# Management of Prolonged Ventilation in ICU

***An Essay***

Submitted for Partial Fulfillment of Master Degree ***in General Intensive Care***


***By***

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# Abstract

***Background:*** Mechanical ventilation offers essential ventilatory support, while the respiratory system recovers from acute respiratory failure. Yet, invasive mechanical ventilation is associated with risks and complications that prolong the duration of mechanical ventilation and increase the risk of death.

***Aim of the Work:*** The aim of this essay is to discuss the recent definitions, pathophysiology, new predictors and guidelines of management of prolonged mechanical ventilation.

***Summary:*** According to the European Respiratory Society Task Force: prolonged weaning patients are those requiring more than 7 days of weaning after the first spontaneous breathing trial.

The pathophysiologic mechanisms of weaning failure need to be understood for an optimal management of the patient. These mechanisms include respiratory pump insufficiency, cardiovascular dysfunction, neuromuscular disorders, psychological factors as well as metabolic and endocrine diseases, alone or combined.

After a failed weaning test or extubation failure, a ventilation mode allowing a supposedly normal level of work of breathing is resumed. A thorough diagnostic work-up is then carried out. Subsequently, all reversible pathologies met are corrected, weaning readiness regularly ascertained and the weaning test is repeated. Tracheostomy may be considered as a useful adjunct for an easier care of the patient, especially for mobilization.


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***Keywords:*** *Prolonged Mechanical Ventilation - Respiratory Intensive Care Units- Pathophysiology – Weaning failure.*

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# List of Abbreviations

| | | |
|---|---|---|
| AKI | : | Acute kidney injury |
| ALS | : | Amyotrophic lateral sclerosis |
| APACHE III | : | Age Chronic Health Evaluation III |
| APS | : | Acute Physiology Score |
| ARDS | : | Acute respiratory distress syndrome |
| ASV | : | Adaptive support ventilation |
| ATP | : | Adenosine tri-phosphate |
| BUN | : | Blood Urea Nitrogen |
| CAM-ICU | : | Cognitive assessment method in ICU |
| $CaO_2$ | : | Content of oxygen in arterial blood |
| $CCO_2$ | : | CO2 content in blood |
| CIM | : | Critical illness myopathy |
| CINMAs | : | Critical illness neuromuscular abnormalities |
| CIP | : | Critical illness polyneuropathy |
| CIPNM | : | Critical illness polyneuropathy and myopathy |
| CNS | : | Central nervous system |
| COPD | : | Chronic obstructive pulmonary disease |
| C,rs | : | Compliance of the respiratory system |
| CSF | : | Cerebrospinal spinal fluid |
| DRW | : | Day of readiness for weaning |
| DVT | : | Deep venous thrombosis |

# List of Abbreviations (Cont.)

| | | |
|---|---|---|
| E,rs | : | Elastance of the respiratory system |
| ERV | : | Expiratory reserve volume |
| FiO2 | : | Fraction of inspired Oxygen |
| FEV1 | : | Forced expiratory volume in 1 second |
| FRC | : | Functional residual capacity |
| FVC | : | Forced vital capacity |
| F/VT | : | Frequency to tidal volume ratio |
| GABA | : | Gamma-amino butyric acid |
| GBS | : | Guillain–Barré syndrome |
| IC | : | Inspiratory capacity |
| ICU | : | Intensive care unit |
| ICU-AW | : | ICU acquired weakeness |
| IRV | : | Inspiratory reserve volume |
| IWI | : | Integrative weaning index |
| LMNs | : | Lower motor neurons |
| LTCH | : | Long-term care hospitals |
| LWH | : | Long-term weaning hospital |
| LV | : | Left ventricle |
| MG | : | Myasthenia gravis |
| MICU | : | Medical intensive care unit |
| MV | : | Mechanical ventilation |

