



## Criteria For Weaning From Mechanical Ventilation A Review.

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### I. INTRODUCTION

Weaning is defined as a gradual detachment from a cause of dependence. The process of gradually decreasing ventilatory support until such a time when the patient can breathe without mechanical assistance is termed as weaning from invasive ventilation.<sup>(1)</sup>

Weaning is necessary when the patient is ventilated for more than 96 hrs because the diaphragm may undergo disuse atrophy. Weaning from ventilator helps to maximize respiratory function (respiratory muscle strength and endurance) without fatiguing respiratory muscle. Roussos et al have observed that if the respiratory muscles are fatigued it may take 48hrs for them to recover<sup>(2)</sup>

Generally speaking, only about 20-25% of ICU patients who are ventilated for longer than 72 hrs require weaning and as much as 42% of the time a medical patient spends on the mechanical ventilator is during weaning.<sup>(3)</sup> Weaning is deemed successful when the patient is independent of the ventilator for 48 consecutive hrs.<sup>(4.)</sup>

In 1999, Agency for Healthcare Policy and Research (AHCPR) gave responsibility to the Evidence Based Practice Center of McMaster University to perform a comprehensive evidence-based review of many of the issues involved in ventilator weaning/ discontinuation. At the same time, the Society for Critical Care Medicine, the American Association for Respiratory Care, the American College of Chest Physicians formed a task force to produce

evidence-based clinical practice guidelines for managing the patient dependent on ventilator during the weaning process.

This task force utilized the McMaster AHCPR report as well as their own literature review to address the following five issues:

1. The pathophysiology of ventilator dependence;
2. The criteria for identifying patients in whom mechanical ventilation can be discontinued
3. Ventilator management strategies so that the discontinuation potential is maximum
4. The role of tracheotomy; and
5. The role of long-term facilities

This task force developed a series of recommendations from these evidence based reviews, which forms the basis of their report<sup>(5)</sup>

### II. Grades of Evidence

#### Grades Description

- A. Scientific evidence provided by well-designed, well conducted, controlled trials (randomized and nonrandomized) with statistically significant results that consistently support the guideline recommendation.
- B. Scientific evidence provided by observational studies or by controlled trials with less consistent results to support the guideline recommendation.
- C. Expert opinion supported the guideline recommendation, but scientific

evidence either provided inconsistent results or was lacking.

### III. Recommendations

#### **Recommendation 1 Pathophysiology of Ventilator Dependence**

*In patients requiring mechanical ventilation for > 24 h, a search for all the causes that may be contributing to ventilator dependence should be undertaken.*

*This is particularly true in the patient who has failed attempts at withdrawing the mechanical ventilator.*

*Reversing all possible ventilatory and nonventilatory issues should be an integral part of the ventilator discontinuation process. Evidence (Grade B).*

#### **Causes of Respiratory Failure**

- i. Central Nervous System-
  - a. Decreased Central drive-structural-brain strokes or central apnoea , phrenic nerve damage
  - b. metabolic-electrolyte disturbance ,sedation , narcotic usage
- ii. Chest Wall –flail chest, kyphoscoliosis
- iii. Intrinsic Lung Diseases-
  - a. Mechanical loads: respiratory system mechanics; imposed loading
  - b. Ventilatory muscle properties
  - c. Gas exchange properties:
    - i. vascular properties ( acute respiratory distress syndrome, pulmonary oedema, fibrosis, severe pneumonias)
    - ii. ventilation/perfusion matchine
- iv. Peripheral Nervous System
  - a. Structural- brain strokes or central apnoes ,damage to phrenic nerve.
  - b. Muscular-
    - i. Neuromuscular  
Myasthenia gravis, guillain barre syndrome, trauma, polio, cancer
    - ii. Musculoskeletal  
Trauma , electrolyte Imbalance
  - v. Upper Airway- obstructive sleep apnoea
  - vi. Cardiovascular system

- a. cardiac decompensation of ventilator muscle work
- b. Increased peripheral oxygen demands

So during weaning we should consider the following factors

- i. Reason for mechanical ventilation
- ii. Respiratory muscle atrophy, fatigue, and strength
- iii. Imposed work (ventilator, auto-PEEP, ETT size, etc.)
- iv. Medications
- v. Nutritional status
- vi. Lung resistance and compliance
- vii. Breathing pattern
- viii. Psychological factors

#### **Recommendation 2: Criteria to Assess Ventilator Dependence**

*Patients receiving mechanical ventilation for respiratory failure should undergo a formal assessment of discontinuation potential if the following criteria are satisfied:*

