

Prolonged Weaning After Mechanical Ventilation

A summary of highlights from presentations at the 1st Respiratory Failure and Mechanical Ventilation Conference 2020 by M. Tobin (Chicago, USA), N. Hart (London, United Kingdom) and F. Magnet (Köln, Germany)

As populations age worldwide, the number of patients requiring prolonged mechanical ventilation (MV, ≥ 21 consecutive days) is increasing. This in turn, is increasing demand for long-term acute care hospitals (LTACHs) which focus on weaning patients from prolonged ventilation.¹ In-hospital MV is expensive; in the US costs of ICU beds increased by 30.4% between 2000 and 2005 and costs of MV are estimated at \$12 billion (12% of all hospital costs).² The number of LTACHs has doubled over the past 25 years; there are now 437 treating c. 200,000 patients/year. Patients requiring prolonged MV consume huge resources and suffer considerable disabilities and long-term sequelae but have attracted surprisingly few investigations.³

A randomised trial (n=500), surprisingly, found that a third of prolonged MV patients could have been weaned at the hospital without transfer to a LTACH.⁴ This indicated serious deficiencies in weaning at some ICUs. Among patients randomised (n=316), successful weaning (5 days breathing without MV assistance) was significantly shorter ($p < 0.01$) and the proportion remaining on MV significantly smaller ($p = 0.016$) in patients who were allowed to breathe unassisted via a tracheostomy collar compared with those who received pressure support ventilation (PSV). Survival was improved and the rate of successful weaning was $1.43 \times$ faster unassisted breathing through a tracheostomy collar than with PSV. This advantage resulted from trach collar breathing being driven solely by the patient. With this method, the physician can clearly assess the patient's respiratory capabilities whereas with PSV the weanability of the patient is clouded by MV.

Studies in recent decades have shown rapid disuse atrophy appearing in myofibers in respiratory muscles in animal models and in patients after only short durations (> 18 hr) of MV.⁵ Despite this, a recent longitudinal study of patients at an LTACH (n=315) found that after a mean 46.2 days of MV did not cause a decrease in maximum inspiratory pressure between admission and discharge for ventilator-attached or ventilator-detached patients (36.2 vs 35.2 cm H₂O and 45.4 vs 48.1 cm H₂O, respectively). This study also showed pronounced decreases in peripheral muscle strength at enrolment and discharge. This strength recovered over the following 6–12 months. This was attributed to respiratory muscles contracting continually for ventilator triggering, whereas limb muscles were almost completely inactive in bed-ridden patients.



The experience of MV breathing and weaning can be highly traumatic and unpleasant for many patients. Nevertheless, patients tend to consider the overall outcome rather than trauma of short duration.⁶ This was supported by a total of 84.7% of patients in this LTACH study indicating willingness to undergo prolonged MV again if necessary.⁵

Among patients receiving MV, 60% remain on it for < 4 days and 75% are weaned in < 10 days.^{7–11} However, up to 10% of patients require ventilatory support ≥ 30 days¹² and for some of these, weaning is complex. The recognised categories of weaning are: 1. 'simple' (< 14 days), 2. 'difficult' (14–21 days, delayed) and 3. 'very difficult' (> 21 days, failure).¹² It is important to identify 'difficult' weaning patients as early as possible and focus attention on them rather than the 'simple' cases. Weaning attempts often fail; an observational study of patients post cardiac arrest with poor neurological prognosis (n=209) found the median time from intubation to PSV was 11 h but the proportion failing to remain in PSV mode at 24 h was 25.4%.¹³ The only factors associated with this failure were MV > 7 days (RR 2.12, $p = 0.002$ and ICU mortality (RR 2.94, $p = 0.002$).

For weaning to succeed, a dedicated multidisciplinary team that takes a patient-centred approach is needed. This can usually be better provided by a specialist weaning centre than by an ICU. The emphasis of such centres is the provision of a high-quality service that is available close to the patient's home. They should offer clinical, research and educational excellence and provide rehabilitation and support home ventilation (HMV) and have high core service standards. The centres should operate a comprehensive co-ordinated

care pathway from inpatient to long term outpatient follow-up and outcomes benchmarked to national and international standards.

