Complications of long term mechanical ventilation in critically ill patient

Essay

Submitted in partial fulfillment for the master degree in intensive care unit

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Ali Fikry Ali Moselhy

List of Contents

List of Abbreviations

APACHE III	:	Acute Physiology and Chronic Health Evaluation III
APTT	:	Activated Partial Thromboplastin Time
ARDS	:	Acute (adult) Respiratory Distress Syndrome
BNP	:	Brain Natriuretcic Peptide
CAM-ICU	:	Confusion Assessment Method for ICU
CDC	:	Center of Disease Control
COPD	:	Chronic Obstructive Pulmonary Disease
CPAP	:	Continuous Positive Airway Pressure
CROP index	:	Compliance,Respiratory rate,Oxygenation and Pressure
FiO2	:	Inspired Oxygen Tension
ICU	:	Intensive Care Unit
LTOT	:	Long-term Oxygen Therapy
MRSA	:	Methicillin-Resistant Staphylococcus Aureus
NIV	:	Non invasive Ventilation
NPPV	:	Non invasive Positive Pressure Ventilation
PEEP	:	Positive End Expiratory Pressure
SBT	:	Spontaneous breathing trial
SGRQ	:	St. George's Respiratory Questionnaire
SIMV	:	Synchronized Intermittent Mandatory Ventilation
SvO2	:	Mixed Venous Oxygen Saturation
TPN	:	Total Parenteral Nutrition
VAP	:	Ventilator-Associated Pneumonia
VE	:	Minute Ventilation
VILI	:	Ventilator-Induced Lung Injury
Vt	:	Tidal Volume

List of Figures

List of Figures (Cont.)

List of Tables

Introduction

A mechanical ventilator is a machine that generates a controlled flow of gas into a patient's airways. Oxygen and air are received from cylinders or wall outlets, the gas is pressure reduced and blended according to the prescribed inspired oxygen tension (FiO2), accumulated in a receptacle within the machine, and delivered to the patient using one of many available modes of ventilation ***(Slutsky, 2015).***

Failure to oxygenate is caused by reduced diffusing capacity and ventilation perfusion mismatch. This can often be overcome by restoring functional residual capacity (FRC) by increasing baseline airway pressure using continuous positive airway pressure (CPAP). If the problem is atelectasis due, for example, to mucus plugging or diaphragmatic splinting following abdominal surgery, or moderated amounts of pulmonary edema, CPAP, as delivered by facemask or endotracheal tube, may sufficiently restore pulmonary mechanics to avoid addition inspiratory support. CPAP is easy to apply: all that is required is a positive end expiratory pressure (PEEP) valve and a flow generator ***(Lovas et al., 2015).***

The rate, pattern and duration of gas flow control the interplay between volume and pressure. In volume controlled modes, a desired tidal volume is delivered at a specific flow (peak flow) rate, using constant, decelerating or sinusoidal flow patterns: the airway pressure generated may be higher than is desirable. In pressure controlled modes, we must program the limiting or maximum pressure, the inspiratory time (Ti), frequency and the rest of values common to other modes such as PEEP level, FiO2 and the alarms. All these initial parameters can subsequently be adjusted to optimize ventilation according to the ventilation strategy we wish to use. Pressure is the "independent variable", and will be maintained constant and independent of changes in compliance, resistance and patient inspiratory effort ***(Heyse et al., 2014).***

Long-term mechanical ventilation has been proposed in addition to long-term oxygen therapy (LTOT) in chronically hypercapnic chronic obstructive pulmonary disease (COPD) patients with the theoretical rationale: to improve gas exchange; to unload the ventilatory muscles; to reset the central respiratory drive. Physiological studies have shown that non-invasive mechanical ventilation may unload the diaphragm in stable COPD while some clinical studies suggested that non-invasive nocturnal ventilation could be associated with day-time arterial blood gas improvement, reduced hospitalization and need of tracheotomy ***(Duiverman et al., 2016).***

Aim of the Essay

The aim of this work is to discuss the uses, modes of mechanical ventilation, complications of long term-mechanical ventilation in intensive care patients and benefits of tracheostomy in prolonged mechanical ventilation.

