Central venous oxygen saturation as predictor of failure of weaning from mechanical ventilation

Thesis

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By

Muhammad Essam El-Senosy Nagy
(M.B.,B.Ch.)

Supervised by

Prof. Dr. Samiha Sayed Ashmawi
Professor of Chest Diseases
Faculty of Medicine - Ain Shams University

Dr. Hala Mohamed Salem
Assistant Professor of Chest Diseases
Faculty of Medicine - Ain shams University

Faculty of Medicine
Ain Shams University
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List of Abbreviations

ABG	Arterial Blood Gases
AECOPD	Acute Exacerbation OF Chronic Obstructive Pulmonary Disease
CLD	Chronic Liver Disease
CNS	Central Nervous System
CO_2	Carbon Dioxide
COPD	Chronic Obstructive Pulmonary Disease
CPAP	Continuous Positive Airway Pressure
DM	Diabetes Mellitus
ED	Emergency Department
ETT	Endotracheal Tube
FiO_2	Fraction of Inspired Oxygen
HR	Heart Rate
HTN	Hypertension
I/E	Inspiration /Expiration Ratio
ICU	Intensive Care Unit
IHD	Ischemic Heart Disease
MV	Mechanical Ventilation
Old TB	Old Pulmonary TB
$PaCO_2$	Partial Arterial Carbon Dioxide Tension
PaO_2	Partial Arterial Oxygen Tension
PEEP	Positive End Expiratory Pressure

List of Abbreviations

PS ..... Pressure Support

$PvCO_2$ ..... Partial Venous Carbon Dioxide Tension

RR ..... Respiratory Rate

SBP..... Systolic Blood Pressure

SBT .....Spontaneous Breath Trial

ScvO2 .....Central Venous Oxygen Saturation

SD..... Standard Deviation

SpO_2 ..... Oxygen Saturation

VAP..... Ventilator Associated Pneumonia

VBG ..... Venous Blood Gas

VT..... Tidal Volume

WOB..... Work of Breathing

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ABSTRACT:

Background: In the process of weaning from mechanical ventilation, tolerance to the pre-extubation attempts of spontaneous breathing doesn't completely ensure a favorable outcome. In such conditions it was possible to predict the result of extubation by the drop of central venous oxygen saturation readings. Therefore, the evaluation of central venous oxygen saturation during spontaneous breathing trials may be considered as a novel predictor for weaning success.

Methods: This is a prospective cohort clinical research that involved 50 patients admitted to respiratory intensive care unit of Abbassia chest hospital. Those patients were subjected to intubation and mechanical ventilation for the period of two successive days or more and followed up for signs of post extubation respiratory failure for 48 hours. All patients were daily evaluated for fulfilling of the weaning criteria and were weaned in a two-step protocol: A spontaneous breathing trial for 30 mins followed by extubation. Central blood gasses were evaluated in the beginning (1st min) and at the end (30th min) of the trial. Hemodynamic and ventilatory parameters were also assessed.

Results: Thirty-nine patients (78%) had a successful extubation while eleven patients (22%) failed extubation process. Logistic regression analysis identified the change in central venous oxygen saturation as the only parameter with the ability to distinguish between both probable results of extubation. A reduction of more than 3.8% from the baseline value of central venous oxygen saturation was able to independently predict extubation failure with a sensitivity of 89.74%, a specificity of 90.91, and an OR of 1.48 (95% confidence interval 1.06 – 2.07).

Conclusion: Central venous oxygen saturation is able to successfully and independently predict EF. Adding to that, being a rapid and accurate method with high sensitivity and specificity, it will help in early diagnosing of the extubation failure cases and their proper management.

Keywords: Central venous oxygen saturation, Spontaneous breathing trial, Weaning, Mechanical ventilation.

