

Initial Experience with a Mechanical Ventilation Weaning Unit

Jonathan Cohen MD¹, Daniel Starobin MD^{1,2}, Gregory Papirov MD³, Maury Shapiro MD¹, Elad Grozovsky MD¹, Mordechai R. Kramer MD² and Pierre Singer MD¹

¹General Intensive Care Unit and ²Pulmonary Institute, Rabin Medical Center (Beilinson Campus), Petah Tiqva, Israel
 Affiliated to Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel

³Beit Rivka Rehabilitation Hospital, Petah Tiqva, Israel

Key words: prolonged mechanical ventilation, weaning unit

Abstract

Background: While increasing numbers of patients require prolonged mechanical ventilation, resources for weaning are either limited (ICU beds) or inadequate (general wards).

Objectives: To report on our initial experience over a 7 month period with an eight-bed mechanical ventilation weaning unit.

Methods: Sixty-nine patients requiring MV for >10 days were admitted to the unit (nurse:patient ratio 1:4). Data collected included reason for MV, duration of hospital stay, and MVWU course. Outcome results (successful weaning and mortality) were compared to those in historic controls (patients ventilated in the general wards over a 4 month period prior to the MVWU; n = 100).

Results: The mean age of the patients was 68 ± 16.6 years and hospital stay prior to MVWU admission 28.6 ± 24.2 days (range 10–72). The main reasons for MV included acute exacerbation of chronic obstructive pulmonary disease (31%) and recent pneumonia (28%). Mean MVWU stay was 13.5 ± 15.7 days (range 1–72 days). Thirty-four patients (49%) underwent tracheostomy. Fourteen patients required admission to the ICU due to deterioration in their status. Twenty-nine patients (42%) were successfully weaned and discharged to the wards. A further 20 patients were transferred to the chronic ventilation unit of a regional geriatric rehabilitation hospital, where 5 were subsequently weaned and 15 required prolonged ventilation. Compared to controls (matched for age and reason for mechanical ventilation), more MVWU patients underwent successful weaning (49% vs. 12%, $P < 0.001$) and their mortality rate (n = 12) was significantly lower (17% vs. 88%, $P < 0.001$).

Conclusion: The higher level of care possible in a MVWU may result in a significantly improved rate of weaning and lower mortality. The assessment of long-term outcome in patients discharged to pulmonary rehabilitation centers requires further investigation.

IMAJ 2005;7:166–168

As life-support facilities become increasingly available, more patients with acute exacerbations of chronic diseases undergo intubation and mechanical ventilation that may be required for prolonged periods. While these patients are generally admitted to an intensive care unit, this is a scarce resource and, in fact, many of these patients do not require the intensity of treatment or monitoring available in an ICU. On the other hand, treatment in a general ward imposes an unrealistic burden on an often over-crowded and understaffed resource.

Recently there has been increasing awareness of the importance and effectiveness of dedicated chronic ventilatory units [1–3]. Thus,

according to the recent literature, successful weaning from mechanical ventilation is possible in most patients (68–75%), with an acceptable mortality rate (7–24%) and lower resource utilization when compared to conventional ICUs [1–3]. A mechanical ventilation weaning unit was recently established at our hospital and we report our initial results.

Patients and Methods

All patients admitted to the MVWU over a 7 month period (February to August 2002) were included in this prospective observational study. The MVWU is an eight-bed unit that is adjacent to the main ICU. Each patient station is equipped with continuous, non-invasive monitoring (Datex, Ohmeda, Helsinki, Finland), including electrocardiogram, pulse oximetry and blood pressure, and ventilation facilities (Puritan-Bennet 7200, Carlsbad, CA, USA). The unit is staffed by the same full-time intensivists who staff the main ICU and intensive care-trained nurses. In addition, daily assessments by a physical therapist, dietitian and pharmacist are part of the routine care. The nurse:patient ratio is 1:4 compared to 1:2 in the ICU. Indication for admission was prolonged mechanical ventilation (>10 days) with at least two unsuccessful attempts at weaning. Patients requiring hemodynamic support, renal replacement therapy, invasive monitoring (intra-arterial or central venous catheters) and those with irreversible disease (metastatic cancer, advanced progressive neurologic disorders) were not considered for admission.

