acute respiratory alkalosis by allowing patients to achieve normal alveolar ventilation through an intact ventilator drive (Hudson, Hurlow, Craig, & Pierson, 1985). One concern with synchronized intermittent obligatory ventilation is that it might raise the quantity of effort needed to breathe. One approach to deal with this is by adding pressure support to the synchronized intermittent mandatory ventilation (Patel, Rafferty, Lee, Hannam, & Greenough, 2009).

2.3.3 Contraindications:

SIMV is a ventilator mode that allows for partial mechanical support. It delivers a specific number of breaths at a fixed tidal volume, but a patient

can trigger a spontaneous breath with the volume defined by patient effort (Luo, et al., 2016). Only a patient who is able to take a spontaneous breath may reap the full benefits of synchronized intermittent mandatory ventilation (Lazoff & Bird, 2020).

2.3.4 Complications:

The following are complications that can occur to patients undergoing mechanical ventilation: post-extubation stridor, pneumothorax, atelectasis, acute respiratory distress syndrome (ARDS), barotrauma and ventilator-associated pneumonia (VAP) “with at least three of the following associated symptoms: fever, leukopenia/leukocytosis, increased sputum production, rales, cough, or worsening gas exchange” (Ranieri, et al., 2012).

2.3.5 Clinical Significance

Perceived benefits of synchronized intermittent mandatory ventilation involved: reduction in ventilator dyssynchrony, decrease work of breathing, increased patient comfort on the ventilator, and ease of weaning the patient from ventilator. However, clinical trials examining some of these advantages have not shown them to be significantly beneficial (MacIntyre, 2016).

Chapter Three

Literature Review

The researcher studied and reviewed a lot of studies by viewing a previous literature or researches related to synchronized intermittent mode of ventilation, adaptive support ventilation and Coronary Artery Bypass Grafting Surgery. The researcher used literatures published in critical care research sources which included in (Medscape, Google Scholar, Springer, Elsevier, PubMed, ScienceDirect, Hindawi, Cronicon, etc.) to find researches relevant to the subject of this study. Also, the literatures involve reading and analyzing documents and information from multiple sources, including the Palestinian Ministry of health, websites, reports, books, interviews with experts, thesis, etc.

During the reviewing the researcher used the English language with these keywords: mechanical ventilator modes, adaptive support ventilation, Coronary artery bypass grafting surgery, synchronized intermittent mode of ventilation, and mechanical ventilation. The researcher read all original article related to topic and choose the more specific studies that related to this topic.

In fact, although many research studies have been conducted in the world, this issue has not been well covered in the literature around the world. Hence, this study is considered the first study of its kind to be conducted in Palestine and concerned with this topic.

During reviewing the literature, the researcher viewed several books, one of these books named HAMILTON-C3, Operator's Manual. It designed by Hamilton medical AG and published in 2017. This book prescribes how to deal with mechanical ventilator in details, also it describes all modes that use

on mechanical ventilator (Hamilton Medical, 2017). It is worth mentioning that in this thesis the researcher used the Hamilton Type C ventilator.

Another book (Handbook of Medical-Surgical Nursing, Fourth Edition) was written by Mary Ann Boucher & others, and published by Lippincott Williams & Wilkins in 2006. It includes a brief introduction for each disorder followed by physical assessment findings, causes, expected diagnostic results, strategies of treatment and patient monitoring and teaching. It also, including a description of the treatment entries procedure; possible complications; nursing diagnoses, related nursing interventions for before, during, and after the procedure, and patient outcomes; one of this disorder that included in this book was CABG disorder, so the researcher used this book (Boucher, et al., 2006).

Also, the researcher reviewed and used another book named Essentials of Critical Care Nursing, it written by Dorrie K. Fontaine & Patricia Gonce Morton, and published by Wolters Kluwer | Lippincott Williams & Wilkins in 2013. It is a Holistic Approach, and it was designed as an entrance to the profession of critical care nursing, focusing on basic facts that a novice nurse would need it to manage critically patients. It gives students the most up-to-date and comprehensive knowledge on how to care critically ill patients and their families. It prescribes how to deal whit patients who undergoing to CABG surgery (Morton & Fontaine, 2013).

Regarding to previous studies and published papers, the researcher reviewed several research studies, one of these researches was conducted by Doneria, et al (2017). It showed that the patients who were on ASV was higher P/F ratio and better oxygenation than SIMV during the period of weaning, in addition it showed that the time duration of weaning up to extubating and in

the intensive care unit was less in adaptive support ventilation than in SIMV mode (Doneria, Arshad, Singh, & Verma, 2017).

Also, there is a randomized control trial conducted in 2016 by Yazdannik, Zarei, Massoumi, its goal was to compare the impact of using ASV and SIMV on the duration of MV and staying in hospital after CABG surgery. After coronary artery bypass graft surgery, 64 patients were ventilated and assigned into two groups: experiment group (patients with adaptive support ventilation) and control group (patients with synchronized intermittent mandatory ventilation). The two groups were compared in terms of tracheal intubation time and hospital stay duration. It found that the average duration of MV was significantly lower in adaptive support ventilation group compared with synchronized intermittent mandatory ventilation group; moreover, the hospital stay duration in adaptive support ventilation was significantly lower in adaptive support ventilation group compared with synchronized intermittent mandatory ventilation group. It concluded that the using adaptive support ventilation mode after coronary artery bypass graft surgery led to a reduction in duration of MV and staying in hospital, compared with synchronized intermittent mandatory ventilation group (Yazdannik, Zarei, & Massoumi, 2016).

Another research was done by Sohrabi, et al (2014). It is a systematic review and it was conducted to identify clinical experiences when using adaptive support ventilation mode for patients with cardiac surgery. The researchers selected 8 related articles. The time of disconnection patients from the MV was the only variable that was commonly considered in these 8 articles. The other 4 variables involved numbers of ABGs, length of patient staying in intensive care unit & hospital, requirements of sedative and intubation time. The findings showed that the adaptive support ventilation is a user-friendly

mode and may reduce the length of patient staying in intensive care unit & hospital and the costs of health care as a result of decreased intubation time (Sohrabi, Nouri, Moradian, & Ghiasi, 2015).

In addition, some researchers conducted a crossover clinical study in 2016 to examine the variations in respiratory parameters in ASV & SIMV modes among neurosurgical patients in intensive care unit. The study included patients who were on mechanical ventilation in a neurosurgical critical care unit. For 30 minutes, the patients alternatively experienced 2 types of ventilations (ASV & SIMV). The hemodynamic variables and the respiratory parameters (respiratory dead space, end-tidal carbon dioxide, tidal volume, peripheral oxygenation, airway pressure, lung compliance and respiratory rate) were recorded every 10 minutes, while the ABG analysis were recorded at the end of each 30 minutes. It showed that the values of respiratory dead space, $EtCO_2$ (end-tidal carbon dioxide), tidal volume and P-peak (peak airway pressure) in ASV were significantly less than synchronized intermittent mandatory ventilation. In addition, in ASV mode the average value for dynamic compliance was better. And concluded that the adaptive support ventilation in comparison with synchronized intermittent mandatory ventilation may improve respiratory dead space and lung compliance (Ghodrati, et al., 2016).

Recently, Kirakli, et al conducted a randomized controlled trial in 2015 to identify the effect of adaptive support ventilation on total duration of mechanical ventilation when compared with pressure assist/control ventilation. In which adult patients were intubated and mechanically ventilated for more than 24 hours in a medical intensive care unit were randomized to adaptive support ventilation or pressure assist/control ventilation. Each group received the same sedation and medical treatment.

229 patients were involved. The adaptive support ventilation group had significantly lower median total MV duration, duration of weaning and duration of mechanical ventilation till weaning. In order to attain the desired $Paco_2$ and pH values, patients in the adaptive support ventilation group needed a smaller number of manual settings on the ventilator. In the adaptive support ventilation group, the number of patients who were successfully extubated on the first attempt was substantially higher. It concluded that adaptive support ventilation in medical patients in intensive care units might reduce weaning duration and overall mechanical ventilation duration with a fewer manual ventilator settings number (Kirakli, et al., 2015).

Likewise, Dave A. Dongelmans and others researchers performed a randomized controlled trial in 2009. In which, non–fast-track CABG patients' lungs were ventilated with adaptive support ventilation or pressure-controlled/pressure support ventilation (control) to compare characteristics of ventilation, assisted ventilation versus controlled ventilation duration and time until tracheal extubation. It showed that in non-fast-track CABG patients, weaning automation with adaptive support breathing is suitable, possible and safe. Time until tracheal extubation with adaptive support ventilation is the same as time until tracheal extubation with standard weaning and allows for automatic changes between assisted and controlled ventilation (Dongelmans, et al., 2009).

Moreover, Zhu, et al (2015) conducted a randomized trial to compare between ASV and physician-directed weaning after adult fast-track cardiac valvular surgery. In which, patients aged 18 to 80 years old who were undergoing uncomplicated elective valve surgery and did not have serious impairment of left ventricular function or substantial renal, hepatic, or lung disease were included in the study. Except for postoperative ventilation, the

care was standardized. It showed that the median duration of ventilation was statistically significantly less in the adaptive support ventilation group than that in controls. In the ASV group, estimations of ABGs were more common, while manual ventilator changes and alarms were less common. It concluded that in people who have had fast-track cardiac valvular surgery, the ASV decreases the time of ventilation by more than 2 hours while decreasing the number of manual ventilator changes and alarms (Zhu, Gomersall, Ng, Underwood, & Lee, 2015).

Furthermore, there is randomized controlled trial conducted by Pascale C. Gruber and others in 2008 to investigate if the ventilation in adaptive support ventilation after cardiac surgery led to a faster time to extubation than pressure-regulated volume-controlled ventilation with automode (PRVCa). After elective CABG surgery, 50 patients were randomly allocated to adaptive support ventilation or PRVCa. Respiratory weaning progressed through 3 stages: stage 1 (controlled ventilation), stage 2 (assisted ventilation), and stage 3 (T-piece trial), followed by extubation. The intubation duration (the total of stages 1–3) was the primary outcome. While the MV duration, (the total of stages 1 and 2), ABGs samples number, and manual ventilator setting changes done prior extubation were considered secondary outcomes. In the adaptive support ventilation group the median intubation duration was considerably lower than in the PRVCa group. This difference was occurred because of a reduction in the MV duration. Also, no significant differences were seen between adaptive support ventilation and PRVCa groups in the manual ventilator setting changes made or ABGs number (Gruber, Gomersall, Leung, Ng, & Underwood, 2008).

