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Weaning patients off mechanical ventilation in a chronic ventilation facility – using a standardised approach

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Abstract

Background: We describe the standardised management of patients in a chronic ventilation facility (CVF) and the rate of weaning of chronically ventilated patients off mechanical ventilation. This population of patients is transferred from acute care facilities where they have been deemed "non-weanable" and require prolonged ventilation.

Methods: Admissions to our CVF were audited over a period of 3 years. We collected demographic and outcome data as well as the patients' length of stay and disposition. Weaning in our centre proceeds step-wise with a reduction in the adaptive support ventilation (ASV) minute ventilation target. Once the target reaches 50% of minute ventilation, spontaneous breathing trials are introduced and progressively lengthened until the patient is weaned.

Results: In total, 125 patients were admitted during the 3 years. 109 were not weaned, and 16 were weaned, i.e. 12.8% of patients were safely weaned off mechanical ventilation. Of the patients not weaned, the mortality rate was 34.8%, and 38.5% were discharged alive to either home or another facility.

Conclusions: Weaning chronically ventilated patients is possible without intensivists or respiratory therapists on staff when a standardised approach/manner is implemented. However, weaning success appears to be mainly related to patients' co-morbidities.

Key words: chronic ventilation, weaning off ventilation.

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Patients who in the past may not have survived an acute critical event may now be dependent on long-term support with mechanical ventilation. Such patients are often cared for in chronic ventilation facilities (CVF) for prolonged periods, for months, and even years. Such CVFs do not have the resources of an intensive care unit, and patients in these facilities are often deemed to have a "fixed" (i.e. irreversible) state, from which recovery and discharge from the facility are remote possibilities. Despite this background, there are reports of a proportion of these patients being weaned off and liberated from mechanical ventilation [1, 2]. One review notes mortality rates of 12.0–91.8% and weaning rates of 10.0–78.2% in chronically ventilated patients [3]. In addition to the wide variation in weaning and mortality rates in chronically ventilated patients, there are also other drivers of and incentives for (e.g. financial incentives) weaning patients off ventilation in such facilities in certain health systems [4].

We undertook an audit of patients treated in our CVF in Ashdod, Israel over 3 years to investigate the rate of weaning of patients from chronic mechanical ventilation (CMV), as well as the disposition of these patients during the study period.

METHODS

We reviewed non-identified patient records from one 40-bed chronic ventilation unit at the Medical, Nursing, and Rehabilitation Centre, Bet Hadar, from 1 January 2019 to 31 December 2021. Institutional Review Board (IRB) approval was obtained – BH-001-22. The IRB allowed waiver of consent because all patient records were non-identifiable. Our CVF deals with patients requiring CMV, referred from acute hospitals after failure to wean off mechanical ventilation in the primary facility. We collected data from all admissions to the unit during this period, which comprised 125 patients.

Patients admitted to the CVF at the Medical, Nursing, and Rehabilitation Centre, Bet Hadar have

all failed weaning in the acute care facility from which they were transferred. They are therefore deemed to be dependent on CMV when they arrive at the CVF, with a limited expectation of weaning success in the future. Underlying diagnoses, as listed in Tables 1 and 2, are also often deemed irreversible, such as anoxic brain damage. Many patients arrive at the CVF with ongoing sepsis, such as pneumonia or infected pressure sores.

It should be emphasised that the CVF is not an intensive care unit. Nursing ratios are as for standard ward care (one nurse to 4 patients). The medical staff

TABLE 1. Patients not weaned from ventilation

Factor	2019	2020	2021	Total
Total patients, *N*	32	34	43	109
Male/female, *n*/*n*	17/15	20/14	23/20	60/49
Age, mean (range), years	72.4 (28–96)	67.8 (42–96)	73.6 (28–102)	71.2 (28–102)
Length of stay, mean (range), days	81.5 (1–361)	140.4 (8–323)	78.7 (1–359)	100.2 (1–361)
Diagnoses, *n*				
CNS	14	15	13	42
Respiratory	2	3	12	17
Cardiac	2	1	3	6
Sepsis	9	13	9	31
Degenerative	3	1	3	7
Malignancy	1	0	0	1
Other	1	1	3	5
Disposition, *n*				
Alive in hospital	6	10	13	29
Alive discharged	14	12	16	42
Dead	12	12	14	38
Weaned from ventilation, *n*	6	1	9	16

