



WEANING FROM MECHANICAL VENTILATION: CURRENT LIBERATION THEORY

by *David Wheeler RRT, NPS*

The process of liberating patients from mechanical ventilation and then removing their endotracheal tubes is both an art and a science. On a daily basis the observant Respiratory Therapist will note that the variables affecting weaning outcomes are extensive and at times, complex. One must always remember that our patients are mammals; they enjoy breathing spontaneously. It is our duty to employ the mindful art of weaning and return them to their natural state of being.

It is no longer even remotely acceptable clinical practice to state that one "knows how a patient will do". The one thing that has been demonstrated time and time again is that we cannot predict with any reliability how a patient will handle a Trial of Extubation, (TOE) based on our experience or gestalt alone.

It is important to note that there is not a distinct weaning parameter that can reliably predict a patient's ability to wean. Several studies indicate that daily trials of spontaneous breathing, more commonly referred to as Spontaneous Breathing Trials, (SBT), improve the weaning process and enhance patient outcomes. The compassionate therapist must focus on the needs of the patient and fashion an extubation strategy based upon continued evaluation of a patient's readiness to breathe spontaneously.

Criteria for assessing readiness to wean is widely employed but their sensitivity and specificity are poor

The weaning process must begin with the effective therapeutic treatment of the cause of ventilatory dependency. Other inclusionary criteria include a PaO₂ / FiO₂ ratio of 150 or greater, hemodynamic stability, level of sensorium acceptable to patient context and absence of untreated infectious process.

Typical criteria for assessing a patient's readiness to wean are widely employed however; their sensitivity and specificity are poor. Vital Capacity, (VC), is one of the most common parameters utilized to predict weaning success however this parameter is extremely difficult to accurately measure given the dependence on patient comprehension and performance. Several studies have shown that VC often failed to predict weaning outcome with a high degree of accuracy and is of little use as a clinical tool in weaning from mechanical ventilation.

Maximum voluntary ventilation, (MVV), is the volume of gas exhaled utilizing maximum effort in one minute. The relationship between resting Minute Ventilation, (MV), and MVV denotes the fraction of the patient's ventilatory capacity essential to maintain

normocapnea and reserve for additional cardiopulmonary load. These assessment tools have been associated with significant false-positive and negative rates. Therefore, they are notable in their unreliability and have no clinical utility.

There are no measures of readiness to wean that the bedside clinician can employ with a reasonable amount of confidence. Indeed, one must be mindful of the fact that no parameter or index has proven to be ideal and highly predictive of weaning. I am unaware of a monitoring technique that, in itself, has been shown to improve outcomes of patients during weaning from mechanical ventilation. The single measure demonstrating optimum clinical accuracy in predicting weaning success is the Rapid Shallow Breathing Index, (RSBI), originally described by Yang and Tobin. The rapid shallow breathing index is simply, the spontaneous breathing frequency (breaths/minute) / VT (in liters).


The RSBI is an extremely accurate predictor of weaning outcome. The f/VT ratio is easy to measure and does not rely on either patient comprehension or effort. Originally the value of 104 or lower was utilized to predict a successful Trial of Extubation, (TOE). In general, patients who fail weaning trials drop their VT and increase their respiratory rate. The current thinking is that an RSBI of 80 or lower is extremely reliable in predicting a successful extubation while an RSBI in the 80 -104 range may require patient specific assessment.

The commonly used techniques of weaning are T-piece, synchronized intermittent mandatory ventilation (SIMV), or PSV; however, the optimal mode of ventilation employed for weaning remains controversial. One must be aware of the fact that SIMV weaning prolongs the duration of ventilation. Patients do not need, nor do they benefit from, progressive withdrawal of mechanical ventilation. Evidenced-based practice currently maintains that early attempts at weaning, in a protocol-driven fashion, may improve patient outcomes and decrease cost. Indeed, daily T-piece trials consistently have been superior to the SIMV mode in weaning, and similar to daily PSV weaning.

Protocols are driven by Therapist in a collaborative way with the nursing staff and several papers have demonstrated that protocol-driven weaning by respiratory therapists is superior to physician-directed weaning independent of weaning mode. The primary phase in any protocol-driven ventilator weaning is a daily screening for readiness to wean. It follows then that every mechanically ventilated patient also should undergo a daily interruption of sedation to be in the most advantageous condi-

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Weaning Mechanical Ventilation... continued from page 14

tion for the daily screening or evaluation. Protocol driven liberation theory begins with rather few, inclusionary criteria intended to identify candidates for the daily screening.