Another randomized control trial conducted by Christopher F. Sulzer and others in 2001 to investigate if the respiratory weaning procedure based on adaptive support ventilation may shorten the tracheal intubation duration after uncomplicated heart surgery ("fast-track" surgery). A group of participants who received adaptive support ventilation was compared with a control group. After CABG, participants were allocated to one of two groups: adaptive support ventilation or control group. Both procedures have been categorized into 3 specified stages, and weaning progressed based on ABG and clinical criteria. In the first stage, in the interventional group, adaptive support ventilation was set at 100 percent of the theoretical value of volume/minute, whereas in the control group, SIMV was utilized. When spontaneous breathing happened, the adaptive support ventilation setting was lowered by 50 percent of minute ventilation (stage two) and again by 50 percent (stage three), and the trachea was extubated. When spontaneous breathing happened, adaptive support ventilation setting was lowered by 50 percent of minute ventilation (stage two) and again by 50 percent (stage three), and the trachea was extubated. In control group, the ventilator was set to 10 cmH_2O inspiratory pressure support (stage two), subsequently to 5 cmH_2O (stage three) till extubating. The major result of the study was the tracheal intubation duration in adaptive support ventilation was less than in control group. It found that an adaptive support ventilation-based respiratory weaning procedure is practicable; it can expedite tracheal extubating and facilitate ventilatory control in fast-track patients after heart surgery (Sulzer, Chioléro, Chassot, Mueller, & Revelly, 2001).

On the other hand, another randomized controlled trial carried out by Kirakli and others in 2011 to investigate if the weaning with adaptive support ventilation can shorten the duration of weaning in COPD patients when compared with Pressure support ventilation. In which 97 chronic obstructive

pulmonary disease patients were enrolled. Patients were randomly allocated to either adaptive support ventilation or pressure support ventilation as a weaning mode. Weaning times were shorter with adaptive support ventilation than with pressure support ventilation. likewise, the length of stay in the intensive care unit was shorter with adaptive support ventilation. It suggested that adaptive support ventilation can be utilized in the weaning of chronic obstructive pulmonary disease patients with the benefit of shorter weaning periods (Kirakli, et al., 2011).

Additionally, when the MV was initially fabricated, synchronized intermittent mandatory ventilation was a common method for it. Recent researches show that the SIMV may not be the most effective ventilation mode. Research of premature infants demonstrated that synchronized intermittent mandatory ventilation has significantly worse mean airway pressure, duration from weaning onset to extubating, duration of nasal CPAP support after extubating, and a extubating failure rate when compared to PSV with volume guarantee (Liu, Xu, Han, Meng, & Wang, 2018).

Also, in patients undergoing CABG surgery, ASV revealed a statistically decreased number of ventilator alarms, changes in MV settings, atelectasis, and the length of staying in hospital when compared to synchronized intermittent mandatory ventilation (Moradian, Saeid, Ebadi, Hemmat, & Ghiasi, 2017).

Also, several researches concluded that the synchronized intermittent mandatory ventilation is the lower effective weaning method when compare it with PSV and intermittent T-piece trials (Esteban, et al., 1995). Patients with ARDS also have exhibited higher ventilator weaning duration time with synchronized intermittent mandatory ventilation (Tanaka, 2013). Likewise, pressure support synchronized intermittent mandatory ventilation mode had

a substantially larger number of changes to ventilator settings and MV duration compared with ASV mode in individuals who undergo liver transplantation (Celli, et al., 2014).

On the other side, Aghadavoudi, Kamran, Masoudifar conducted a randomized clinical trial including 100 patients undergoing elective CABG surgery with cardiopulmonary bypass (CPB). Patients were randomly assigned to SIMV or ASV groups after surgery and admission to the ICU. Respiratory & ventilator characteristics such as: (duration of mechanical ventilation & tracheal intubation, Pao2/FIo2, mean airway pressure (p mean), peak inspiratory pressure (P peak), tidal volume, respiratory rate, rapid shallow breathing index (RSBI) and lung compliance); ABGs & hemodynamic variables and length of staying in ICU were evaluated and compared between the two groups. It showed that there were no statistically significant differences between Adaptive support ventilation and synchronized intermittent mandatory ventilation groups in preoperative and demographics characteristics. Both groups had similar tracheal intubation durations and lengths of stay in the ICU. During the ICU stay, the findings revealed that there were no statistically or clinically significant differences in respiratory and ventilator characteristics, hemodynamic changes, and ABG between ASV and SIMV groups (Aghadavoudi, Kamran, & Masoudifar, 2012).

Also, there is a crossover study conducted by Ghodrati , et al (2016). The study goal was to determine the differences in respiratory parameters between ASV and SIMV modes in neurosurgical ICU patients. The results showed that the values of respiratory dead space, tidal volume, end-tidal carbon dioxide (EtCO2) and Peak airway pressure (P-peak) were all considerably lower in ASV mode than in SIMV mode. Although there was

no significant difference in the mean value for dynamic compliance between ASV and SIMV modes, but it was better in ASV mode (Ghodrati, et al., 2016).

After reviewing the literature, the researcher noted that most studies concluded that adaptive support ventilation is more effective than synchronized intermittent mandatory ventilation. Also, the researcher noted that the related studies to this research are limited. And there is a little data to support ASV or SIMV modes of weaning after CABG surgery. Therefore, more researches are needed to better understand the role and potential benefits of adaptive support ventilation and synchronized intermittent mandatory ventilation for different patient groups.

Chapter Four

Methodology

4.1. Research design

Quantitative, comparative research, randomized controlled trial design "single-blind controlled trial" was used in this research.

This design (RCT) was adopted due the strength of the hierarchy of scientific evidence, namely reduced bias and more accurate results, also, it has always been considered the gold standard in clinical research, as it is the most reliable way to assess the effectiveness and efficacy of various preventative and interventional programs (White, Sabarwal, & Hoop, 2014).

4.2. Study Population

The population for this research was all mechanically ventilated patients on ASV or SIMV modes, who undergoing coronary artery bypass grafting surgery.

The population was divided into two group, (1) the interventional group, which include mechanically ventilated patients on ASV mode; (2) the control group, which include mechanically ventilated patients on SIMV mode.

4.3. Study setting

The study performed in the cardiac Care Unit at AL-Istishari Arab Hospital (IAH) in Palestine.

4.4. Study period

It was conducted between August 2020 to June 2021.

4.5. Sample and sampling

As this study has the design of single-blind controlled trial, subjects were selected in a random by using the random number table. The selected subjects were randomized into two groups, the ASV mode group (Group 1, n=50) as an intervention group, and SIMV mode group (Group 2, n=50) as a control group.

Table 4.1: Random Numbers

Random Number Generator | Frequently-Asked Questions | Sample Problems

100 Random Numbers

016 035 025 082 012 048 087 024 013 093 054 071 072 069 078 050 036 008 033 032 063
070 075 059 007 022 092 057 061 001 056 064 091 011 051 077 053 026 079 019 073 038
044 052 002 074 062 098 010 086 027 003 021 067 014 017 080 029 045 085 004 100 055
068 040 065 094 039 023 088 096 083 009 058 005 043 049 084 006 097 041 030 034 089
099 076 015 095 020 028 090 042 037 081 066 047 018 031 060 046

Specs: This table of 100 random numbers was produced according to the following specifications: Numbers were randomly selected from within the range of 1 to 100. Duplicate numbers were not allowed. This table was generated on 7/4/2020.

The required sample size for this study is calculated to be 89 in each group, based on the atelectasis ratio published in Yanez-Brage's study (1-tailed alpha, 0.05; effect, 0.80) and the experimental and control groups distribution (17.3% and 36.3%, respectively). For each group, a sample size of 50 participants was deemed sufficient based on a 10% drop out rate. The sample was calculated by using the Benchmark Sigma Calculator (Yánez-Brage, et al., 2009).

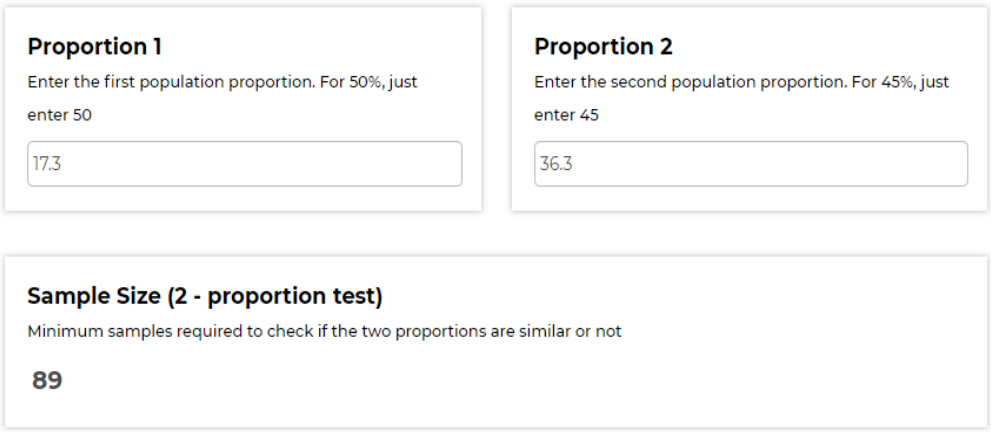

Figure 4.1: The required sample size for this study is calculated to be 89

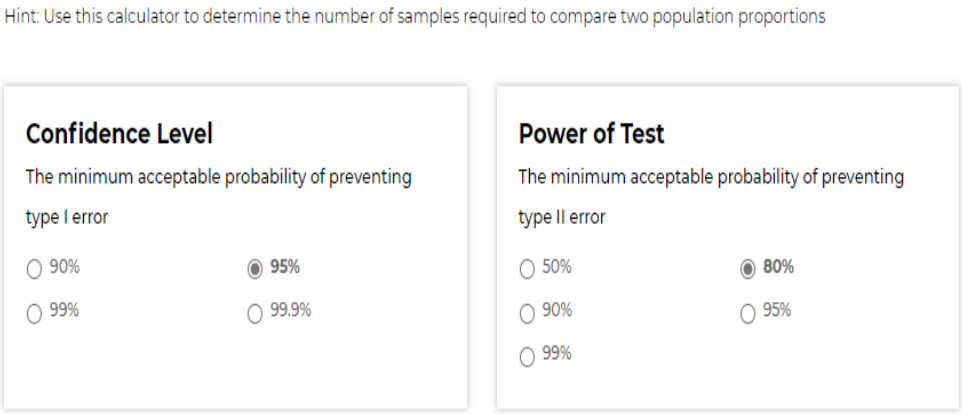

Figure 4.2: Sample size calculator for 2 Proportion Test

4.6. Randomization

Randomization was accomplished using well-sealed, opaque envelopes. Random allotment software 1.0 was used to generate the sequences on the computer. In conjunction with the sequential number, the number was imprinted on envelopes, and the type of the group was written on the card. To see the group to be designated, envelopes were opened when the patients arrived. In this prospective single-blind comparative research, a total of 100 participants were divided into 2 groups, each group include 50 participants.

Fifty participants were weaned by ASV mode (group A), and 50 participants were weaned by SIMV mode (group B). Both ASV and SIMV were use Hamilton C1 ventilator.