An example of a specialist weaning centre is the Lane Fox Respiratory Centre at Redhill, Surrey, UK.¹⁴ This has:

- 34 beds,
- 2,200 patients on HMV (starting 350+ patients on HMV/year)
- 150+ complex patients with neuromuscular disease under active follow-up
- 8 difficult to wean patients referred/month
- 110 tracheostomy-ventilated patients in the community

A prospective observational study (n=262) conducted at the Lane Fox Centre showed that 64.1% were successfully weaned, 38.2% fully weaned, 24% weaned to non-invasive ventilation (NIV), 9% to nocturnal NIV, 21.4% were discharged on long-term tracheostomy ventilation.¹⁵ Weaning success was greatest among obesity-related respiratory failure patients (R 1.48, p<0.001) but did not differ significantly among other diagnostic groups. The median time to wean was 19 days (COPD 16 days, post-surgical 25 days) and median duration of stay was 31 days. The weaning mortality was 14.5% (highest in the COPD group and lowest in neuromuscular and/or chest wall disease group (RR 2.15, p=0.012). The overall 1-year survival was 60%.

At the Lane Fox centre, weaning and rehabilitation interventions take place during daytime and patients are ventilated with PSV (Obstr Lung disease) or PCV (NMD) overnight to minimise the effects of REM hypoventilation and maintain adequate gas exchange and allow effective daytime weaning and rehabilitation. Weaning, rehabilitation and HMV programmes are required to provide life-long support for many patients.

In patients who cannot be successfully weaned from MV, deciding what comes next is a challenging issue. In patients in Group 3, described above, some will die, some will need long-term ventilation and some can still be successfully weaned. In the latter group, studies show that 23%–75% are alive after 1 year and 22%–52% are alive at 5 years.¹⁶ In recent guidelines, Group 3 has been subdivided into further groups:¹⁷

- 3a successful prolonged weaning from MV without need for NIV
- 3b successful prolonged weaning from MV with further need for NIV
- 3c unsuccessful prolonged weaning (3 c I: with HMV, 3c II patient died in hospital)

Studies conducted over the past 20 years show that patients spent a mean 34 days on MV prior to transfer to an LTACH and survival among patients who are not weaned is only 20% after 2 years.^{4,18} An Italian weaning centre study found that the in-hospital mortality rate for MV patients during the years 1991–1995 vs 2001–2005 increased (p=0.049) and weaning success decreased (p<0.001). This was attributed to older and more severely ill patients being transferred to the centre over time and a decline in staff to patient ratio.¹⁹ HMV practice varies widely in different world regions. A European study found invasive MV vs NIV to be 13% vs 87%²⁰ in Australia and New Zealand this was 3% vs 97%²¹ and in Poland it was 48% vs 52%.²²

Recent results from the WeanNet initiative in Germany (n=11,424) show that in a large population of prolonged weaning patients, 14.5% died, 21.2% remained on invasive HMV and 19.6% remained on NIV.²³ The strongest factors associated with death in hospital was age and that associated with weaning failure was days of MV. This study found a decreasing mortality and increasing weaning success during 2011–2015. This could be due to greater experience but also due to stricter patient entry criteria at the weaning centres.

If weaning at an LTACH fails, patients may need rehabilitation, long-term MV in hospital, end-of-life decision or HMV. During HMV, health-related quality of life (HRQoL) is an important issue. A study of HMV patients (n=32) found variable effects on HRQoL with patients with COPD likely to have poorer HRQoL than patients with neuromuscular disorders but living conditions (apartment or treatment centre) had no effect.²⁴ A further study (n=25) found that issues with mobility (e.g. getting out of bed and travelling) and communication had the greatest negative impact on HRQoL.²⁵ These issues were generally worse in patients with COPD than those with neuromuscular disorders. A stark finding of this trial was that over one third of COPD patients said that they would prefer to die in hospital than go through HMV again.

Patients requiring prolonged ventilation have been largely ignored by investigators; it is a ‘Cinderella’ subject but it deserves rigorous and imaginative study because with aging populations and greater requirement for MV, it is an issue that will likely increase. LTACHs are important centres that have demonstrated expertise and success in treating patients who are difficult to wean. They need to take a patient-centred approach and provide coordinated multidisciplinary care for both resident and at-home patients. In patients who have failed to wean, HRQoL is variable but can be satisfactory with appropriate support. For these individuals it is important for physicians to explain the consequences and outcomes of long-term HMV and regularly follow-up, review therapy goals, establish their wishes regarding medical interventions continuing treatment.

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