Inclusionary criteria must be straightforward and prompt decisions concerning the initiation and continuance of Spontaneous Breathing Trials, (SBT) or Trials of Extubation, (TOE). Typical inclusionary criteria for participation in an SBT are; the ability to generate a spontaneous breath, the ability to lift head on command, a PaO₂ / FiO₂ ratio ≥ 150 . on PEEP ≤ 8 cm. H₂O and "hemodynamic stability". No single weaning parameter should be used to preclude patients who demonstrate cardiopulmonary stability from an SBT.

The patients who pass the readiness to wean inclusionary criteria will begin a Spontaneous Breathing Trial, (SBT). The SBT will be terminated and the patient extubated if the patient successfully tolerates an SBT lasting from 30 minutes to 2 hours. Interesting to note is the fact that the predictive utility of the f/Vt, (RSBI), after 30 minutes of an SBT was far superior to the RSBI measured in the first 2 minutes of the SBT. The informed clinician will be aware that the f/Vt measured at the end of SBT is associated with improved outcomes while routinely requiring an acceptable RSBI as an inclusionary criteria for an SBT prolongs the weaning process. The SBT is the gold standard assessment mechanism for determining readiness to breathe without a ventilator. The analytical Therapist understands that weaning parameters are not utilized to disqualify hemodynamically stable, satisfactorily oxygenated patients from a daily SBT. Reliance on traditional weaning parameters will delay the SBT for patients who might be successfully extubated.

An SBT may be initiated on CPAP, T-Piece or low levels of PSV. Studies have demonstrated the clinical efficacy of all three methods. The general thought would be to match the method of SBT to the contextual patient pathophysiology. Patients with severe restrictive disease may fail pressure support trials but pass a subsequent T-piece without difficulty. The notion is that outcomes are improved with systematic attention to reversing processes contributing to respiratory failure followed by a daily SBT. Every day a patient remains on the ventilator Respiratory Therapists must quantify and treat reversible causes of respiratory decompensation.

The cogent therapist defines SBT failure by a sustained respiratory or hemodynamic decompensation or a sustained tachycardia and tachypnea. It remains a matter for further investigation whether subtle changes in monitored variables during SBTs can predict with any certainty those patients with an amplified possibility of post-extubation failure. Again, the RSBI has been the most reliable monitored value associated with extubation outcomes. Rapid shallow breathing during the SBT is indicative of an underlying disproportion in the primary ventilatory capacity-load relationship and requires systematic examination for any reversible aspects of ventilator reliance.

The RSBI will change in some patients during spontaneous breathing trials. Some patients may still have residual effects of sedatives while other patients may dynamically hyperinflate during the SBT. In those patients with significant neuromuscular weakness; a respiratory muscle fatigue may ensue even without dramatic fluctuations in respiratory loads. Patients who fail the SBT should be placed on appropriate levels of ventilatory support and evaluated continuously for another SBT opportunity.

The next evolution in protocolized weaning is a Closed-Loop or Ratiocinative control algorithm. In a recent trial a computer-driven system reduced duration of ventilation and ICU length of stay. I agree with those who contend that some form of "closed-loop" ventilation system may be a future standard of patient care. These systems have the ability to monitor and assess the mechanically ventilated patient on a continuous basis. Every system examines the patients breathing in a unique way and utilizes assessment based information to adapt or adjust the subsequent level and method of ventilatory support to perfect the patient-ventilator concerto.

One of the primary advantages of Optimal Control algorithms is that they free the Respiratory Therapist to perform patient management rather than tactical duties. A weaning protocol based on ASV in fast-track cardiac surgery reduced human intervention related to respiratory management without delaying extubation. The clinician is freed of the minutia related to making small incremental changes and can now function on a more professional level.

Both Optimal and Knowledge base systems are in their infancy in terms of clinical utilization however, the competent clinician will want to become familiar in more than a passing way with these systems and their advanced weaning protocols and capabilities.

The informed and conversant Respiratory Therapist must demonstrate an appreciation for the critical urgency inherent in the act of liberating the mechanically ventilated patient from both endotracheal tube and ventilatory support. The patient does not need our permission to get better. However, we need to demonstrate we are indeed trusted partners in the patient's recovery by constantly assessing the patient and strategizing for extubation.

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