



Mechanical ventilation weaning protocol improves medical adherence and results[☆]



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ARTICLE INFO

Keywords:

Mechanical ventilation
Weaning protocol
Intensive care unit
Physician adherence

ABSTRACT

Introduction: Implementation of a weaning protocol is related to better patient prognosis. However, new approaches may take several years to become the standard of care in daily practice. We conducted a prospective cohort study to investigate the effectiveness of a multifaceted strategy to implement a protocol to wean patients from mechanical ventilation (MV) and to evaluate the weaning success rate as well as practitioner adherence to the protocol.

Methods: We investigated all consecutive MV-dependent subjects admitted to a medical-surgical intensive care unit (ICU) for >24 h over 7 years. The multifaceted strategy consisted of continuing education of attending physicians and ICU staff and regular feedback regarding patient outcomes. The study was conducted in three phases: protocol development, protocol and multifaceted strategy implementation, and protocol monitoring. Data regarding weaning outcomes and physician adherence to the weaning protocol were collected during all phases.

Results: We enrolled 2469 subjects over 7 years, with 1,943 subjects (78.7%) experiencing weaning success. Physician adherence to the protocol increased during the years of protocol and multifaceted strategy implementation (from 38% to 86%, $p < 0.01$) and decreased in the protocol monitoring phase (from 73.9% to 50.0%, $p < 0.01$). However, during the study years, the weaning success of all subjects increased (from 73.1% to 85.4%, $p < 0.001$). When the weaning protocol was evaluated step-by-step, we found high adherence for noninvasive ventilation use (95%) and weaning predictor measurement (91%) and lower adherence for control of fluid balance (57%) and daily interruption of sedation (24%). Weaning success was higher in patients who had undergone the weaning protocol compared to those who had undergone weaning based in clinical practice (85.6% vs. 67.7%, $p < 0.001$).

Conclusions: A multifaceted strategy consisting of continuing education and regular feedback can increase physician adherence to a weaning protocol for mechanical ventilation.

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1. Introduction

The process of discontinuing mechanical ventilation (MV) support begins with the recognition that the patient has begun to recover from the problems that necessitated ventilatory support [1,2]. The criteria by which clinicians decide whether the patient has recovered enough to tolerate withdrawal of ventilatory support have not been clearly

defined nor prospectively evaluated in randomized controlled trials. Instead, many combinations of subjective and objective assessment criteria that may be surrogate markers of recovery have been employed, although they lack adequate confidence [3–7]. Usual weaning indexes are poor predictors for extubation outcome in the overall ICU population [8].

The initial few minutes of the spontaneous breathing trial (SBT) should be closely monitored. The tolerant patients should continue the SBT for at least 30 min but no > 120 min to assure maximum sensitivity and safety [9]. For patients who pass the SBT, the decision to extubated must be guided by clinical judgment and objective data to minimize the risk of unnecessary reintubations [10–11]. In summary,

[☆] This study was conducted in the Intensive Care Unit in Moinhos de Vento Hospital Porto Alegre, Rio Grande do Sul, Brazil.

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protocols should not represent rigid rules but, rather, guides to patient care [12]. Evidence-based reviews suggest that protocols to manage the weaning and liberation of subjects from Mechanical Ventilation could reduce the time that subjects spend receiving mechanical ventilation [10–14]. However, even when research clearly supports a change in approach, it is very difficult to get physicians to alter their practice and management styles. Improvement programs in the implementation of a protocol of weaning of mechanical ventilation may be necessary for success of the medical team. It is unclear how many members of a medical team are needed to successfully deploy a weaning protocol. We believe that education, systematic guidance, and weekly meetings are needed for all members of the team to adopt a new routine in an intensive care center. A recent study has shown that in ICUs that use protocols, the most used are those for discontinuation of oxygen therapy (64%) and weaning (57%) [15]. The literature contains scarce reports regarding medical adherence to weaning protocols; furthermore, although education, constant training, and reminders to use a new tool can improve adherence, there are no reports regarding the medical adherence rate [16].

One study that showed good medical acceptance of the protocol by a group of nurses who conducted the weaning from mechanical ventilation; the study reported reduction in the time of mechanical ventilation and in ICU time, without adverse effects. There was good medical acceptance of the implementation of the protocol for some factors, including multidisciplinary guidance and education of the ICU staff; additionally, a weaning program was developed that included leadership, education, and supervision [17]. The use of protocols reduces costs and improves patient satisfaction and quality. Moreover, there is no impact on the workload of health professionals [16].

The purpose of this study was to evaluate how a multifaceted strategy consisting of continuing education and regular feedback would affect the acceptance and institutional use of a weaning protocol from mechanical ventilation, as well as to evaluate the weaning success (WS) rate and practitioner adherence to the protocol.