CNS – central nervous system, degenerative – degenerative neuromuscular conditions, other – miscellaneous diagnoses, sepsis – sepsis from all causes including pneumonia, alive discharged – patient discharged alive home or to another facility

TABLE 2. Patients weaned from ventilation

Factor	2019	2020	2021	Total
Total patients, *N*	6	1	9	16
Male/female, *n*/*n*	5/1	1/0	5/4	11/5
Age, mean (range), years	74 (68–86)	75	72.2 (50–86)	73.7 (50–86)
Length of stay, mean (range), days	110.2 (64–86)	85	90.4 (16–240))	95.2 (16–240)
Diagnoses, *n*				
CNS	3	0	3	6
Respiratory	1	0	3	4
Cardiac	2	0	2	4
Sepsis	0	0	0	0
Degenerative	0	0	0	0
Malignancy	0	0	0	0
Other	0	1	1	2
Disposition, *n*				
Alive in hospital	0	0	0	0
Alive discharged	6	1	9	16
Dead	0	0	0	0

CNS – central nervous system, degenerative – degenerative neuromuscular conditions, other – miscellaneous diagnoses, sepsis – sepsis from all causes including pneumonia, alive discharged – patient discharged alive to home or to another facility

do not have specialist qualifications in related specialties such as pulmonology or intensive care. They do have access to consultations from ear, nose, and throat (ENT) specialists, neurologists, geriatricians, and infectious diseases specialists. The medical and nursing staff are supported by allied health staff, physiotherapy, occupational therapy, and speech therapy but do not have access to respiratory technicians who adjust ventilator settings. An intensive care specialist (PVvH) undertakes a weekly ward round in the CVF to advise on issues of mechanical ventilation and weaning of patients deemed suitable for weaning. The physiotherapists undertake an expanded role in that they also perform respiratory assessments, mobilise the patients, undertake chest physiotherapy, and advise on patients' suitability for weaning off ventilation.

As far as possible, care for patients in the CVF is standardised. The main points of this care are itemised in Table 3. This allows for uniform, consistent, and excellent care to be delivered to the patients. As part of this standardised care, patients are managed with adaptive support ventilation (ASV) via Hamilton mechanical ventilators (Hamilton Medical, Switzerland). The ASV mode delivers pressure-support ventilation tailored to the compliance and resistance of the patient's respiratory system to reduce the work of breathing. The amount of support delivered by ASV can be tailored to the minute ventilation (V_m) requirements of the patient based on the ideal body weight or body mass index of the patient. The "target" amount of ASV, compared to the required V_m, can be varied as a percentage of the V_m.

The weaning strategy at our CVF is based on attention to detail of the standardised treatment approach (Table 3). Based on clinical assessment of the general state of the patient (e.g. nutritional status, level of consciousness, co-operation) and lack of signs of ongoing sepsis (e.g. fever, excessive respiratory secretions, hypotension), the patient may be deemed suitable for an attempt at weaning off mechanical ventilation. The patient is assessed by the intensive care specialist, together with resident medical staff, nursing staff, and the physiotherapist. Suitable patients are then weaned, also using a standardised approach, as follows – the ASV minute ventilation target is reduced in steps at a rate commensurate with the physiological coping skills of the patient, e.g. 10% every week, as long as the patient does not develop rapid shallow breathing and does not request cessation of further reductions in ASV target due to fatigue. Once the ASV target has been reduced to 50% and the patient remains comfortable and stable (heart rate [HR], blood pressure [BP], respiratory rate [RR], oxygen saturation SpO_2]), without documented evidence (on the trend monitor of the ventilator) of apnoeic episodes, then spontaneous breathing trials (SBT) are commenced. Typically, SBT trials are initially performed for 60–120 minutes once or twice a day, during daytime hours when staffing levels are more generous, and patients are closely observed and monitored (HR, BP, RR, and SpO_2). The duration of SBTs is increased each week following assessment by the intensivist until the patient is free of the ventilator for all the daytime hours (08:00–16:00). After another week at this level, the SBT may be extended into the night – up to 22:00. After a week at this level, and with the patient stable and comfortable, the SBT may be extended to 24 hours a day. Decannulation (removal of the tracheostomy can-

