# Prevalence of Myocardial Ischemia during Mechanical Ventilation and Weaning

## Essay

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in Intensive Care

## By

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# List of Contents

# List of Abbreviations

**A-C** : Assist control
**ACIP** : Asymptomatic Cardiac Ischemic Pilot
**ACS** : Acute coronary syndrome
**AMI** : Acute myocardial infarction
**ATC** : Automatic tube compensation
**BNP1** : Brain Naturetic Peptide
**BiPAP** : Bilevel positive airway pressure
**CABG** : Coronary Artery By Pass Graft
**CAD** : Coronary artery Disease
**CPAP** : COntinous Positive airway pressure
**COPD** : Chronic obstructive Plumonary disease
**CMV** : Controlled Mechanical Ventillation
**ECG** : Electro-Cardiography
**ETT** : Excercise Treadmill Test
**HFV.A** : High Frequency ventilation (Active)
**HFVP** : High frequency ventilation (Passive)
**ICU** : Intensive Care Unit
**IPC** : Ischemic Preconditioning
**ITP** : IntraThoracic Pressure
**LV** : left ventricle
**RV** : Right Ventricle
**MICU** : Medical Intensive Care unit
**MIP** : Maximum Inspiratory Pressure
**MMV** : mandatory Minute Ventillation
**MV** : Mechanical ventilation
**MPI** : Myocardial Perfusion Imaging
**NAVA** : Neutrally Adjusted Ventillatory Assist
**NIV** : Non invasive ventilation

# List of Abbreviations

| | |
|---|---|
| **NSTEMI** | : Non ST Elevation Myocardial Infarction |
| **PAV** | : Proportional Asist Ventillation |
| **PAOP** | : pulmonary artery occlusion pressure |
| **PCI** | : Percutaneous Coronary Intervention |
| **PEEP** | : Positive end expiratory pressure |
| **PLV** | : Partial Liquid Ventillation |
| **PTCA** | : Percutaneus transluminal coronary angioplasty |
| **PSV** | : Pressure support ventilation |
| **RSBI** | : Rapid Shallow Breathing Index |
| **SBT** | : Spontaneous Breathing Trial |
| **ScVO2** | : mixed Venous Blood Saturation |
| **SMI** | : Silent myocardial ischemia |
| **STEMI** | : ST segment elevation myocardial infarction |
| **Vc** | : Volume Control |
| **VE** | : Minute Ventillation |
| **VT** | : Tidal volume |
| **TLC** | : Total Liquid Capacity |
| **TLV** | : Total Liquid Ventillation |
| **TTE** | : Trans Thoracic Echo cardiography |
| **WOB** | : Work OF Breathing |

# LIST OF TABLES

# LIST OF FIGURES

# Introduction

Mechanical ventilation (MV) is a procedure widely used in intensive care units (ICUs) ***(Esteban et al., 2002).***

Recent studies show that 33% to 46% of patients admitted to these units use MV at some point during hospitalization ***(Esteban et al., 2000).*** Currently, most patients undergoing mechanical ventilatory support can be quickly removed from the ventilator, so that the ‘condition responsible for establishing the MV has been treated and / or stabilized'.

Removing the patient from MV can be harder than keeping them on it. The withdrawal process of the ventilatory support takes about 40% of the total time of MV. Some authors describe the weaning as the “shadow area of intensive care" and even in experienced hands, it can be considered a mixture of art and science ***(Tobin, 2006).***

Several factors contribute to weaning failure and return to the MV، such as rentention of secretions, atelectasis, pulmonary congestion, myocardial ischemia, and laryngeal edema. The prolonged use of the MV can cause respiratory muscles atrophy and decrease performance of the diaphragm ***(Maclniyre et al., 2011).***

The effects of MV in patients with heart disease are complex and depend on a number of variables, especially the patients volume status, the role of right and left ventricles, afterload, lungs functional status and chest and abdominal compliance ***(Laaban, 2003).***

Myocardial ischemia may be considered both a consequence of weaning from ventilation and a potential of weaning failure and prolonged dependence on MV.

Cardiac ischemia results from imbalance between oxygen supply and demand. Oxygen supply is reduced by hypoxemia which is common during weaning. Myocardial oxygen delivery is also reduced by catecholamine induced tachycardia, which limit-diastolic perfusion time.

An increase in cardiac after load, caused by changing from positive pressure ventilation to negative pressure spontaneous breathing ***(Scharf et al., 1998).***

Treatment of weaning induced ischemic LV failure with diuretics and cardiac medications allowing successful in most cases; However, in some cases weaning failure is reversed by emergency transluminal coronary angioplasty.

# Aim of the Work

The aim of the work is to evaluate frequency and outcome of myocardial ischemia in mechanically ventilated patients. And the association of myocardial ischemia with failure to wean from MV.