Chapter One

Modes of Mechanical Ventilation

Ventilator parameters vary by manufacturer; however, basic parameters are present on all machines: percent oxygen, tidal volume and/or minute ventilation, respiratory rate, inspiratory time or flow rate, and alarm limit settings. A thorough understanding of common ventilator settings will assist nurses in optimizing patients' care to meet the overall oxygenation and ventilation goals, maintain safe lung pressures, and provide breathing comfort .Mode of ventilation refers to the method of inspiratory support provided by the mechanical ventilator. It is the specific combination of breathing pattern and control variables to deliver inspiration ***(Chatburn, 2007).***

Some modes guarantee a constant volume (volume-targeted or volume controlled) with each machine breath, whereas other modes guarantee a constant pressure (pressure-targeted or pressure-controlled). An additional option on some ventilators is a dual- controlled mode that combines the features of volume- and pressure- targeted ventilation to ensure a minimum tidal volume (Vt) or minute ventilation (VE) while limiting pressure ***(Santanilla et al., 2008).***

Volume-Targeted Modes:

In a volume-targeted mode, Vt is the targeted parameter, and a fixed Vt is delivered with each breath.

Volume targeted modes are the most commonly used modes. The mode may be labeled by different names, including controlled mandatory ventilation, continuous mandatory ventilation, and assist/ control mode ventilation. In volume-targeted modes, the ventilator delivers machine-guaranteed breaths at the set respiratory rate and Vt if the patient is not making respiratory efforts due to sedation, paralysis, or other factors affecting drive to breathe ***(Pierson, 2008).***

Fig. (1): Mechanical ventilation

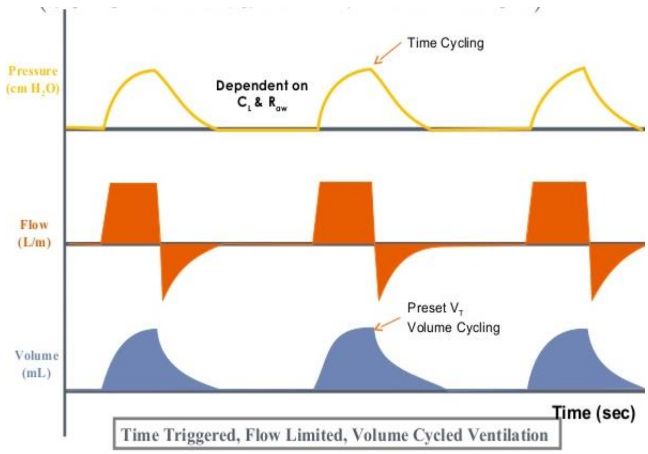

Fig. (2): Volume targeted ventilation ***(Pierson, 2008).***

Pressure-Targeted Modes:

Pressure is the ventilator's targeted parameter in pressure support ventilation. Breaths in this mode are triggered by the patient and augment or support a patient's spontaneous inspiratory effort with a preset positive pressure level. Inspiration ends after delivery of the set inspiratory pressure. Two pressure-targeted modes are common: pressure support ventilation and pressure control mode ***(MacIntyre, 2011).***

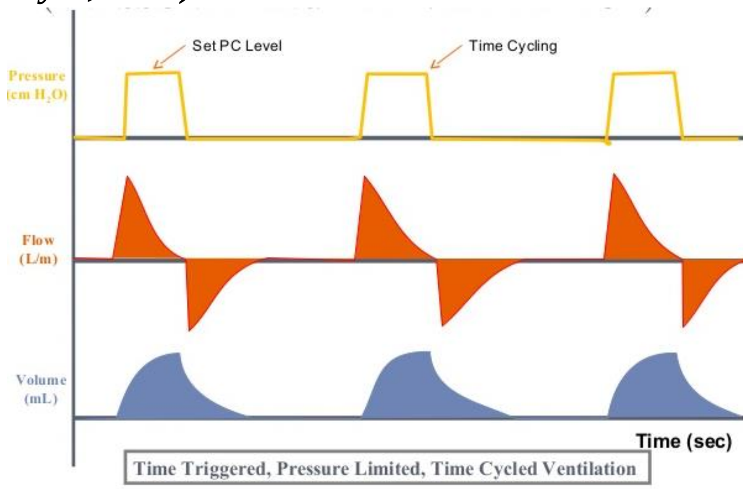

Fig.(3): Control mode (pressure targeted ventilation) ***(MacIntyre, 2011)***.