TABLE 3. Standardised care for patients chronically ventilated at the facility

Mechanical ventilation
Ventilation via Portex brand standard size 7 mm or 8 mm cannula tracheostomy
Heat and moisture exchanger changed daily or as necessary
Suction of secretions via closed suction system, as required, by nursing staff
Adaptive support ventilation as soon as physiologically feasible
Change of patient posture every 2–4 hours
Head-up posture in the bed
Endotracheal cuff pressure maintained at less than 30 cm H_20
Chest physiotherapy
Neurological system
Avoid sedation if possible
If sedation required, no intravenous sedation used, only enteral – benzodiazepines avoided, and atypical antipsychotics used instead
Regular review by a neurologist to assess neurological status
Physiotherapy to avoid contractures and to promote mobility
Cardiac
Meticulous management of heart failure and hypertension
Bedside echocardiography to aid diagnosis and treatment
Endocrine system
Detecting and managing thyroid under- and over-activity, diabetes, Addison's syndrome
Nutrition
Enteral feeding via nasogastric tube or percutaneous entero-gastric tube
Nutritional requirements assessed regularly by dietitian
Swallow reflexes assessed by speech therapist once oral feeding is considered safe and suitable
Detecting and treating mineral, trace element, and vitamin deficiencies
Sepsis
Prompt diagnosis and treatment of sepsis, e.g. line sepsis, pressure sores, pneumonia, urinary tract infection, sinusitis, etc.
General nursing and psychological care
Management of patient in general
Administration of medications
Dealing with welfare and placement issues together with the social worker

nula) is considered after a week of the patient being liberated from the ventilator and after assessment by the ENT specialist to exclude tracheomalacia or other upper airway pathology. At any point along this weaning trajectory, ventilatory support may have to be increased by reducing the period of SBT or by increasing the ASV target if the patient is not coping with the weaning strategy, either by physiological instability, rapid shallow breathing, fatigue, or general distress or by signs of new sepsis.

It should be noted that according to the Israeli Ministry of Health, every patient in the facility should undergo at least one trial of weaning, and this is undertaken at the optimal time in terms of physiological stability and lack of any signs of sepsis.

RESULTS

During the study period 109 patients were not weaned off CMV (Table 1), and 16 patients were weaned (Table 2). Major admission diagnoses are listed in the tables, with the dominant diagnoses in patients who were not weaned being neurological, such as an acute cerebrovascular accident or anoxic brain damage (38.5%) or sepsis, including pneumonia (28.4%). Neurological, cardiac, and respiratory diagnoses were more common in the group who were weaned (Table 2). Mortality was 34.9% in the group of patients not weaned, with no mortality in the group who were weaned. All the weaned patients were discharged from the CMV unit, whilst 38.5% of the non-weaned patients were eventually discharged to other facilities or home. The length of stay in the CMV unit varied from 1 day to 361 days (see Tables 1 and 2). The mean age in the weaned and non-weanable groups was comparable (see Tables 1 and 2).

DISCUSSION

The management strategy outlined above in the methods section has allowed us to successfully wean 12.8% of patients admitted to our CVF who were deemed unweanable in the referring centre. The general management of the patients and the weaning program is standardised to allow for the safe care of patients by staff who are not experts in mechanical ventilation but work under the direction of visiting specialists. It should be noted that there is no financial incentive to either wean or not wean patients in this health system [4].

Our experience of weaning chronically ventilated patients fall within the general published standard of care [3]. It should be noted that there are no clear definitive markers of which patients will succeed in being weaned off CMV, which could be used to select patients for weaning or to predict success [5. 6], nor can we predict which patients will fail at weaning [7, 8]. The use of ASV for weaning and safe ventilation of patients has been proven in several trials, and our experience highlights the ease and safety of the use of this mode of ventilation [9–11].

It should be noted that the patients listed as "weaned" in this study are those who were fully liberated from mechanical ventilation. There are a proportion of patients who reach a steady state of being able to breathe spontaneously for some hours or even all the daylight hours without mechanical ventilation. Even this degree of partial weaning from ventilation improves the quality of life of these patients in that they can speak and often take oral nutrition when they are not ventilated, and they find it easier to mobilise physically without attachment to ventilator tubing.

CONCLUSIONS

We describe our management of chronically ventilated patients and our success rate at weaning patients in our CVF. In our opinion, as more patients survive their acute intensive care admission and may be discharged chronically ventilated, this population of patients will increase. We describe one approach to management and weaning in a CVF with limited staff, but making use of a standardised approach, which is both safe and efficacious – making the most of patient weaning potential. However, much needs to be refined about the care of this patient population, including the definition of what is meant by "chronic" mechanical ventilation [12].

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