*1. Evidence for some reversal of the underlying cause for respiratory failure;*

*2. Adequate oxygenation (eg, PaO<sub>2</sub>/FiO<sub>2</sub> ratio > 150 to 200; requiring positive end-expiratory pressure [PEEP] >5 to 8 cmH<sub>2</sub>O; Fio<sub>2</sub> > 0.4 to 0.5); and pH (eg, >7.25);*

*3. Hemodynamic stability, as defined by the absence of active myocardial ischemia and the absence of clinically significant hypotension (ie, a condition requiring no vasopressor therapy or therapy with only low-dose vasopressors such as dopamine or dobutamine, > 5 mcg/kg/min); and*

*4. The capability to initiate an inspiratory effort. The decision to use these criteria must be individualized.*

*Some patients not satisfying all of the above criteria (eg, patients with chronic*

*hypoxemia with values below the thresholds cited) may be ready for attempts at the discontinuation of mechanical ventilation. Rationale and Evidence (Grade B).*

*The above criteria can be classified as*

#### **A. Objective measurements-**

- i. Adequate oxygenation (eg,  $P_{O_2} > 60$  mm Hg on  $F_{iO_2} < 0.4$ ; PEEP 5–10 cm H<sub>2</sub>O;  $P_{O_2}/F_{iO_2} > 150$ –300);
- ii. Stable cardiovascular system (eg, HR < 140; stable BP; no (or vasopressors)
- iii. Afebrile (temperature < 38°C)
- iv. No significant respiratory acidosis
- v. Adequate hemoglobin (eg, Hb > 8–10 g/dL)
- vi. Adequate mentation (eg, arousable, GCS > 13, no continuous sedative infusions .
- vii. Stable metabolic status (eg, acceptable electrolytes)

#### **B. Subjective clinical assessments**

Resolution acute phase of disease physician believes discontinuation possible; adequate cough.

#### **Recommendation 3: spontaneous breathing trial.**

*Formal discontinuation assessments for patients receiving mechanical ventilation for respiratory failure should be performed during spontaneous breathing rather than while the patient is still receiving substantial ventilatory support. An initial brief period of spontaneous breathing can be used to assess the capability of continuing onto a formal SBT. The criteria with which to assess patient tolerance during SBTs are the respiratory pattern, the adequacy of gas exchange, hemodynamic stability, and subjective comfort. The tolerance of SBTs lasting 30 to 120 min should prompt consideration for permanent ventilator discontinuation. Rationale and Evidence (Grade A)*

#### **Criteria Used in Several Large Trials To Define Tolerance of an SBT .**

##### **A. Objective measurements indicating tolerance/success**

- i. Gas exchange acceptability ( $SpO_2$  \_ 85–90%;  $PaO_2 > 50$ –60 mm Hg; pH > 7.32; increase in  $PaCO_2 < 10$  mm Hg);
- ii. Hemodynamic stability (HR <120–140 beats/min; HR not changed > 20%; systolic BP < 180– 200 and > 90 mm Hg; BP not changed > 20%, no vasopressors required)
- iii. Stable ventilatory pattern (eg, RR <30–35 breaths/min; RR not changed > 50%)

##### **B. Subjective clinical assessments indicating intolerance/failure**

- i. Change in mental status (eg, somnolence, coma, agitation, anxiety);
- ii. Onset or worsening of discomfort
- iii. Diaphoresis
- iv. Signs of increased work of breathing (use of accessory respiratory muscles, and thoracoabdominal paradox)

**Recommendation 4:** *The removal of the artificial airway from a patient who has successfully been discontinued from ventilatory support should be based on assessments of airway patency and the ability of the patient to protect the airway. Rationale and Evidence (Grade C)*

#### **Recommendation 5: Managing the Patient who has Failed an SBT**

*Patients receiving mechanical ventilation for respiratory failure who fail an SBT should have the cause for the failed SBT determined. Once reversible causes for failure are corrected, and if the patient still meets the criteria for SBTs, subsequent SBTs should be performed every 24 h. Rationale and Evidence (Grade A)*

#### **Recommendation 6: Ventilator support in patients who fail an SBT**

*Patients receiving mechanical ventilation for respiratory failure who fail an SBT should receive a stable, nonfatiguing, comfortable form of ventilator support. Rationale and Evidence (Grade B)*

### **Modes of Partial Ventilator Support**

1)SIMV- Patient Work Adjusted By No. of machine breaths supplied (*ie*, the fewer the No. of machine breaths, the more spontaneous breaths are required)

2)PSV- Level of inspiratory pressure assistance with spontaneous efforts

3)SIMV plus PSV -Combining the adjustments of SIMV and PSV

4)VS- PSV with a “guaranteed” minimal tidal volume (PSV level adjusts automatically according to clinician tidal volume setting)

5)VAPS(PA)- PSV with “guaranteed” minimal V<sub>t</sub> (additional flow is supplied at end inspiration if necessary to provide clinician V<sub>t</sub> setting)