Pressure Support Ventilation:

In pressure support ventilation, volume is variable, rather than a fixed Vt as in volume-targeted modes, and is determined by the patient's effort or drive, preset pressure level, and various airway resistance and lung compliance factors. Flow rate is also variable, depending on the patient's needs and not fixed by a clinician as it is in volume-targeted modes. The clinician does not set a respiratory rate setting, and the mode does not function if the patient is apneic. Although pressure support ventilation is commonly thought of as a weaning mode with low pressure support levels set to overcome resistance in the endotracheal tube and ventilator circuit, high press support levels may also provide almost total ventilator support ***(Tobias, 2010).***

Pressure Control Mode:

Pressure control ventilation operates in a manner similar to pressure support ventilation in that it relies on a pre-set pressure to determine the volume delivered and volume is variable depending on various factors that affect airway resistance and/or lung compliance. However, in pressure control mode, a respiratory rate is set by the clinician in order to support patients with apnea or an unreliable respiratory drive. Pressure control mode may be used in patients with acute respiratory distress syndrome to control plateau pressures and Vt. Patients with acute respiratory distress syndrome have low lung compliance; therefore, inappropriately high Vt and pressure settings can overstretch and injure the lung. Current strategies in such patients should be focused on limiting Vt and maximal lung stretch ***(MacIntyre, 2011).***

Dual-Controlled Modes:

Newer ventilators offer hybrid modes that combine features of volume-targeted and pressure-targeted ventilation in an attempt to avoid both the high peak airway pressures of volume ventilation and the varying tidal volumes that may occur with pressure ventilation. Volume and pressure control variables adjust automatically to ensure a minimum VT or VE. Pressure-targeted logic is used when the ventilator determines after each breath if the pressure applied to the airway was adequate to deliver the desired Vt. If the Vt did not meet the set target, the ventilator adjusts the pressure applied on the next breath ***(Vanani and Patel, 2013).***

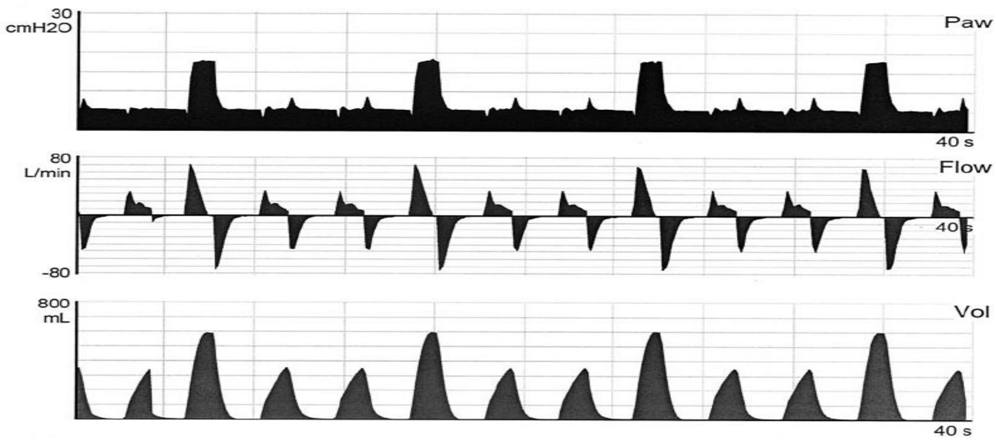

Fig. (4): Dual control ventilation ***(Vanani and Patel, 2013)***.

Synchronized Intermittent Mandatory Ventilation (SIMV) Plus Pressure Support:

Two modes are in operation on the SIMV plus pressure support mode: mandatory breaths are volume-targeted and spontaneous breaths are pressure-targeted. The patient receives a preset number of volume-targeted mandatory breaths at a set Vt. Between mandatory breaths, the patient breathes spontaneously on pressure supported breaths. The ventilator recognizes spontaneous breaths and