4.7. Blindness

Single blindness that is the patients were unconcerned of the treatment group appropriation.

4.8. Inclusion & Exclusion Criteria

4.8.1 Inclusion Criteria

- Mechanically ventilated patients who assigned for planned CABG.
- Mechanically ventilated patients aged more than 35 years.
- Mechanically ventilated patients with a left ventricle ejection fraction greater than 30%.
- Mechanically ventilated patients who did not have brain stroke or seizure, liver disorders or any liver-related problems, and any history of lung diseases like COPD or asthma.
- Mechanically ventilated patients who are hemodynamically stable when they admitted to the CCU, and have a mean arterial pressure (MAP) greater than 60 mmHg & less than 90 mmHg, Heart rate less than 100 bpm and more than 50 bpm, Respiratory rate less than 22 breath per minute and more than 10 breath per minute and were not under the intra-aortic balloon pump support.

4.8.2 Exclusion Criteria

- Rejection to enlist in the study.
- Having chronic obstructive pulmonary disease
- Aged less than 35 years.

- Ejection fraction less than 30%.
- Patients who experience instability in homodynamic during the study or who require higher-than-normal doses of inotropic medications (dopamine more than 5 mcg/min, norepinephrine more than 8 mcg/min, dobutamine more than 5 mcg/min, and epinephrine more than 8 mcg/min) or whom need intra-aortic balloon pump.
- Patients who suffering from severe bleeding after surgery (chest tube's discharges higher than 500 cc per hour, higher than 350 cc per hour within two hours, or higher than 1000 cc in total) and they need for repeated anesthesia and surgical intervention.
- Patients who need to Re Operation due to surgical complications.

4.9. Study tool

To achieve the research purposes, the patient checklist was used (Annex 1). The study checklist was adopted after modification from some of previous studies and literature. It was designed in English language, and consisted of:

- The first part consisted of patient's information (gender, age group, BMI, past medical or surgical history, mechanical ventilation duration, length of stay in CCU, and number of ABGs)
- The second part contains of smoking status.
- The third part consisted of hemodynamic changes (Respiratory rate, heart rate, SPO_2 and blood pressure).
- The fourth part consisted of respiratory setting (mode, FIO_2, set rate, tidal volume, PEEP, I:E ratio and minute volume).
- The fifth part consisted of Intake and Output.

4.10.Response rate

The response rate was 100% and the number of respondents was 100 from out 100.

4.11.Validity and Reliability of the checklist:

4.11.1 Validity of the checklist

A panel of specialists was consulted to determine validity. As arbitrators, the checklist was presented to a panel of specialists (Annex 2) with competence and expertise in the critical care sector, to provide their judgments and recommendations on the checklist's suitability and adequacy, identify and assess whether the items of the checklist are in accordance with the aims of the study and the extent to which these items represent the research topic and to estimate whether the checklist used is valid statistically and well-designed enough to examined variables and provide relationships.

The specialists provided their comments on the clarity, straightforwardness, simplicity and sufficiency of the parts & questions in the checklist; as a result, the researcher have had some adjustments in the checklist, such as rewording, merge or deletion of some questions. After some changes the checklist was considered valid.

4.11.2Reliability of the study tool

The reliability of the study tool is the consistency degree with which the study tool measures the attribute it is assumed to be measuring. Cronbach's Alpha coefficient was used to determine the study tool's reliability. Cronbach's alpha reliability coefficient vary between 0 to 1, where 1 indicating that there is no error at all and 0 indicating a study tool with full of error. A reliability considered acceptable when a cronbach's alpha reliability coefficient equal to 0.70 or above.

For these study, Cronbach's Alpha was calculated to each question in the checklist and the values ranged from 0.787 and 0.909. As a result, Cronbach's alpha for all questions in the checklist is 0.833, indicating that the checklist is generally reliable.

4.12. Pilot Study

The researcher carried out the pilot study prior to data collection by using a sample of 10 participants selected randomly (5 interventional and 5 control). It carried out to verify the checklist reliability and validity, examine the response rate, ensure the clarity of the checklist, ease and time of filling the checklist. Adjustments were done in response to feedback. The study sample included everyone who selected in the pilot study

4.13. Data Collection

Data was collected over a period of 6 months between November 2020 and May 2021. The researcher took permission from the MOH and An-Najah National University before starting the collection of data.

The researcher was collected the data by using checklist, which contain information about patient's information, smoking status, hemodynamic changes, respiratory setting and intake & output.

The researcher interviewed all participants face to face. The interview was utilized to filling in the checklist that was designated for interventional and control groups to meet study’s needs.

The researcher was introduced himself to the patients, and establish a rapport with them. The interview was beginning by providing detailed information, descriptions and explanations about the research and its aims, and the value

of participate, to the patients. The interview was taking all ethical considerations (such as confidentiality and patients consent).

Patient's information and smoking status were collected before applying CABG surgery. Also, hemodynamic changes, respiratory setting, intake and output were assessed at first 12 hour after surgery and record the values every hour.

4.14. Anesthesia protocol

A physical assessment was performed by anesthesiologist, and Cardiothoracic Surgeon, and patient's data was collected by the researcher, Pre operation medication was given on all patient 0.5 mg alprazolam before 8 hr. from operation. Accordance to a protocol, the patients were anesthetized, where the first dose of used anesthesia was 2-3 mg midazolam then etomidate, sufentanil, and rocuronium for anesthesia induction and intubation facilitation (Yazdannik, Zarei, & Massoumi, 2016).

After patient intubation and when the surgeon started the procedure, minimal doses of sufentanil were used as analgesic dose. In addition, propofol and sevoflurane were administered to keep the patient completely anesthetized (Yazdannik, Zarei, & Massoumi, 2016).

At the end of the surgery, low dosages of midazolam and morphine were occasionally administered. Under moderate hypothermia (28–32°C), using a non-pulsatile blood flow and a membrane oxygenator, the cardiopulmonary bypass was done (Yazdannik, Zarei, & Massoumi, 2016).

When the surgeon and anesthesiologist finished the operation, all of the patients were moved to cardiac care units with endotracheal tube, where they also managed according to standardized protocol. In addition, according to pain scale, the patient’s need for analgesia was evaluated by the nurse and

anesthesiologist. When the patient complained, fentanyl (1-2 mcg/kg/ hr.) was administered intravenously in a bolus, followed by a continuous infusion of 1-2 mcg/kg/hr. intravenously, where the boluses have been repeated as necessary. If the patient suffered from shivering, he was treated with 25 mg of pethidine intravenously (Yazdannik, Zarei, & Massoumi, 2016).

4.15. Weaning Protocol

The ventilator that used throughout this research was Hamilton C1 ventilator. The initial settings of Adaptive Support Ventilation_group were adjusted according to ideal weight for the body, the proportion of target minute volume (TMV) (proportion of respiratory support) was 100%, and the maximum pressure was 25 cm H_2O. The initial sitting of FiO_2 was 70%, target pao_2 from 70% into100 % while O_2 sat target above 94% and make positive end expiratory pressure (PEEP) was 5 cm H_2O until extubating (Hamilton Medical, 2017).

After twenty minutes from initial settings, arterial blood sample was sent to laboratory for analysis of arterial blood gas and to assess the respiratory status for the patients. According to ABGS, if the PCO_2 was less than 32 mmHg or above 50 mmHg, the proportion of target minute volume decreased or increased 20%, from the initial sitting respectively (Hamilton Medical, 2017).

The initial settings of SIMV group cm H_2O PEEP 6 cm H_2O TV 6ml/kg to 8ml/kg RR 16 breath /min the amount of FiO_2 was 70%, target pao_2 from 70% into100 % while o_2 sat target above 94% (Hamilton Medical, 2017).

4.16. Parameter adjustment based on arterial blood gases

If $paCO_2$ above or below the target in ASV mode we increase or decrease minute ventilation by 20% while in SIMV mode we increase or decrease respiratory rate 2/min

If paO_2 above or below the target in ASV mode we increase or decrease fio_2. In SIMV mode we increase or decrease fio_2, arterial blood gases were repeated after 20 min after each change on setting.

4.17. Study Variables

- Independent variable: ASV& SIMV modes.
- Dependent variables: gender, age, BMI, past medical or surgical history, mechanical ventilation duration, length of stay in CCU, number of ABGs, smoking status, hemodynamic changes (Respiratory rate, heart rate, SPO_2 and blood pressure), respiratory setting (mode, FIO_2, set rate, tidal volume, PEEP, I:E ratio and minute volume), and Intake & Output.

4.18.Data entry and analysis

Statistical Package for Social Sciences (SPSS) system version 25 was used to analyze data. The researcher was performed the following statistical tests. The researcher used proper statistical calculation including mean and SD for quantitative data. The researcher used repeated ANOVA measure (F-test) to compare between ASV and SIMV. However, pairwise comparisons were used to compare between parameters levels in 12 hours (hr.) during ASV or SIMV. Student t-test (independent t-test) was utilized to compare whether there is a statistically significant difference between the means in two unrelated groups such as compared between ASV and SIMV regarding body mass index (BMI), Mechanical ventilation duration, length of stay in CCU, and Number of ABGs. While Pearson's chi-squared test is performed to see if there is a statistically significant difference between the expected

frequencies and the observed frequencies in one or more categories of a contingency table such as compared with between ASV and SIMV regarding gender, age groups, smoking, past medical history … etc. P-value is significant at $P \leq 0.05$.

4.19. Ethical Consideration

This research was conducted in commitment to Declaration of Helsinki guidelines and with institutional review board (IRB) approval letter (Annex 3). An-Najah National University's approval letter (Annex 4), Istishari Arab Hospital Approval letter (Annex 5) and all Human Rights were taken into account. Before starting data collection, the consent of every participant was obtained to participate in the study, and the consent form stated that the information was gathered using an anonymous name method, the data used for research goals only, and the participant was aware of his or her right to refuse or withdraw from the research at any time.

Chapter Five

Results

This chapter points out the results of the statistical analysis of the data, including descriptive analysis that presents the study and the answers to the questions of the study. The study included one hundred patients undergoing coronary artery bypass grafting surgery. The researcher used a random sample to select patients and the participants were divided into two groups; the first group (interventional group) included 50 mechanically ventilated patients on adaptive support ventilation (ASV) and the second group (controls group) included 50 mechanically ventilated patients on synchronized intermittent mode of ventilation (SIMV), the researcher aimed to investigate the duration of mechanical ventilation and length of hospital stay and compare between two groups.

5.1. Comparison between SIMV and ASV regarding socio-demographic in patients undergoing coronary artery bypass grafting surgery.