# Chapter (1)
# Mechanical Ventilation

M**echanical ventilation** is a method to mechanically assist or replace spontaneous breathing. This may involve a machine called a ventilator or the breathing may be assisted by a physician, respiratory therapist or other suitable person compressing a bag or set of bellows. There are two main divisions of mechanical ventilation: invasive ventilation and non-invasive ventilation. There are two main modes of mechanical ventilation within the two divisions: positive pressure ventilation, where air (or another gas mix) is pushed into the trachea, and negative pressure ventilation where air is essentially sucked into the lung ***(Cabrini et al., 2011).***

## Non Invasive Positive Pressure Ventilation (NIPPV)

NIPPV refers to mechanical ventilation that is not delivered via endotracheal or tracheostomy tube (often through a facemask). The benefits of NIPPV include and are not limited to:

- Decreased technical difficulty.
- Avoiding sedation.
- Avoiding complications of intubation, for example, nosocomial infections such as ventilator-associated pneumonia.
- Decreased morbidity/mortality.
- Decreased cost.

Despite these benefits, there are data showing NIPPV is still underutilized by clinicians ***(Sweet et al., 2008).***

## Physiology

NIPPV provides positive end-expiratory pressure and ventilatory support to recruit collapsed alveoli, increase tidal volume and functional residual capacity, and improve lung compliance. The physiological sum manifests as decreased respiratory effort and improved oxygenation. Recruitment of alveolar units maintains gas exchange during the entire respiratory cycle, as well as increasing intra-alveolar forces against pulmonary edema. In addition to these respiratory benefits, NIPPV can increase cardiac output by decreasing LV preload in heart failure or decreasing LV afterload by reducing systolic wall stress ***(Chadda et al., 2002).***

## Patient Selection

The fundamental success of NIPPV lies in the emergency physician's selection of the appropriate patient. NIPPV is ultimately used to improve or prevent worsening acute respiratory failure. In objective measures, this can be described as:

- $SaO_2$ less than 90%.
- Use of accessory muscles.
- Inability to speak in full sentences.
- Respiratory rate greater than 24.
- Altered mental status.
- Not all disease processes are equally amendable to NIPPV. Table 1 summarizes the disease processes for which NIPPV is most useful; these are addressed later in more detail

1- Strong evidence a-cardiogenic pulmonary edema. b-Acute or chronic COPD

2- Intermediate evidence a-asthma b-community –acquired pneumonia

3- Weak evidence

   a- Trauma
   b- Neuromuscular disease (myasthenia-gravis)

As important as knowing indications for the NIPPV, knowledge of the contraindications is equally vital.

**Contraindications of NIPPV**

1-Inability to protect air way or clear secretions

2-Impaired consciousness (agitated patient unco operative patients)

3-Cardiac or respiratory arrest 4-haemodynamic arrest

5-Fascial trauma.surgery,deformity 6-pneumothorax

***(Shrank et al., 2007).***

# Tables of Indication and Contraindications of NIPPV
# Of NIPPV Table 1 indication

**Table (1):** Selecting Patients for NIPPV Based on Disease Process

| |
|---|
| ***Strong evidence*** <br>• Cardiogenic pulmonary edema.<br>• Acute or chronic respiratory failure (COPD).<br>• Respiratory failure in immunocompromised patients. |
| ***Intermediate evidence:*** <br>• Asthma.<br>• Community-acquired pneumonia. |
| ***Weak evidence:*** <br>• Trauma.<br>• Neuromuscular diseases (e.g., myasthenia gravis).<br>• Cystic fibrosis. |

***(Shrank et al., 2007).***

**Table (2):** Contraindication of NIPPV

| |
|---|
| o I Impaired consciousness (including agitated/uncooperative patients). |
| o C Cardiac or respiratory arrest. |
| Hemodynamic instability |
| Facial surgery/trauma/deformity |
| o P Pneumothorax.<br>o U Upper airway obstruction.<br>o C Complicated multi-organ failure. |
| Recent esophageal anastomosis. |

***(Shrank et al., 2007)***

Monitoring pH and CO2 is helpful to trend patient status, but these should not be used as exclusion criteria. In 2005, Diaz and colleagues used NIPPV successfully in patients with hyerpcapnic comas ***(Diaz, 2005).***

## Disease Processes Appropriate For NIPPV

**1-COPD.** Chronic obstructive pulmonary disease (COPD) affects 32 million people in the United States and is the fourth leading cause of death. Often, this disease presents in respiratory emergencies, and NIPPV has quickly emerged as a standard of care in treatment of severe exacerbations. When comparing NIPPV usage to treatment without it, multiple meta-analyses have revealed statistically significant reductions in intubation rates, mortality, and hospital length of stay ***(Kleinschmidt et al., 2009).***

In addition to these mortality and morbidity benefits, Light owler's meta-analysis showed significant physiological changes with NIPPV therapy. Within the first hour, patients exhibited improvement in pH, PaCO2, and respiratory rate. NIPPV can be utilized successfully in hypercapnic patients with a GCS less than 8 secondary to acute respiratory failure ***(Lightow Le et al., 2003).***

As previously noted, the key to success with NIPPV usage is selection. A randomized, controlled trial by Keenan and colleagues showed that NIPPV therapy had no benefit versus standard therapy in mild COPD exacerbation ***(Keenan et al., 2005).***