2. Methods

2.1. Patients and facility

The study was conducted over seven years in a 31-bed medical-surgical ICU. Study patients included all critically ill patients who received MV for >24 h using Servo 900C® (Siemens-Elma AB, Solna, Sweden) or Evita 2 dura® and Evita 4® (Dräger Medical AG & Co., Lubeck, Germany) ventilators.

2.2. Design and multifaceted strategy

This was a prospective cohort clinical study and was approved by the Ethical Research Committees of the Institution. Implementation of the protocol began in January 2004 and was divided into three phases: development (2004), application of the protocol and multifaceted strategy (2005, 2006, and 2007), and monitoring (2008, 2009, and 2010). The multifaceted strategy consisted of continuing education of attending physicians and intensive care unit (ICU) staff and regular feedback regarding patient outcomes. The data were presented and actualized to the ICU staff every 6 months in programmed meetings during the protocol application period (2005 to 2007).

In 2004, a weaning protocol for mechanical ventilation was created by a group of ICU health professionals (physicians, physiotherapists, and nurses). Thus, after the patients were eligible for weaning from mechanical ventilation, the protocol was offered to the patient's attending physician, who was then at liberty to determine whether to use the protocol. If the protocol was not applied, the patient was followed and extubated following the routine of ICU. Application of the protocol consisted of the patient going through at least four of the five existing steps of the protocol, which are avoidance of water balance, daily

interruption of sedation, evaluation of weaning predictor indices, tube test and, if necessary, the use of NIV after extubation. The implementation phase (2004) of the protocol consisted of the education and guidance to health professionals regarding use of the protocol. The implementation phase of the protocol (2005–2007), as a multifaceted strategy, consisted in the continuation of education and guidance to health professionals with daily rounds, weekly meetings, supervision, and collection of data concerning use of the protocol as well as how the protocol was disseminated. Finally, the protocol monitoring phase (2008–2010) consisted only of education and guidance when necessary and daily rounds as routine of ICU.

Inclusion criteria were that all patients admitted to the Hospital Moinhos de Vento ICU from 2004 to 2010 and who were on mechanical ventilation for >24 h. The exclusion criteria was use of tracheostomy.

Successful weaning of mechanical ventilation was considered when the patient tolerated extubation for 48 h or more.

2.3. Characteristics of the weaning protocol implementation program

The implementation of the protocol was addressed to the ICU team consisting of intensivist physicians, physiotherapists, nurses, and physician assistants who met patients in the ICU. Weekly meetings and orientations were held regarding the team routine on how to use the weaning protocol.

For each patient included in the weaning protocol, a sign was placed visibly on the edge of the bed indicating that the patient was participating in the study. Daily rounds were conducted by ICU staff to determine which subjects were eligible to start the weaning process; upon physician agreement, the subject was included in the protocol.

2.4. Weaning protocol

The institutional protocol was developed with multidisciplinary planning (physician, physiotherapist, and nurse) and required no additional support personnel for its implementation. The five steps of the institutional weaning protocol were as follows.

- (1) Avoidance of positive fluid balance for 24 h prior to the weaning trial. Fluid balance is a potentially modifiable variable associated with weaning outcomes.
- (2) Daily interruption of sedation conducted by the ICU staff or the subject's attending physician. During this time, subjects were monitored for the following: improvement or resolution of the underlying cause of acute respiratory failure, adequate gas exchange as indicated by $\text{PaO}_2 > 60$ mm Hg while breathing with an $\text{FIO}_2 \leq 0.4$ with a positive end-expiratory pressure ≤ 8 cm H_2O , low or no further need for vasoactive agents (dopamine or dobutamine ≤ 5 $\mu\text{g}/\text{kg}$ per min, or norepinephrine ≤ 0.05 $\mu\text{g}/\text{kg}$ per min), and no evidence of increased intracranial pressure.
- (3) Evaluation of weaning predictors. The following measurements of ventilatory parameters were recorded over 1–3 min of a spontaneous breathing trial (SBT): frequency to tidal volume ratio (f/VT) measured using a ventilometer (Ainca Model 295, Ainca, San Marcos, CA, USA) during 1 min of monitoring with the subject in a semi-recumbent position; maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) measured using a manovacuometer (Suporte, Famabra, Brazil) and defined as the most negative (and positive, respectively) value produced by three consecutive respiratory efforts after 30 s of occlusion against a unidirectional valve (NIF-Tee® Non-Rebreathing T-Piece, Smiths Medical ASD Inc., Keene, NH, US).
- (4) T-tube trial for 30–120 min. Patients with $f/\text{VT} < 105$ breaths/L/min and $\text{MIP} < -30$ cmH_2O underwent 30 min of SBT with a T-tube trial enriched by oxygen to achieve arterial oxyhemoglobin saturation (SpO_2) $> 90\%$ as measured using pulse oximetry. Extubation was performed after adequate clinical tolerance to

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