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Predictors of successful weaning from prolonged mechanical ventilation in Taiwan

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Summary
Background: For adult patients on prolonged mechanical ventilation (PMV, ≥21 days), successful weaning has been attributed to various factors. The purpose of this study was to describe patient outcomes, weaning rates and factors in successful weaning at a hospital-based respiratory care center (RCC) in Taiwan.
Methods and results: This was a retrospective observational study performed in a 24-bed RCC over six years. A total of 1307 patients on PMV were included in the study. The overall survival rate was 62%. Fifty-six percent of patients were successfully weaned. Unsuccessfully weaned patients had higher MICU transfer rates, higher Acute Physiology and Chronic Health Evaluation II scores, longer duration of RCC stay, higher rates of being bed-ridden prior to admission, increased hemodialysis rates, higher modified Glasgow Coma Scale scores, higher rapid shallow breathing index, lower inspiratory pressure at residual volume (PImax) and lower blood urea nitrogen (BUN) and creatinine levels. Factors found to be associated with unsuccessful weaning were length of RCC stay (OR = 1.04, $P < 0.001$), modified GCS score (OR = 0.93, $P < 0.046$), PImax (OR = 0.97, $P < 0.001$), serum albumin concentration (OR = 0.62, $P < 0.023$) and BUN level (OR = 1.01, $P < 0.002$).
Conclusion: High rates of ventilator independence can be achieved in an RCC setting as an alternative to ICU care. Factors associated with unsuccessful weaning included longer duration of RCC stay, elevated BUN levels and lower modified GCS scores, serum albumin and PImax levels.

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Introduction

Prolonged mechanical ventilation (PMV) is defined as the need for mechanical ventilation for in excess of 21 days and for 6 or more hours per day.[1] The number of intensive care unit (ICU) patients requiring PMV ranges from 3 to 10%, with these patients accounting for an estimated 37–40% of ICU resources.[2–6] The number of patients requiring PMV has increased, and indeed is projected to increase further.[7] As a result of this, lower level specialized care facilities have been developed to manage ventilator weaning of these patients at a reduced cost. Current weaning success rates average around 50%.[2,4,6,8,9] Successful weaning has been attributed to a number of factors including age, the presence or absence of comorbid conditions, nutritional status, muscle strength and lung mechanics.[2,10,11]

In Taiwan, the National Health Insurance Bureau (NHIB) established a policy of gradual care reduction for these patients with transfer to a Respiratory Care Center (RCC) after 21 days in the ICU and then to a Respiratory Care Ward (RCW) after 42 days in the RCC. The RCC at Chang Gung Memorial Hospital (CGMH) is a hospital-based RCC and was the first major RCC established in Asia. The purpose of RCC facilities is to manage patients who require specialized respiratory care, but no longer need ICU monitoring, and thereby improve the implementation of specialized care and reduce wastage of medical resources. There have been few clinical studies performed to evaluate weaning predictors in patients on PMV in an RCC setting. Here we report our experience over a 6-year period with regards to successful weaning rates and factors influencing successful weaning in an RCC.

Methods

This study was approved by the Institutional Review Board of CGMH.

Setting

The facility was a 24-bed RCC within a 3800-bed tertiary medical center containing 350 ICU beds. Nurse to patient ratios in the RCC were 1:3 and respiratory therapist to patient ratios were 1:8. Pulmonary and critical care medicine specialists served as primary physicians for all patients with in-hospital night coverage provided by fellows. Consultation services were available for most medical and surgical specialties. Discharge planning was managed by nurse and social work case managers. Hemodialysis was available as needed.

Patients

All patients transferred to the RCC between November 1999 and December 2005 were identified and eligible for inclusion in this study. Patients with respiratory failure were included if MV lasted longer than 3 weeks in the ICU and previous weaning attempts had failed. Eligibility criteria as per NHIB requirements included: hemodynamic stability with no vasoactive drug infusions for at least 24 h prior to transfer; fraction of inspired oxygen (FiO_2) $\leq$40%; positive end-expiratory pressure (PEEP) $<$10 cmH_2O; no acute hepatic or renal failure; no surgical intervention within 2 weeks of transfer; or the attending pulmonary physician's judgment that the patient would benefit from being transferred to the RCC. Admission decisions were not strictly based on diagnosis, route of MV, prognosis, weaning or rehabilitation potential. Any patient with hemodynamic instability or multiple organ failure was transferred back to the appropriate ICU. Terminal cancer patients were excluded. Although some patients had more than one RCC admission during a hospital stay, for statistical purposes only the first admission was used for analysis.

Patients from CGMH ICUs accounted for 97% of study participants, with the remainder comprising transfers from other hospitals.

Weaning process

The unit provided all forms of ventilatory support including invasive and non-invasive nose/face mask positive pressure facilitations. Our approach to weaning was dependent on extensive use of non-invasive MV as a bridge to spontaneous breathing, coupled with techniques to clear respiratory secretions.[12]

All patients met the following criteria before weaning was attempted: no evidence of hemodynamic instability; no inotropic agent use; systolic blood pressure $>$100 mm Hg; heart rate $<$130 and $>$50 bpm; body temperature $<$38 °C; fraction of inspired oxygen $<$40%; PEEP $\leqq$8. A therapist-implemented weaning protocol was then commenced. The protocol was comprised of 16 steps, where patients progressed one step every 12 h from full ventilatory support to 24 h of spontaneous, unassisted breathing.

Ventilatory support was gradually reduced to ''half-ventilatory-support'' by first reducing the level of synchronized intermittent mandatory ventilation (SIMV) and then reducing the level of pressure-support ventilation (PSV). Following this, self-breathing trials (SBT) were implemented in tracheostomized patients using a Venturi tracheostomy mask. The duration of these trials was gradually increased (beginning at 2 h and finishing at 24 h), between which PSV (level 6) was reapplied. Patients were liberated from ventilatory support after the 24 h SBT. Translaryngeal intubated patients were extubated after a 2 h T-piece trial (following the aforementioned reductions in SIMV and PSV) during which there were no indicators of weaning failure.

Two acceleration steps were incorporated into the protocol. A patient could progress faster than one step every 12-hour interval if[1]: the level of SIMV was maximally reduced in one step and PSV breaths were adequate in volume or[2] any SBT was well tolerated (in which case SBTs were extended through the duration of the next step).

Measurements

Patient characteristics

Medical records were retrospectively reviewed. Recorded data included demographics, previous ICU type, reason for