Comparison between SIMV and ASV regarding socio-demographic in patients undergoing coronary artery bypass grafting surgery in Table 5.1. Regarding to gender the study showed that 26/50 (52%) males and 24 (48%) females in SIMV versus 20/50 (40%) males and 30/50 (60%) females in ASV, P>0.05). Also, as for participant's age in years, the age was divided into 4 groups and compared between SIMV and ASV, the highest age group is from 56-65 years, which represent 44% from total sample, (21/50 (42%) in SIMV versus 23/50 (46%) in ASV), while the lowest age group is from 35-45 years, which represent 9% from total sample, (6/50 (12%) in SIMV versus 3/50 (6%) in ASV). In addition, the age group from 46-55 years

represent 26% from total sample, (12/50 (24%) in SIMV versus 14/50 (28%) in ASV), and the age group more than 65 years represent 21% from total sample, (11/50 (22%) in SIMV versus 10/50 (20%) in ASV).

The Mean±SD for Body mass index was 28.91±4.44 kg/m^2 among the SIMV group while 28.74±3.63 kg/m^2 among the ASV group (P>0.05).

The results showed that no statistically significant difference between SIMV and ASV regarding gender, age and BMI in patients undergoing coronary artery bypass grafting surgery.

Table (5.1): Comparison between SIMV and ASV regarding socio-demographic in patients undergoing coronary artery bypass grafting surgery

Smoking status	Total n (%) (n=100)	Cases n (%)		Statistical test		
		SIMV (n=50)	ASV (n=50)	t	χ^2	P-value
Gender						
Male	46 (46)	26 (52)	20 (40)		1.449	0.229
Female	54 (54)	24 (48)	30 (60)			
Age (years)						
35-45	9 (9)	6 (12)	3 (6)		1.292	0.731
46-55	26 (26)	12 (24)	14 (28)			
56-65	44 (44)	21 (42)	23 (46)			
More than 65	21 (21)	11 (22)	10 (20)			
		Mean±SD	**Mean±SD**			
Body mass index (kg/m^2)	28.83±4.04	28.91±4.44	28.74±3.63	-0.215		0.830

* Significant difference at P≤0.05; P>0 05: Not significant difference; **SIMV**: synchronized intermittent mode of ventilation; **ASV**: **BMI**: body mass index. adaptive support ventilation; **n:** number of the subjects; **SD:** standard deviation; **t:** student t-test and **χ^2:** chi-square test.

5.2. Comparison between SIMV and ASV regarding smoking status in patients undergoing coronary artery bypass grafting surgery.

Table 5.2 indicates the comparison between SIMV and ASV regarding smoking status in patients undergoing coronary artery bypass grafting surgery. The table pointed out that 44% from total participants were

nonsmoker, the percentage of nonsmoker was higher in ASV compared with SMIV (25/50 (50%) vs. 19/50 (38%), respectively. While 20% from total participants were light smoker (1–10 cigarettes per day), the percentage of light smoker was 11/50 (22%) in ASV vs. 9/50 (18%) in SIMV. And 36% from total participants were heavy smokers (more than 11 cigarettes per day), the percentage of heavy smokers was lower in ASV Compared with SMIV (14/50 (28%) vs. 22/50 (44%), respectively.

There is no statistically significant between ASV and SIMV regarding smoking status (P > 0.05). In contrast, the results showed that the percentage of smokers' hookah among ASV was statistically significant compared with SIMV (18% vs. 42.0%, respectively, P<0.05).

Table (5.2): Comparison between SIMV and ASV regarding smoking in patients undergoing coronary artery bypass grafting surgery.

Smoking status	Total n (%) (n=100)	Cases n (%)		Statistical test	
		SIMV (n=50)	ASV (n=50)	χ^2	P-value
Cigarette smoking					
Nonsmoker.	44 (44.0)	19 (38.0)	25 (50.0)	0.245	0.247
Light smoker (1–10 cigarettes per day).	20 (20.0)	9 (18.0)	11 (22.0)		
Heavy smoker (more than 11 cigarettes per day).	36 (36.0)	22 (44.0)	14 (28.0)		
Smoke hookah	30 (30.0)	21 (42.0)	9 (18.0)	0.016	0.008*
Yes					
No	70 (70.0)	29 (58.0)	41 (82.0)		

∗ Significant difference at P≤0.05; P>0.05: Not significant difference; **SIMV**: synchronized intermittent mode of ventilation; **ASV**: adaptive support ventilation; **n:** number of the subjects; χ^2**:** chi-square test.

5.3. Comparison between SIMV and ASV regarding past medical history in patients undergoing coronary artery bypass grafting surgery.

Table 5.3 showed Comparison between SIMV and ASV regarding past medical history in patients undergoing coronary artery bypass grafting surgery. The table showed that 35% from total participants didn't have past medical history (Free); the percentage of free past medical history was lower in ASV Compared with SMIV (17/50 (34%) vs. 18/50 (36%)) and there is no statistically significant (P > 0.05). Also, it pointed out the percentage of past medical history studied (DM, HTN, PVD, and IHD) was lower in ASV compared with SMIV (42% vs. 44% for DM, 36% vs. 48% for HTN, 0% vs. 1% for PVD, 0% vs. 4% for IHD, respectively) but also there is no statistically significant (P > 0.05).

Table (5.3): Comparison between SIMV and ASV regarding past medical history in patients undergoing coronary artery bypass grafting surgery

Past medical history	Total n (%) (n=100)	Cases n (%)		Statistical test	
		SIMV (n=50)	ASV (n=50)	χ^2	P-value
Free					
Yes	35 (35)	18 (36)	17 (34)	8.119	0.150
No	65 (65)	32 (64)	33 (66)		
DM					
Yes	43 (43)	22 (44)	21 (42)	0.041	0.840
No	57 (57)	28 (56)	29 (58)		
HTN					
Yes	42 (42)	24 (48)	18 (36)	1.478	0.224
No	58 (58)	26 (52)	32 (64)		
PVD					
Yes	1 (1)	1 (2)	0 (0)	1.010	0.315
No	99 (99)	49 (98)	50 (100)		
IHD					
Yes	2 (2)	2 (4)	0 (0)	2.041	0.495
No	98 (98)	48 (96)	50 (100)		
DM & HTN together.	18 (18)	12 (24)	6 (12)		
DM & PVD together.	1 (1)	1 (2)	0 (0)		
HTN, DM, and IHD together.	2 (2)	2 (4)	0 (0)		

∗ Significant difference at P≤0.05; P>0 05: Not significant difference; **n:** number of the subjects; **SIMV**: synchronized intermittent mode of ventilation; **ASV**: adaptive support ventilation; **DM:** diabetes mellitus**; HTN:** hypertension**; PVD:** Peripheral vascular disease; **IHD**: ischemic heart disease and χ^2**:** chi-square test.

5.4. Comparison between SIMV and ASV regarding past surgical history in patients undergoing coronary artery bypass grafting surgery.

Comparison between SIMV and ASV regarding past surgical history in patients undergoing CABG surgery illustrated in Table 5.4. The results showed that 85% of participants didn't have past surgical history (Free); the percentage of free past surgical history was higher in ASV compared with SMIV (47/50 (94%) vs. 38/50 (76%)). Also, the other frequencies (%) of past surgical history studied was displayed it the table 5.4, and they don't reach to statistically significant difference (P > 0.05).

Table (5.4): Comparison between SIMV and ASV regarding past surgical history in patients undergoing coronary artery bypass grafting surgery

	Total n (%) (n=100)	Cases n (%)		Statistical test	
		SIMV (n=50)	ASV (n=50)	χ^2	P-value
Past surgical history					
Free	85 (85)	38 (76)	47 (94)	13.286	0.056
Appendectomy	3 (3)	2 (4)	1 (2)		
Umbilical hernia	1 (1)	0 (0)	1 (2)		
Caesarean section (CS)	3 (3)	3 (6)	0 (0)		
Cervical disk	1 (1)	1 (2)	0 (0)		
Disc	1 (1)	1 (2)	0 (0)		
Femoral to popliteal graft	1 (1)	1 (2)	0 (0)		
Hysterectomy	1 (1)	0 (0)	1 (2)		
Laminectomy	1 (1)	1 (2)	0 (0)		
Laparotomy	2 (2)	2 (4)	0 (0)		
Thyroidectomy	1 (1)	1 (2)	0 (0)		

* Significant difference at P≤0.05; P>0 05: Not significant difference; **SIMV**: synchronized intermittent mode of ventilation; **ASV**: adaptive support ventilation; **n:** number of the subjects and χ^2**:** chi-square test.

5.5. Comparison between SIMV and ASV regarding mechanical ventilation duration, length of stay in CCU and number of ABGs in patients undergoing coronary artery bypass grafting surgery.

Table 5.5 showed the comparison between SIMV and ASV regarding mechanical ventilation duration, length of stay in CCU, and number of ABGs during first 12 hours after surgery in patients undergoing coronary artery bypass grafting surgery. The mean of mechanical ventilation duration was lower statically significant in ASV patients compared with SIMV (4.88±0.48 hr. vs. 5.98±0.77 hr. respectively and $P < 0.005$). By same away, the mean of length of stay in CCU was lower statically significant in ASV patients compared with to SIMV (3.66±0.56 vs. 6.02±0.84 days respectively and $P < 0.005$).

Regarding the number of ABGs, the average number of ABGs in this study was lower statically significant in ASV patients compared with to SIMV (4.00±0.64 vs. 5.86±0.64 respectively and $P < 0.005$).

Table (5.5): Comparison between SIMV and ASV regarding mechanical ventilation duration, length of stay in CCU, and number of ABGs in patients undergoing coronary artery bypass grafting surgery

	Total Mean±SD	Cases Mean±SD		Statistical test	
		SIMV (n=50)	ASV (n=50)	t	P-value
Mechanical ventilation duration (hr)	5.43±0.84	5.98±0.77	4.88±0.48	8.581	<0.001 *
Length of stay in CCU (days)	4.84±1.38	6.02±0.84	3.66±0.56	16.487	<0.001 *
Number of ABGs	4.93±1.13	5.86±0.64	4.00±0.64	14.553	<0.001 *

* Significant difference at P≤0.05; P>0 05: Not significant difference; **SIMV**: synchronized intermittent mode of ventilation; **ASV**: adaptive support ventilation; **n:** number of the subjects; **SD:** standard deviation; **t:** student t-test.

5.2. Comparison between SIMV and ASV regarding total intake and output during the first 12 hours after operation and patient have given inotrope drugs in patients undergoing coronary artery bypass grafting surgery.

Comparison between SIMV and ASV regarding total intake and output of during first 12 hours after operation and patient have given inotrope drugs in patients undergoing coronary artery bypass grafting surgery summarized in table 5.6. Independent t-test showed that there are no statistically significant differences between SIMV and ASV regarding average total intake (3532.6±519.63 ml vs. 3485.98±350.21 ml; P>0.05), as well as regarding an average total output (2764±926.59 ml vs. 2911±438.84 ml; P>0.05), and regarding if the patient was given adrenaline drugs (4.11±2.09 µg vs. 3.48±1.68 µg, respectively; P>0.05; P>0.05). In contrast, the independent t-test showed that the mean of ASV patient who given noradrenalin drugs is lower statistically significantly compared with SIMV (3.65±2.17 µg vs. 5.48±2.5 µg, respectively; P>0.05).