Patients were considered eligible for weaning under the following conditions: improvement or resolution of the underlying reason for mechanical ventilation, the patient is fully awake, body temperature <38.5°C, hemoglobin >8 g/dl, systolic blood pressure >90 mmHg, no sedation, ratio of partial pressure of oxygen/inspired oxygen concentration >200, positive end-expiratory pressure <7.0 cm H₂O, and respiratory rate to tidal volume ratio <105 breaths/min/L. This assessment was performed daily in all patients (daily screen), and in patients fulfilling these criteria a 1 hour spontaneous breathing trial using the pressure support mode (inspiratory pressure support level set at 8 cm H₂O) was performed. In the absence of hemodynamic or respiratory distress the trachea was immediately extubated. A tracheostomy was performed in patients requiring ventilation for more than 7 days, preferably at the bedside, unless the procedure was considered technically difficult in which case it was performed in the operating room. The choice of post-MVWU disposition depended on patient status as follows:

- Patients failing more than two weaning trials despite having undergone tracheostomy and mechanical ventilation for >10

MV = mechanical ventilation

MVWU = mechanical ventilation weaning unit

ICU = intensive care unit

days in the MVWU, who were hemodynamically stable, afebrile and with no other organ failure were transferred to the chronic ventilation unit of a regional geriatric rehabilitation hospital (Beit Rivka). This unit is staffed by a full-time senior geriatric physician, with a nurse:patient ratio of 1:7. Mechanical ventilation is provided by the Newport HT 50 (Costa Mesa, CA, USA) and all patients are monitored with pulse oximetry. The hospital has only limited specialized diagnostic capabilities.

- Patients developing hemodynamic instability, renal failure requiring replacement therapy or worsening respiratory failure (PEEP > 10 cm H₂O, or FiO₂ > 0.8) were transferred to the ICU.
- Patients maintaining spontaneous unassisted breathing for > 24 hours were discharged either to a general ward or directly home.

A control group comprised patients (n=100) who were ventilated in the general medical (n=88) and surgical wards (n=12) of our hospital over a 4 month period in 1996–1997 (historic controls) [4]. All these patients were ventilated using a Puritan Bennett MA2 ventilator (Carlsbad) in the assist control mode. Management was supervised by the attending ward staff and no formal protocols for weaning were used.

The data collected included age, gender, referring department, reason for mechanical ventilation, length of MVWU stay, hospital stay, patient disposition, and outcome – namely, successful weaning (the ability to breathe spontaneously for > 24 hours) – and in-hospital mortality. Data are summarized as mean values ± standard deviation or medians (range) for highly skewed variables. Student's *t*-test was used to compare baseline characteristics and outcome results. A *P* ≤ 0.05 was considered statistically significant.

Results

Demographic data for the two groups are shown in Table 1. During the study period, 69 patients were admitted to the MVWU – 40 (58%) from internal medicine wards, 14 (20%) from surgical wards and 15 (22%) from the ICU. The reasons for respiratory failure and mechanical ventilation were similar in both groups. Mean stay prior to MVWU admission was 28.6 ± 24.2 days (range 10–72) and patients had undergone a mean of 3.1 ± 1.0 unsuccessful extubations in their referring departments.

The outcome of the MVWU patients is shown in Figure 1. Twenty-nine patients (42%) were successfully weaned and discharged from the MVWU – 20 to an internal medicine ward, 5 to a surgical ward, and 4 directly home. Twenty patients were transferred to the regional geriatric rehabilitation hospital, where 5 were successfully weaned and subsequently discharged, while 15 required long-term ventilation. Thus, in total, 34 patients (49%) were successfully weaned. The number of weaning trials was 1.7 ± 1.0 for successfully weaned patients and 2.8 ± 2.0 for non-weaned patients. Tracheostomy was performed in 34 patients (49%), in 21 as a bedside procedure. Of these patients, 18 (53%) were subsequently weaned from mechanical ventilation. Mean stay in the MVWU was 13.5 ± 15.7 days (range 1–72). Fourteen patients required ICU

Table 1. Demographic data

Parameter	Historic data (n=100)	MVWU (n=69)	P
Mean age (yrs)	77.3 ± 11.9	68 ± 16.6	NS
Gender (M/F)	47/53	33/36	NS
Diagnosis			
Chronic obstructive pulmonary disease	30 (30%)	23 (31%)	
Pneumonia	19 (19%)	21 (28%)	
Neurologic (including stroke)	15 (15%)	10 (13.5%)	NS
Congestive heart failure	16 (16%)	4 (5.4%)	
Postoperative	7 (7%)	5 (7.2%)	
Post-trauma	4 (4%)	6 (8.7%)	
Malignancy	9 (9%)		