# List of Abbreviations (Cont.)

| | | |
|---|---|---|
| NAVA | : | Neurally adjusted ventilatory support |
| NIPPV | : | Non-invasive positive pressure ventilation |
| $NMBA_S$ | : | Neuro-muscular blocking agents |
| $NMBD_S$ | : | Neuro-muscular blocking drugs |
| NTIS | : | Non-thyroidal illness syndrome |
| P0.1 | : | Airway occlisuion pressure 0.1 seconds after onset of inspiratory effort |
| PA | : | Alveolar pressure |
| Pa | : | Pulmonary artery pressure |
| PaCO2 | : | Partial pressure of carbon-dioxide |
| PEFR | : | Peak expiratory flow rate |
| P-ACV | : | Pressure assist control ventilation |
| PBW | : | Predicted body weight. |
| PEEP | : | Positive end-expiratory pressure |
| $PEEP_i$ | : | Inrinsic PEEP |
| PC | : | Pressure control |
| PMV | : | Prolonged mechanical ventilation |
| PSV | : | Pressure support ventilation |
| $P_V$ | : | Pulmonary venous pressure |
| RAAS | : | Richmond Agitation-Sedation Scale |
| RCTs | : | Randomised controlled trials |

# List of Abbreviations (Cont.)

RR : Respiratory system

RSBI : Rapid-shallow breathing index.

RICU : Respiratory intensive care units

RV : Residual volume

SaO2 : Arterial oxygen saturation

SAPSII : Simplified Acue Physiology Score II

SBTs : Spontaneous breathing trials

SCI : Spinal cord impairment

SIMV : Synchronised intermittent mandatory ventilation

$T_E$ : Expiratory time

$T_I$ : Inspiratory time

TLC : Total lung capacity

TV : Tidal volume

UMN : Upper motor neuron

VA/Q : Ventilation-Perfusion ratio

VC : Vital capacity

VE : Minute ventilation

VT : Tidal volume

WOB : Work of breathing

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# Introduction

Mechanical ventilation offers essential ventilatory support, while the respiratory system recovers from acute respiratory failure. Yet, invasive mechanical ventilation is associated with risks and complications that prolong the duration of mechanical ventilation and increase the risk of death.

Substantial variability exists in the definition of Prolonged Mechanical Ventilation, with ventilation duration ranging from more than 6 hours to more than 29 days (***Rose et al., 2015)***.

According to the European Respiratory Society Task Force: prolonged weaning patients are those requiring more than 7 days of weaning after the first spontaneous breathing trial (***Boles et al., 2007)***.

These patients may represent up to 14% of patients admitted to ICU for intubation and mechanical ventilation, accounting for 37% of all ICU costs and are associated with an in-hospital mortality up to 32% (***Funk et al., 2009).***

Data from meta-analysis of studies of chronically critically ill patients requiring prolonged ventilatory support revealed that, mortality at 1 year was 58%, 57% of patients were liberated from mechanical ventilation, and only 22% were discharged to home (***Damuth et al., 2015).***

These data are of great importance as prolonged mechanical ventilation is the hallmark of chronic critical illness, an important and growing public health problem with an estimated cost of 35 billion dollars annually in the US alone (***Khan et al., 2015)***.

The pathophysiologic mechanisms of weaning failure need to be understood for an optimal management of the patient. These mechanisms include respiratory pump insufficiency, cardiovascular dysfunction, neuromuscular disorders, psychological factors as well as metabolic and endocrine diseases, alone or combined (***Perren and Brochard, 2013).***

Early identification of those Individuals who will ultimately require prolonged mechanical ventilation would likely alter traditional ventilator and sedation management or identify those who may benefit from early tracheostomy. A novel predictive model; the I-TRACH model, was highly specific in identifying patients who subsequently required prolonged mechanical ventilatory support and was associated with greater accuracy than traditionally used models (***Clark and Lettieri, 2013).***

Also, Measuring the percentage of change in the B-Type Natriuretic Peptide level during a spontaneous breathing trial may be a good predictor of successful weaning from mechanical ventilation, and it had the best sensitivity and specificity as compared to other traditional weaning parameters (Rapid shallow breathing index, Minute ventilation, and PaO2/FiO2) (***Farghaly et al., 2015)***

After a failed weaning test or extubation failure, a ventilation mode allowing a supposedly normal level of work of breathing is resumed. A thorough diagnostic work-up is then carried out. Subsequently, all reversible pathologies met are corrected, weaning readiness regularly ascertained and the weaning test is repeated. Tracheostomy may be considered as a useful adjunct for an easier care of the patient, especially for mobilization (***Perren and Brochard, 2013).***

Tracheostomy was independently associated with reduced ICU and in-hospital mortality, and increased successful weaning rate, for critically ill patients requiring MV for at least 14 days (***Lin et al., 2015).***

In several countries specialized units have been created to accommodate patients requiring just prolonged mechanical ventilatory support and being otherwise clinically stable (***Perren and Brochard. 2013)***