Table (5.6): Comparison between SIMV and ASV regarding Total intake and output of during first 12 hr after operation and patient gave Inotrope drugs in patients undergoing coronary artery bypass grafting surgery

	Cases		Statistical test	
	SIMV (n=50) Mean±SD	ASV (n=50) Mean±SD	t	P-value
Total Output (ml)	3532.6±519.63	3485.98±350.21	0.526	0.600
Total Intake (ml)	2764±926.59	2911±438.84	-1.014	0.313
Adrenaline (µg)	4.11±2.09	3.48±1.68	1.174	0.246
Noradrenalin (µg)	5.48±2.5	3.65±2.17	3.003	0.004*

* Significant difference at P≤0.05; P>0 05: Not significant difference; **SIMV**: synchronized intermittent mode of ventilation; **ASV**: adaptive support ventilation; **n:** number of the subjects; **SD:** standard deviation and **t:** student t-test.

5.6. Comparison between SIMV and ASV regarding studied parameters during 12 hours after surgery.

Comparison between SIMV and ASV regarding average studied parameters during 12 hours after surgery illustrated in table 5.7. Independent t-test showed that the respiratory rate (resp/m) in ASV was higher statistically significant than SIMV. The results showed that the level the respiratory rate was 16.43±1.47 resp/m for SIMV while the level the respiratory rate was 18.74±1.22 resp/m for ASV. As showed in table, the effect size was 65.4% & P<0.05) This indicate that ASV lead to elevated respiratory rate in first 12 Hours and the mean levels of respiratory rate levels after surgery gradually increased with values of respiratory rate in both type of ventilation Figure (5.1).

By same away, the mean of SPO_2 in ASV patients was higher statistically significant than SIMV patients (97.32±0.62 vs. 96.43±0.96 %; Effect size = 48.7% & P < 0.05). Figure (5.2) display the comparison between SIMV and ASV regarding SPO_2 during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

In contrast, the mean of heart rate in ASV groups was lower statistically significant than SIMV groups (78.91±13.02 b/m vs. 84.89±15.2 b/m Effect size = 20.9% & P < 0.05). Figure (5.3) display the comparison between SIMV and ASV regarding heart rate during the first 12 hr. after surgery in patients undergoing coronary artery bypass grafting surgery.

In addition, the Mean±SD of Fio_2 was 42.27±7.99 in ASV and 40.85±4.5 in SIMV, Figure (5.4); the PEEP was 5±0 cm in ASV and SIMV, Figure (5.5); the IE ratio was ½ in ASV and SIMV; the Mean±SD of SBP during 12 hours after surgery was 120.01±7.33 mm/Hg in ASV and 122.76±9.07 mm/Hg for

SIMV, Figure (5.6); the Mean±SD of DBP during 12 hours after surgery was 75.28±8.16 mm/Hg in ASV and 73.88±7.97 mm/Hg for SIMV, Figure (5.7); the set rate among SIMV patients was 14.3±1.41%, Figure (5.8); tidal volume among SIMV patients was 533.04±52.42 ml/Kg, Figure (5.9); and finally, the minute volume among ASV patients was 95.59±16.62 L/min, Figure (5.10), whereas the repeated ANOVA measures showed that there is no statistically significant difference in minute volume after surgery in follow up from 1 to 4 hrs. in ASV and the effect size was low.

Independent t-test showed that there are no statistically significant differences between SIMV and ASV regarding average FIO_2, PEEP, IE ratio, SBP, DBP.

Table (5.7): Comparison between SIMV and ASV regarding studied parameters during 12 hours after surgery.

Average parameters during 12 hours after surgery	Cases		Statistical test		Effect size
	SIMV (n=50)	ASV (n=50)	t	P-value	
Respiratory rate (resp/m)	16.43±1.47	18.74±1.22	8.556	0.000	0.654
Heart rate (b/m)	84.89±15.2	78.91±13.02	-2.114	0.037	0.209
SPO_2 (%)	96.43±0.96	97.32±0.62	5.517	0.000	0.487
FIO_2 (%)	40.85±4.5	42.27±7.99	-1.093	0.277	0.110
PEEP (cm)	5±0	5±0	0.000	1.000	0.000*
IE ratio	½	½	0.000	1.0000	0.000*
SBP (mm/Hg)	122.76±9.07	120.01±7.33	1.665	0.099	0.166
DBP (mm/Hg)	73.88±7.97	75.28±8.16	-0.871	0.386	0.088
Set rate (%)	14.3±1.41	-			
Tidal volume (ml/Kg)	533.04±52.42	-			
Minute volume (L/min)	-	95.59±16.62			

* Significant difference at P≤0.05; P>0 05: Not significant difference; **SIMV**: synchronized intermittent mode of ventilation; **ASV**: adaptive support ventilation; **n:** number of the subjects; **SD:** standard deviation and **t:** student t-test.

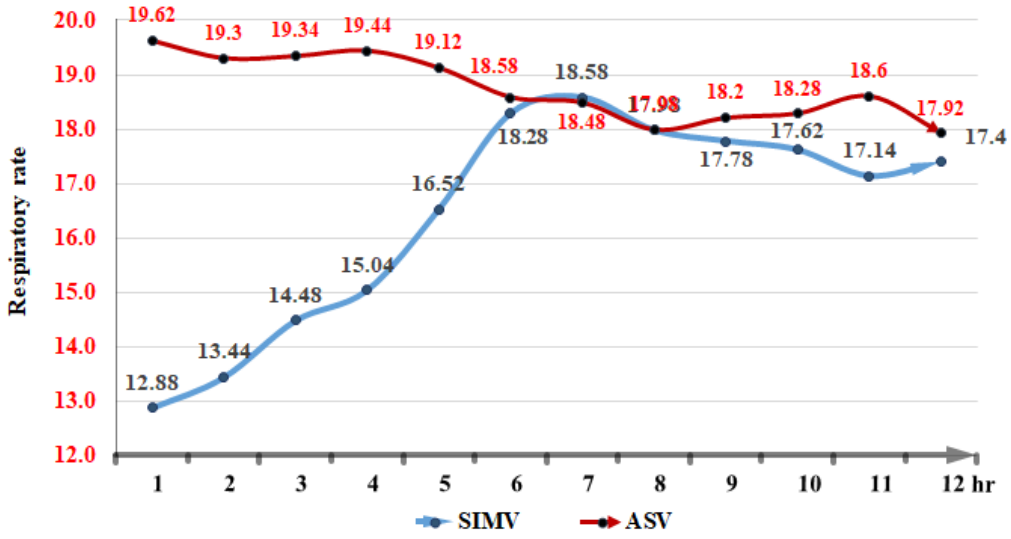

Figure (5.1): Comparison between SIMV and ASV regarding respiratory rate during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

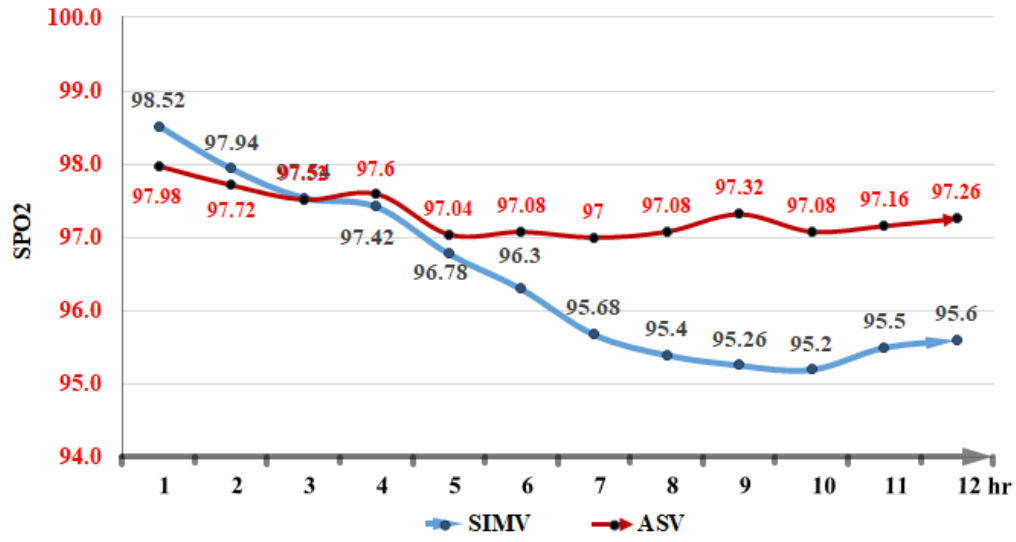

Figure (5.2): Comparison between SIMV and ASV regarding SPO2 during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

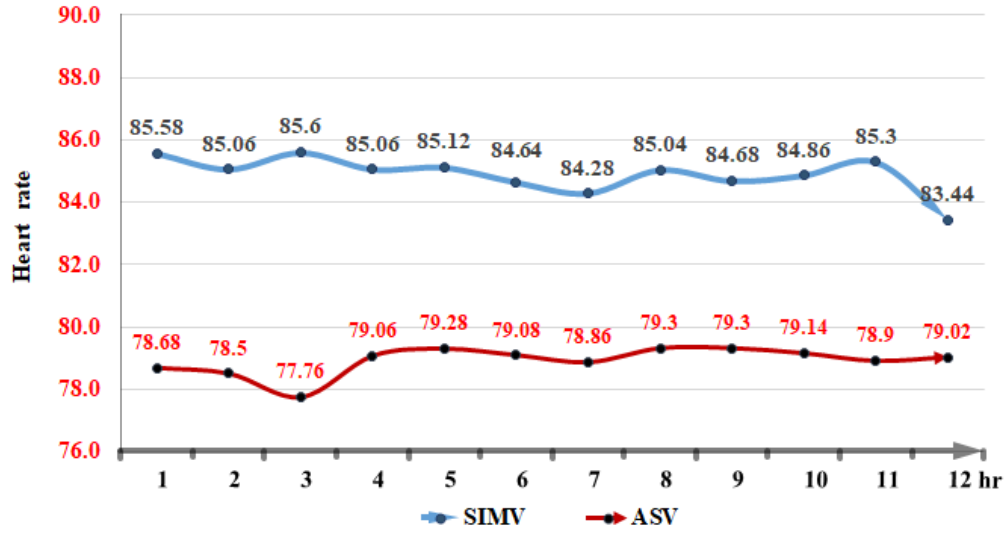

Figure (5.3): Comparison between SIMV and ASV regarding heart rate during the first 12 hr. after surgery in patients undergoing coronary artery bypass grafting surgery.