Table 2. Comparison of outcomes between MVWU and historic hospital controls

Parameter	Historic data	MVWU	P
Mortality (%)	88%	7%	<0.001
Successful weaning	12%	49%	<0.001

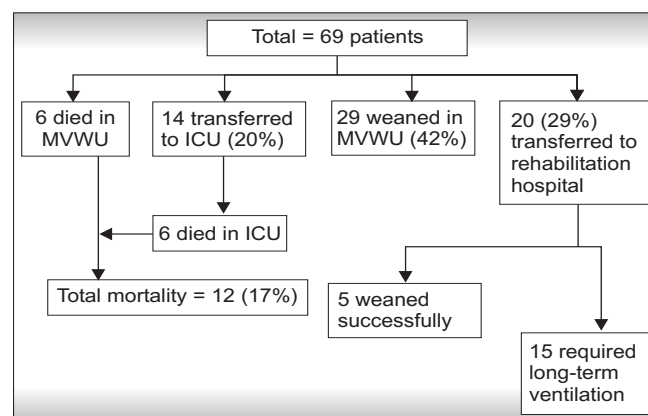


Figure 1. Patient outcomes in MVWU

admission (6 of these patients died and the remainder were discharged directly from the ICU). The mortality rate was 17% (n=12), 6 patients dying in the MVWU due to respiratory or cardiac failure and 6 in the ICU as a result of sepsis.

Table 2 compares the outcomes between the MVWU and historic control groups. Significantly more patients in the MVWU were successfully weaned (49% vs. 12%, *P* < 0.001) and their mortality was significantly lower (17% vs. 88%, *P* < 0.001).

Discussion

Patients requiring prolonged mechanical ventilation pose considerable medical, social and economic burdens on the healthcare system [5,6]. For this reason, the concept of specialized weaning units has received increasing interest [7]. Vitacca et al. [1] showed that a specialized Respiratory Intermediate Intensive Unit was effective (75%) in liberating a heterogeneous group of ventilator-dependent patients after a mean stay of 17 ± 7 days, with a low

PEEP = positive end-expiratory pressure
FiO₂ = forced expiratory oxygen

mortality rate (7%). Experience over a 5 year period in the Mayo Clinic Ventilator-Dependent Rehabilitation Unit yielded similar results (74% of patients successfully weaned) with a mortality of 8% [2]. Schonhofer and colleagues [3] described their experience with a specialized national weaning center that admitted ventilator-dependent patients from a number of referring ICUs. After a mean duration of 41 days of mechanical ventilation, 68% of patients were successfully weaned from the ventilator and the in-hospital mortality was 24.3%. Indeed, it has been suggested that about 50% of so-called difficult or impossible-to-wean patients can in fact be successfully weaned in specialized units [8–10]. Our initial results are in agreement with these results: 49% of patients were successfully weaned, with a mortality of 17%.

The MVWU at our hospital may be defined as an intermediate-care, non-invasive monitoring and treatment unit, which is staffed by full-time intensivists. The MVWU admits patients with reversible, acute or chronic respiratory failure who require prolonged ventilation following repeated weaning failures. In order to maximize the potential of the unit, we devised a management strategy that utilized all available resources, including the ICU and a regional rehabilitation center. Patients' ability to breathe spontaneously was assessed daily. In those with a positive result a breathing trial was performed, which if successful, was followed by immediate extubation. Patients requiring ventilation for more than 7 days (n=34) underwent tracheostomy, in most cases (62%) in the ward as a bedside procedure. Tracheostomy has been reported to be an important part of the weaning strategy of chronically ventilated patients [11], allowing for more patient mobility, comfort and the possibility of speech. In our series, 53% of tracheostomized patients were successfully weaned from the ventilator. A significant number of our patients (n=20, 29%) required ventilation for >10 days despite tracheostomy and were transferred to a regional geriatric rehabilitation hospital. Close cooperation with this hospital ensured the continuing availability of beds in the MVWU, allowing us to accept new patients to the unit. The fact that the majority of these patients (n=15) continued to require permanent ventilatory support emphasizes the need for such an outlet. Since the regional rehabilitation center associated with our hospital has only limited specialized diagnostic capabilities (no computerized tomography or ultrasound services, and no specialist pulmonology or infectious disease services), we defined a period of 10 days in the MVWU prior to transfer as being necessary to stabilize the patient and exclude reversible conditions.