INTRODUCTION

Mechanical ventilation is a life-saving intervention, but it is also associated with complications. Therefore, it is desirable to liberate patients from mechanical ventilation as soon as the underlying cause that led to the mechanical ventilation has sufficiently improved and the patient is able to sustain spontaneous breathing and adequate gas exchange ***(ATS/ACCP, 2016).***

Weaning from mechanical ventilation is an essential and universal element in the care of mechanically ventilated patients. The weaning process comprises progressive withdrawal from the invasive ventilatory support until removal of the endotracheal tube and it could represent approximately 40% of the patient's time on mechanical ventilation (MV) ***(Boles et al., 2007).***

Success of the weaning process depends on improvement of the acute illness, adequate oxygenation and ventilatory parameters, hemodynamic stability, adequate mentation and cough, and normal acid base and electrolytes values ***(Teixeira et al., 2010).***

Clinicians tend to underestimate the capacity of patients to breathe successfully when disconnected from the ventilator, as shown by two large weaning trials. Moreover, weaning predictors such as maximal inspiratory

pressure, static respiratory system compliance, and rapid-shallow breathing index, lack sufficient positive and negative predictive value to make them routinely useful for judging patients' ability to wean. Once patients meet several readiness criteria, a preferred approach is to conduct a spontaneous breathing trial (SBT) involving little or no ventilator support. If the SBT provokes signs of respiratory failure, ventilation is resumed but, if it does not, the clinician may move towards extubation ***(ATS/ACCP, 2016).***

Tolerance of a spontaneous breathing test (SBT) indicates weaning success, but variably predicts extubation success. After successful SBT, the need for reintubation within the subsequent 24 hrs to 72 hrs occurs in 5% to 30% of patients, depending on the population. Which indicates that the traditional two-step weaning protocol (evaluation of predictors followed by spontaneous breathing trial) does not adequately detect failure of extubation ***(Epstein, 2002).***

The change in central venous saturation (ScvO2) during the SBT was evaluated as a predictor of extubation failure. It is hypothesized that ScvO2 could be a reliable and convenient tool to rapidly warn about the acute changes in oxygen supply and demand of the patient during weaning ***(Teixeira et al., 2010).***

Aim of the Work

To evaluate the predictive value of central venous oxygen saturation (ScvO2), as a potential predictor of extubation failure in mechanically ventilated patients.

Chapter (1): Mechanical Ventilation

Mechanical ventilation is a supportive therapy used to treat respiratory failure. This supportive therapeutic technique is used to control or assist the respiration of patients who are unable to maintain an adequate ventilator status because of an underlying disease or physical condition. Mechanical ventilation reduces the work of breathing and improves ventilator efficiency by manipulating the respiratory pattern and airway pressure ***(Tobin, 2001).***

Objectives of MV are summarized by *(Tobin, 2001)* as:

1- Improves pulmonary gas exchange:

- Reverse hypoxemia.
- Relieve acute respiratory acidosis.

2- Relieve respiratory distress:

- Reverse respiratory muscle fatigue.

3- Alter pressure-volume relationship:

- Prevent or reverse atelectasis.
- Improve lung compliance.
- Prevent further lung injury.

4- Permit lung and airway healing and avoid complications.

Invasive Mechanical Ventilation:

Patients who show impending respiratory failure and those with life threatening acid-base status abnormalities and/or altered mental status despite aggressive pharmacological therapy are likely to be the best candidates for IMV ***(Esteban et al., 2002).***

Indications:

Apart from its supportive role in patients undergoing operative procedures, mechanical ventilatory support is indicated when spontaneous ventilation is inadequate for the sustenance of life.

Mechanical ventilation is not a cure for the disease for which it is instituted: it is a form of support, offering time and rest to the patient until the underlying disease processes are resolved.

- **The main indications for mechanical ventilation are:**
    - Apnea.
    - Clinical Signs of Increased Work of Breathing.
    - Hypoxemic Respiratory Failure.
    - Hypercapnic Respiratory Failure.
    - Postoperative Respiratory Failure.
    - Hypoventilation