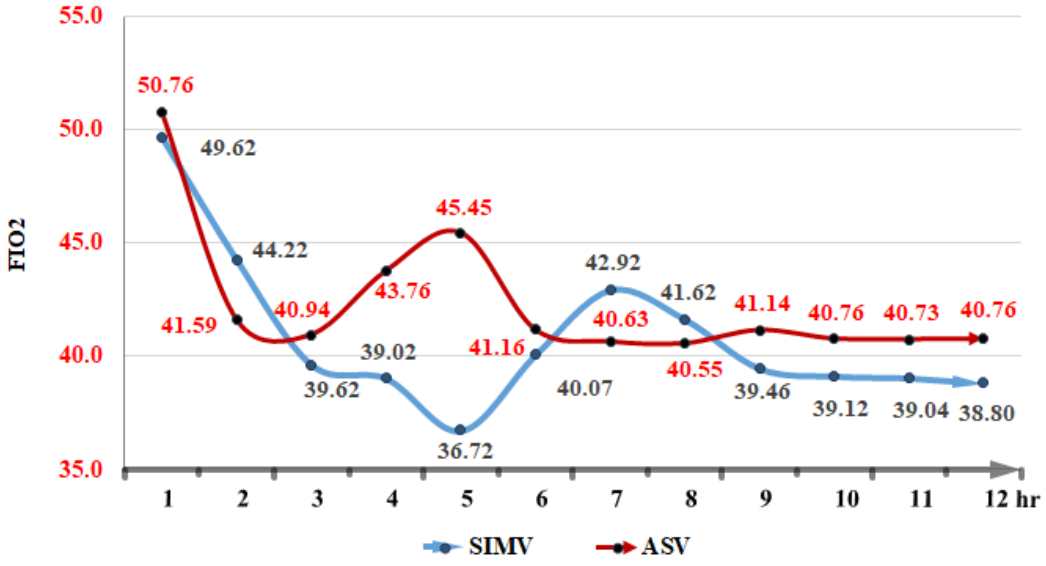

Figure (5.4): Comparison between SIMV and ASV regarding FIO2 during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

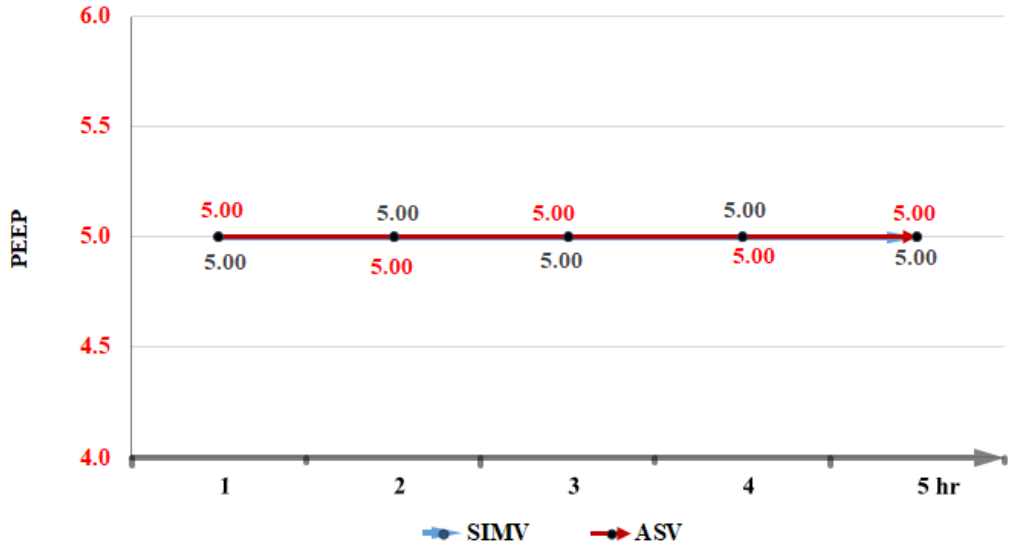

Figure 5.5: Comparison between SIMV and ASV regarding PEEP during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

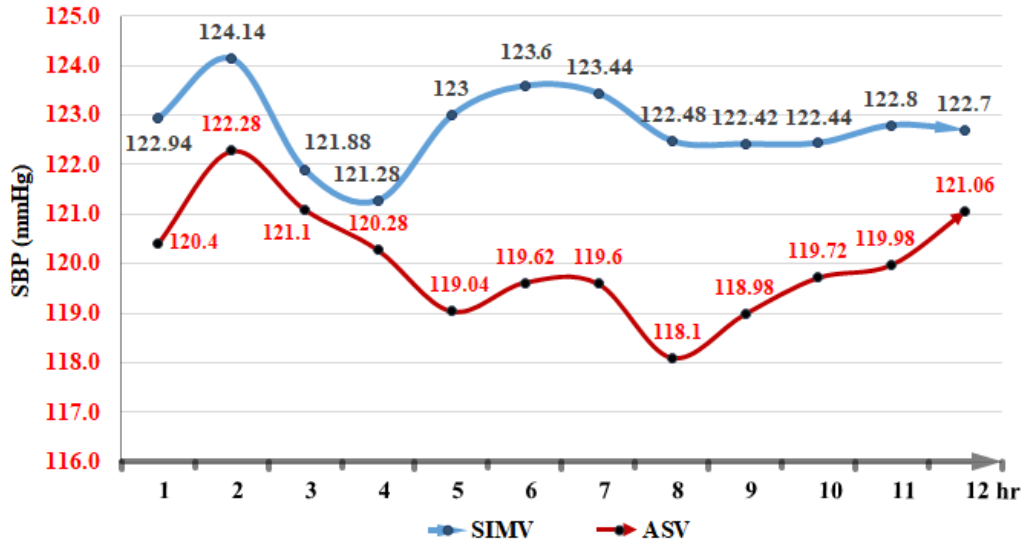

Figure (5.6): Comparison between SIMV and ASV regarding SBP during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

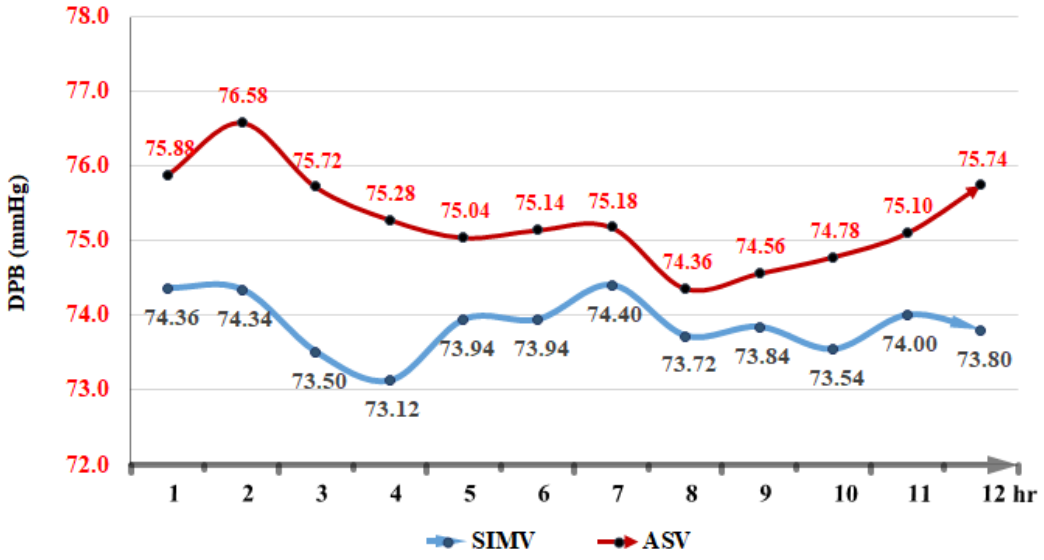

Figure (5.7): Comparison between SIMV and ASV regarding DBP during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

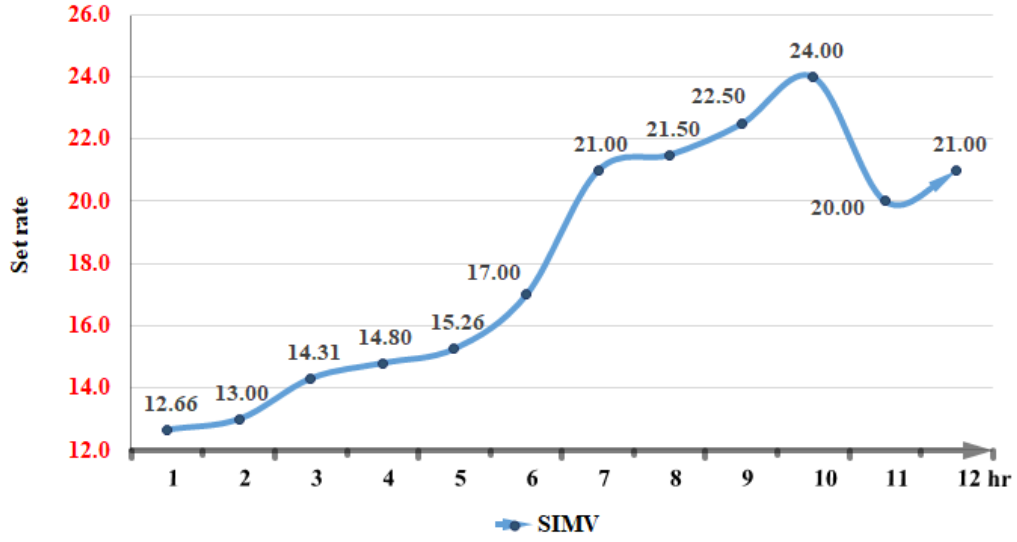

Figure (5.8): Comparison between SIMV measures regarding set rate during the first 12 hr after surgery in patients undergoing coronary artery bypass grafting surgery.