The close physical proximity of the MVWU to the ICU had distinct advantages. Firstly, it allowed for the flexible use of medical and nursing staff between the two units. Secondly, it ensured that a trained ICU specialist or resident was always available in the event of an emergency and was able to supervise therapy until such time as the patient could be transferred to the ICU. In our series 14 patients required ICU admission, of whom 6 died and 8 were discharged directly from the ICU. Most ICU admissions (8 of 14) occurred in the first week of MVWU stay, lending further support to our policy of not transferring patients immediately to the rehabilitation center.

In order to objectively assess the impact of the new unit, we

compared outcomes of MVWU patients with an historic control group of patients who were ventilated in the general medical and surgical wards and represent the standard of care prior to the MVWU. More detailed information concerning this group – for example, the number of failed weaning trials, the total number of tracheostomies performed – were not noted at the time of data collection and this represents a limitation of the present study. The differences in outcome between the MVWU and controls, while expected, are nevertheless striking, both regarding success of weaning (49% vs. 12%) and mortality (17% vs. 88%). The high mortality of ward-treated patients reflects the difficulties of providing mechanical ventilation in a general ward, such as lack of adequately trained medical and nursing staff, overcrowded conditions with chronic understaffing, and lack of appropriate equipment for treatment and monitoring.

We conclude that the level of care possible in a MVWU may significantly improve the rate of weaning from mechanical ventilation and reduce mortality in patients requiring prolonged ventilation. Close cooperation with a regional geriatric rehabilitation center ensured the continuing availability of beds in the MVWU. However, the assessment of long-term outcome for patients discharged from the MVWU to pulmonary rehabilitation centers requires further investigation.

References

1. Vitacca M, Clini E, Porta R, Serene D, Ambrosino N. Experience of an intermediate respiratory intensive therapy in the treatment of prolonged weaning from mechanical ventilation. *Minerva Anesthesiol* 1996;62:57–64.
2. Gracey DR, Hardy DC, Naessens JM, Silverstein MD, Hubmayr RD. The Mayo Ventilator-Dependent Unit: a 5 year experience. *Mayo Clin Proc* 1997;72:13–19.
3. Schonhofer B, Euteneuer S, Nava S, Suchi S, Kohler D. Survival of mechanically ventilated patients admitted to a specialized weaning centre. *Intensive Care Med* 2002;28:908–16.
4. Grunberg G, Cohen J, Kogan A, Keslin J, Grozovski E, Singer P. Should mechanical ventilation be performed in a general ward? [Abstract]. *Crit Care* 1997;236.
5. Lemaire F. Difficult weaning. *Intensive Care Med* 1993;19:S69–73.
6. Carson SS, Bach PB, Brzozowski L, Leff A. Outcomes after long-term acute care. An analysis of 133 mechanically ventilated patients. *Am J Respir Crit Care Med* 1999;159:1568–73.
7. Daly BJ, Rudy EB, Thompson KS, Happ MB. Development of a special care unit for chronically critically ill patients. *Heart Lung* 1991;20:45–51.
8. Scheinhorn DJ, Chao DC, Stearn-Hassenpflug M, LaBree LD, Heltsley DJ. Post-ICU mechanical ventilation: treatment of 1123 patients at a regional weaning center. *Chest* 1997;111:1654–9.
9. Elpern EH, Larson R, Douglass P, Rosen RL, Bone RC. Long-term outcomes for elderly survivors of prolonged ventilator assistance. *Chest* 1989;96:1120–4.
10. Indihar FJ. A 10-year report of patients in a prolonged respiratory care unit. *Minn Med* 1991;74:23–7.
11. Heffner JE, Hess D. Tracheostomy management in the chronically ventilated patient. *Clin Chest Med* 2001;22:55–69.

Correspondence: Dr. P. Singer MD, Director, General Intensive Care Unit, Rabin Medical Center (Beilinson Campus), Petah Tiqva 49100, Israel. Phone: (972-3) 937-6525
Fax: (972-3) 923-2333
email: psinger@clalit.org.il