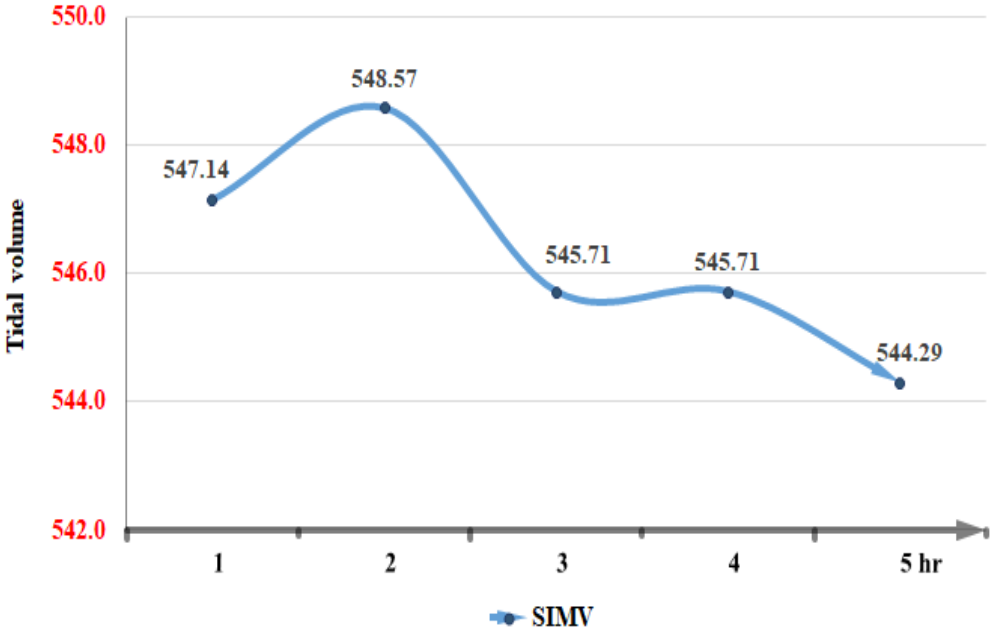

Figure (5.9): Comparison tidal volume during the first 12 hr after surgery in SIMV patients undergoing coronary artery bypass grafting surgery.

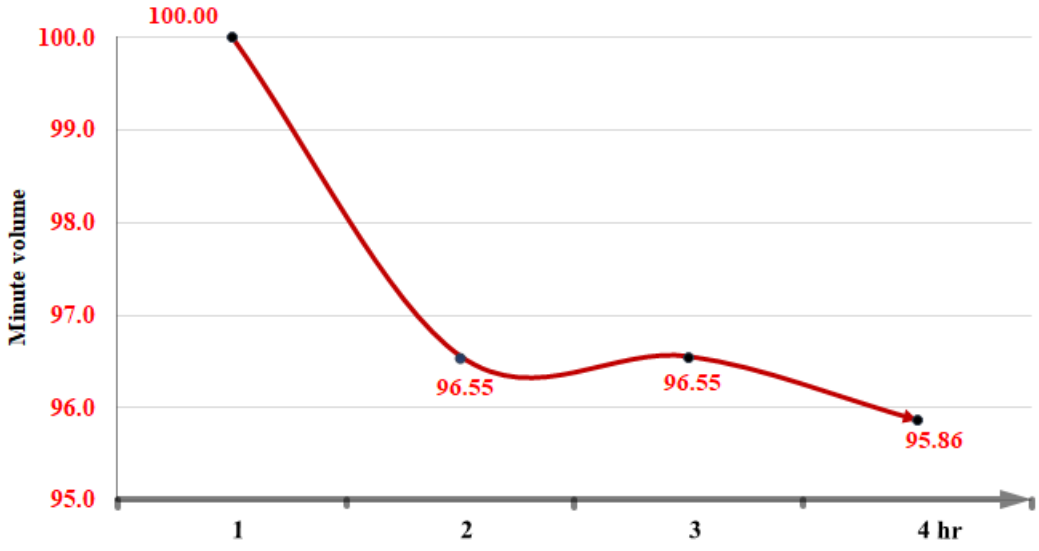

Figure (5.10): Comparison of minute volume during the first 12 hr after surgery in ASV patients undergoing coronary artery bypass grafting surgery.

Chapter Six

Discussion

A Quantitative, comparative research, randomized controlled trial design "single-blind controlled trial" was used in this research to measure the effects of Adaptive Support Ventilation (ASV) on duration of mechanical ventilation and Hospital Stay in CCU compare with Synchronized Intermittent Mode of Ventilation (SIMV) as controls among patients undergoing CABG surgery.

Socio-demographic characteristics:

The results showed that there is no statistically significant difference between SIMV and ASV regarding gender, age and BMI in patients undergoing coronary artery bypass grafting surgery. This indicated that no association between the type of ventilator and socio-demographic characteristics.

Also, the results showed that the percentage of past medical history studied (DM, HTN, PVD, and IHD) was lower in ASV compared with SMIV but not statistically significant. Moreover, 85% of participants didn't have past surgical history (Free); the percentage of free past surgical history was higher in ASV compared with SMIV, but not statistically significant.

The study results are corresponding with the study that performed by Aghadavoudi, Kamran, Masoudifar (2012). And showed that there were no differences between ASV and SIMV groups in demographics characteristics and BMI.

Mechanical ventilation duration, length of stay in CCU and Number of ABGs:

The study findings revealed that the mean of mechanical ventilation duration, length of stay in CCU and number of ABGs were lower statically significant in ASV patients compared with SIMV.

The results of this study are agreeing with the results of the study that conducted by Doneria, et al. (2017) which showed that the time duration of weaning up to extubating and length of stay in intensive care unit was less in adaptive support ventilation than in SIMV mode.

Also, the results of this study are agreeing with the results of the study that conducted by Yazdannik, Zarei, Massoumi (2016). Which found that the average duration of MV was significantly lower in adaptive support ventilation group compared with synchronized intermittent mandatory ventilation group in patients with CABG surgery; moreover, the hospital stay duration in adaptive support ventilation was significantly lower in adaptive support ventilation group compared with synchronized intermittent mandatory ventilation group.

In addition, it corresponding with the study of Sohrabi, et al. (3014). Its findings showed that the adaptive support ventilation is a user-friendly mode and may reduce the length of patient staying in intensive care unit & hospital and the costs of health care as a result of decreased intubation time.

At the same way, the results of this study are agreeing with the study results of Kirakli, at al (2015), and find that the adaptive support ventilation group had significantly lower median total MV duration, duration of weaning and duration of mechanical ventilation till weaning. and concluded that adaptive support ventilation in medical patients in intensive care units might reduce

weaning duration and overall mechanical ventilation duration with a fewer manual ventilator settings number.

Likewise, it corresponding with the study of Christopher F. Sulzer and others which conducted in 2001 and aimed to investigate if the respiratory weaning procedure based on adaptive support ventilation may shorten the tracheal intubation duration after uncomplicated heart surgery (“fast-track” surgery). Where a group of participants who received adaptive support ventilation was compared with a control group who received SIMV. The major result of the study was the tracheal intubation duration in adaptive support ventilation was less than in control group. It found that an adaptive support ventilation-based respiratory weaning procedure is practicable; it can expedite tracheal extubating and facilitate ventilatory control in fast-track patients after heart surgery.

On the other hand, the study results are differing with the study that performed by Aghadavoudi, Kamran, Masoudifar (2012). Which showed that the duration of tracheal intubation and the length of ICU stay were similar in both groups (ASV and SIMV).

Regarding to ABG, the study results are corresponding with the study that conducted by Ghodrati, et al (2016), which revealed that ventilation by two modes of ASV and SIMV has no significant difference.

Also, the study results are differing with the study that performed by Aghadavoudi, Kamran, Masoudifar (2012). Which showed that there were no statistically and clinically relevant differences between the ASV and SIMV groups in ABGs.

Total intake and output, respiratory rate, SPO_2, heart rate, FIO_2, PEEP, SBP, DBP, set rate, tidal volume and minute volume.

Regarding to total intake and output, the results showed that there are no statistically significant differences between ASV and SIMV regarding average of total intake, average of total output and regarding if the patient was given adrenaline drugs. In contrast, the mean of ASV patient who given noradrenalin drugs is lower statistically significantly compared with SIMV.

The results showed that the respiratory rate (resp/m) in ASV was higher statistically significant than SIMV, and the mean levels of respiratory rate levels after surgery gradually increased with values of respiratory rate in both type of ventilation. By same away, the mean of SPO_2 in ASV patients was higher statistically significant than SIMV patients. In contrast, the mean of heart rate in ASV groups was lower statistically significant than SIMV groups. The study showed that there is a statistically significant difference in heart rate levels between SIMV and ASV. In addition, there are no statistically significant differences between SIMV and ASV regarding average FIO_2, PEEP, IE ratio, SBP, DBP.

The study results are agreeing with the results of the study that conducted by Doneria, et al (2017). Which showed that the patients who were on ASV was better oxygenation than SIMV during the period of weaning.

The study results are differing with the study that performed by Aghadavoudi, Kamran, Masoudifar (2012). Which showed that there were no statistically and clinically relevant differences between the ASV and SIMV groups in hemodynamic changes, and respiratory & ventilator characteristics during ICU stay.

Also, regarding to heart rate, SPO2 and tidal volume, the study results are differing with the study that performed by Ghodrati, et al. (2016) and others

which revealed that there is no significant difference between two modes of ventilation (ASV and SIMV) regarding to HR and SPO2. In contrast, regarding to tidal volume, the findings showed that there is a significant differences and better results in ASV group compared to SIMV.

Chapter seven

Conclusion and Recommendations

7.1. Conclusion:

In comparison to the SIMV group, employing ASV mode for mechanical ventilation following CABG resulted in a shorter number of ABGs performed, a shorter mechanical ventilation duration and a shorter hospital stay. According to the findings of this study, it is suggested that patients undergoing coronary artery bypass graft surgery use ASV mode on ventilators for respiratory support.

7.2. Recommendations:

- The researcher recommends the Palestinian Ministry of Health to doing protocol related to ASV mode in patients that undergoing to coronary artery bypass graft surgery and provide more training to team to deal whit this mode .
- Also; the researcher recommends the Isteshari Arab Hospital to encourage the health team members to use the ASV mode.
- For clinical practice, it is recommended to use the ASV mode in clinical areas in our hospital in patients that undergoing to coronary artery bypass graft surgery, because this mode can help in reducing mechanical ventilation duration, length of stay in CCU and number of ABGs in patients undergoing CABG surgery. Further, this mode is very safe on patient.
- Moreover, the health care providers including specialists, doctors, and nurses should follow the protocol of ASV mode .

- In addition, the researcher recommends to encourage team for conducting more research about topics, it is also suggested to replicate this research with more subjects in all medical centers.
- Further studies with large sample sizes are needed to investigate the role and potential advantages of ASV mode in the weaning period and CCU stay of different patient groups.

7.3. Strengths points and limitation of the study:

Strengths points:

- This study is new and is being applied for the first time in Palestine.
- The study used ASV mode in cardiac care unit to decrease the morbidity ratio in hospital.
- The researcher has extensive experience in the department in which the study was applied, and also experience in dealing with patients after CABG surgery.

Limitation of the study

- The studies over this subject are limited.
- There are no research studies in Palestine that have conducted.
- The article that published in this subject low.
- The number of participants that undergoing to coronary artery bypass graft surgery and fit to inclusion criteria is very low, so the researcher took a long time to collect data.
- The spread of the Covid-19 pandemic and the researcher's application of preventive measures to prevent the spread of COVID-19, which led to a delay in data collection.
- There is no specified protocol or guideline related to ASV mode.
- ASV mode is not available in all types of ventilators.

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Appendices

Appendix A: Data Sheet

Data sheet

Comparing the effects of Adaptive Support Ventilation and Synchronized Intermittent Mode of Ventilation on duration of mechanical ventilation and Hospital Stay in Patients Undergoing Coronary Artery Bypass Grafting Surgery.

Patient's Information

Gender:

- Male.
- Female.

Age group:

- 35-45.
- 46-55.
- 56-65.
- 65 and more.

Past medical history (other than lung diseases) ……..……
……..……

Past surgical history …….

Height …… cm.

Weight …… gm.

BMI: …….. kg/m^2

Mechanical ventilation duration …… hr.

Length of stay in CCU …… days.

Number of ABGs ……

Smoking status:

Cigarette smoking status:

- Non smoker.
- Light smoker (1–10 cigarettes per day).
- Heavy smoker (more than 11 cigarettes per day).

Did you smoke hookah?

- Yes.
- No.

Hemodynamic changes

	1st hr.	2nd hr.	3rd hr.	4th hr.	5th hr.	6th hr.	7th hr.	8th hr.	9th hr.	10th hr.	11th hr.	12th hr.
Respiratory rate												
Heart rate												
SPO2												
Blood pressure												

Respiratory setting after surgery

	1st hr.	2nd hr.	3rd hr.	4th hr.	5th hr.	6th hr.	7th hr.	8th hr.	9th hr.	10th hr.	11th hr.	12th hr.
Mode												
FIO2												
Set rate												
Tidal volume												
PEEP												
I:E ratio												

Minute volume												

Intake and Output

Total Intake during first 12 hr. after operation …….….. ml.

Total Output during first 12 hr. after operation …….. ml.

Is the patient given Inotrope drugs?

- Yes.
- No.

If yes, specify……..

Appendix B: Expert's panel

Expert's panel	
Name	**Position**
Dr. Aidah Abo Elsoud Alkaissi.	Director of Nursing and Midwifery Department.
Dr. Hadeel Ghaith.	Anesthesiologists.
Dr. Nizar Awwad.	Cardiothoracic surgeon.
Dr. Moeen Faqeeh.	Cardiothoracic surgeon.
Dr. Ahmad Darsleam	Cardiothoracic surgeon.
Mr. Mohammad Hannon	Head nurse in surgical CCU.

Appendix C: IRB Approval letter

An-Najah
National University
Health Faculty of medicine&
Sciences
IRB

جامعة النجاح
الوطنية
كلية الطب وعلوم الصحة
لجنة اخلاقيات البحث العلمي

Ref: Nurs. July /2020/24

IRB Approval Letter

Study Title:

"Comparing the effects of Adaptive Support Ventilation and Synchronized Intermittent Mode of Ventilation on duration of mechanical ventilation-and Hospital Stay in Patients Undergoing Coronary Artery Bypass Grafting Surgery"

Submitted by:
Nawras Sawalha

Supervisor:
Aidah Abo Elsoud Alkaissi, Hadeel Ghaith

Date Approved:

23rd July 2020

Your Study Title "**Comparing the effects of Adaptive Support Ventilation and Synchronized Intermittent Mode of Ventilation on duration of mechanical ventilation and Hospital Stay in Patients Undergoing Coronary Artery Bypass Grafting Surgery**" was reviewed by An-Najah National University IRB committee and was approved on 23rd July 2020.

Hasan Fitian, MD

IRB

IRB Committee Chairman

An-Najah National University

نابلس - ص.ب 7 أو 707 || هاتف (09)2342902/4/7/8/14 (970) || فاكسميل 2342910 (09) (970)

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Appendix D: An-Najah National University Approval letter

An- Najah
National University
Faculty of Medicine & Health Sciences
Department of Nursing

بسم الله الرحمن الرحيم

جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
دائرة التمريض

التاريخ:22/10/2020

حضرة الدكتور عاطف الريماوي المحترم / المدير التنفيذي للمستشفى الاستشاري العربي ، ،

الموضوع: تسهيل مهمة طالب الماجستير نورس تحسين صوالحة /ماجستير تمريض عناية مكثفه

تحية طيبة وبعد،

تهديكم دائرة التمريض والقبالة في كلية الطب وعلوم الصحه / جامعة النجاح الوطنية أطيب التحيات ونشكر لحضرتكم حسن تعاونكم معنا ونرجو التكرم بالموافقه على تسهيل مهمة الطالب نورس صوالحه في قسم العناية المكثفه في المستشفى لديكم مع العلم بان الطالب نورس صوالحة يعمل كممرض قانوني ويعمل في قسم العناية المكثفه في المستشفى الاستشاري، وحيث أنه سيقوم بعمل دراسة بغرض البحث العلمي لأطروحة التخرج تحت عنوان:

Comparing Adaptive Support Ventilation (ASV) and Synchronized Intermittent Mode of Ventilation (SIMV) in Patients Undergoing Coronary Artery Bypass Grafting Surgery

تحت اشراف: -د. عائدة القيسي ، د.هديل غيث

- مرفق ملخص الدراسه و IRB
- Data Sheet

وتفضلوا بقبول الطلب ولكم فائق الاحترام ، ،

منسقة برنامج ماجستير تمريض الصحة النفسية المجتمعيه
منسقة برنامج ماجستير تمريض العناية المكثفه
منسقة برنامج ماجستير تمريض التخدير
د. عائدة أبو السعود القيسي

الاخ د. محمد ابو علواد
الاخ اباء/ستاد/م
جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
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للعمل بالالتزام مع الشكر
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Appendix E: Istishari Arab Hospital Approval letter

ISTISHARI ARAB HOSPITAL
المستشفى الإستشاري العربي

Dear Dr Atef

After I reviewing the data and data sheet and abstract for this study from the nurse Nawras saleh and he get the IRB approval from Alnajah university .

From ethical point of view :

1- The research provider must not interfere, either directly or indirectly, with the respirator settings by requesting the specialist or the resident to change the settings to match that with the required numbers for the study
2- 2- the information collected is very confidential and he should not allowed to use any of this information except for this study and should submit the data to our unit after he finished from the study
3- He should receive the head of CCU approval for each patient enrolled in the study
4- I preferred to be supervised by another collogues who have no conflict of interest with this study

Dr Mohammad Zaidan

Consultant of diabetes and endocrinology

Head of medical ethics

18/11/2020

original copy

22/11/2020

ISTISHARI ARAB HOSPITAL
إباء الرغوثي
مدير الجودة

Ebaa Barghouthi
Director of Quality Department
Chief Quality Officer

22/11/2020

22/11/2020

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More than Just a Hospital
أكثر من مجرد مستشفى

جامعة النجاح الوطنية

كلية الدراسات العليا

مقارنة التهوية الداعمة التكيفية (ASV) والوضع المتقطع المتزامن للتهوية (SIMV) في المرضى الذين يخضعون لجراحة القلب وتغير الشريان التاجي

إعداد

نورس صوالحة

إشـراف

د. عايدة القيسي

د. هديل غيث

قدمت هـذه الأطروحة استكمالاً لـمتطلبات الحصول على درجة الـماجستير في العنايـة المكثفة، بكلية الدراسات العليا في جامعة النجاح الوطنية، نـابلس- فـلســـطين.

2021

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إعداد

نورس صوالحة

إشراف

د. عايدة القيسي

د. هديل غيث

الملخص

الخلفية: يستخدم جهاز التنفس الصناعي بشكل كبير ومتكرر لدعم الجهاز التنفسي لمرضى عمليه تغير الشرايين التاجية، ومن أكثر الانماط التنفسية الشائعة لدعم التنفس هي التنفس الالزامي المتزامنة المتقطعة ويمكن ايضا استخدام نمط اخر هو التهوية الداعمة التكيفية لتقليل المضاعفات الرئوية.

الهدف: الهدف العام من هذا البحث هو قياس تأثيرات تهوية الدعم التكيفي على مدة التهوية التنفسية والإقامة في المستشفى في قسم القلب مقارنة مع وضع التهوية المتقطعة المتزامنة بين المرضى الذين يخضعون لعملية جراحة تطعيم مجازة الشريان التاجي.

المنهجية: تم استخدام عينة عشوائية منتظمة في هذه الدراسة، حيث شملت على ١٠٠ مريض، تم تقسيمهم إلى مجموعتين، المجموعة الأولى تستخدم تهوية الدعم التكيفي، والمجموعة الثانية تستخدم التهوية المتقطعة المتزامنة. تم اجراء الدراسة في وحدة العناية القلبية في المستشفى الاستشاري العربي بفلسطين.

النتائج: أظهرت النتائج عدم وجود فروق ذات دلالة إحصائية بين تهوية الدعم التكيفي والتهوية المتقطعة المتزامنة فيما يتعلق بالجنس والعمر ومؤشر كتلة الجسم ($P> 0.05$). كانت النسبة المئوية

لمدخنين النرجيلة في المرضى الخاضعين لتهوية الدعم التكيفي ذات دلالة إحصائية مقارنة مع التهوية المتقطعة المتزامنة (18٪ مقابل 42.0٪ على التوالي، P <0.05). كان متوسط مدة التهوية الميكانيكية أقل دلالة إحصائية في المرضى الخاضعين لتهوية الدعم التكيفي مقارنة مع التهوية المتقطعة المتزامنة (4.88 ± 0.48 ساعة مقابل 5.98 ± 0.77 ساعة على التوالي وP<0.005). في نفس الوقت، كان متوسط مدة الإقامة في قسم القلب أقل أهمية من الناحية الإحصائية في مرضى تهوية الدعم التكيفي مقارنةً بـ التهوية المتقطعة المتزامنة (3.66 ± 0.56 مقابل 6.02 ± 0.84 يومًا على التوالي وP <0.005). كان متوسط عدد فحص غازات الدم أقل دلالة إحصائية في مرضى تهوية الدعم التكيفي مقارنة بـ التهوية المتقطعة المتزامنة (4.00 ± 0.64 مقابل 5.86 ± 0.64 على التوالي وP <0.005). أخيرًا، كان متوسط معدل التنفس، معدل ضغط الدم الانبساطي، معدل ضغط الدم الانقباضي، ونسبه الاكسجين، أعلى من الناحية الإحصائية في تهوية الدعم التكيفي مقارنة بـ التهوية المتقطعة المتزامنة خلال الـ 12 ساعة الأولى.

الخلاصة: أظهرت النتائج أن هناك اختلافات ذات دلالة إحصائية فيما يتعلق بمدة التهوية الميكانيكية، وطول الإقامة في قسم القلب، ومتوسط عدد فحص غازات الدم، ومعدل التنفس، ومعدل ضربات القلب، ونسبة الاكسجين، ومعدل ضغط الدم الانقباضي، ومعدل ضغط الدم الانبساطي. في المقابل، لا يوجد ارتباط بين نوع التهوية والخصائص الاجتماعية والديموغرافية.

الكلمات المفتاحية: تهوية الدعم التكيفي، التهوية المتقطعة المتزامنة، جراحة تغير الشرايين التاجية.