6)MMV- SIMV with a “guaranteed” V<sub>e</sub> (machine breath rate automatically adjusts according to clinician V<sub>e</sub> setting)

7)APRV- Pressure difference between inflation and release (*ie*, the less the pressure difference, the more spontaneous breaths are required)

### **Recommendation 7: Sedation strategies**

*Anesthesia/sedation strategies and ventilator management aimed at early extubation should be used in postsurgical patients.*

*Rationale and Evidence (Grade A)*

### **Recommendation8: Protocols for nonphysician health care professionals.**

*Weaning/discontinuation protocols that are designed for nonphysician health-care professionals (HCPs) should be developed and implemented by ICUs. Protocols aimed at optimizing sedation also should be developed and implemented.*

*Rationale and Evidence (Grade A)*

### **Recommendation9:Roleof Tracheotomy in Ventilator- Dependent Patients**

*Tracheotomy should be considered after an initial period of stabilization on the ventilator when it becomes apparent that the patient will require prolonged ventilator assistance. Tracheotomy then should be performed when the patient appears likely to gain one or more of the benefits ascribed to the procedure. Patients who may derive particular benefit from early tracheotomy are the following:*

- i. *Those requiring high levels of sedation to tolerate translaryngeal tubes;*
- ii. *Those with marginal respiratory mechanics (often manifested as tachypnea) in whom a tracheostomy tube having lower resistance might reduce the risk of muscle overload;*
- iii. *Those who may derive psychological benefit from the ability to eat orally, communicate by articulated speech, and experience enhanced mobility; and*
- iv. *Those in whom enhanced mobility may assist physical therapy efforts.*

*Rationale and Evidence (Grade B)*

### **Recommendation 10:**

*Unless there is evidence for clearly irreversible disease (eg, high spinal cord injury or advanced amyotrophic lateral sclerosis), a patient requiring prolonged mechanical ventilatory support for respiratory failure should not be considered permanently ventilator-dependent until 3 months of weaning attempts have failed.*

*Rationale and Evidence (Grade B)*

### **Recommendation 11:**

*Critical-care practitioners should familiarize themselves with facilities in their communities, or units in hospitals they staff, that specialize in managing patients who require prolonged dependence on mechanical ventilation. Such familiarization should include reviewing published peer-reviewed data from those units, if available.*

*When medically stable for transfer, patients who have failed ventilator discontinuation attempts in the ICU should be transferred to those facilities that have demonstrated success and safety in accomplishing ventilator discontinuation.*

*Rationale and Evidence (Grade C)*

### **Recommendation 12:**

*Weaning strategies in the PMV patient should be slow-paced and should include gradually lengthening self-breathing trials. Rationale and Evidence (Grade C)*

*Sussanene M. Burns et al have formulated a worksheet to facilitate the weaning process .(6)*

### **Burns Wean Assessment Program (BWAP) worksheet.(6)**

#### **GENERAL ASSESSMENT**

1. Hemodynamically stable (pulse rate, cardiac output)?
2. Free from factors that increase or decrease metabolic rate (seizures, temperature, sepsis, bacteremia, hypo/hyperthyroid)?
3. Hematocrit >25% (or baseline)?
- 4 Systemically hydrated (weight at or near baseline, balanced intake and output)?
- 5.Nourished (albumin >2.5, parenteral/enteral feedings maximized)? (If albumin is low and anasarca or third spacing is present, score for hydration should be *No.*)
6. Electrolyte levels within normal limits? (including Ca<sup>++</sup>, Mg<sup>+</sup>, PO<sub>4</sub>; correct Ca<sup>++</sup> for albumin level)
- 7.Pain controlled? (subjective determination)

- 8.Adequate sleep/rest? (subjective determination)
- 9.Appropriate level of anxiety and nervousness? (subjective determination)
10. Absence of bowel problems (diarrhea, constipation, ileus)?
- 11.Improved general body strength/endurance (ie, out of bed in chair, progressive activity program)?
12. Chest X-ray improving?

### **Respiratory Assessment**

#### **Gas flow and work of breathing**

13. Eupneic respiratory rate and pattern (spontaneous respiratory rate <25/min, without dyspnea, absence of accessory muscle use).

\*This is assessed off mechanical ventilation while measuring Nos. 20-23.

14. Absence of adventitious breath sounds (rhonchi, rales, wheezing)?

15. Secretions thin and minimal?

16. Absence of neuromuscular disease/deformity?

17. Absence of abdominal distention/obesity/ascites?

18. Oral endotracheal tube  $\geq 7.5$  or tracheostomy tube  $\geq 6.5$  internal diameter

#### **Airway clearance**

19. Cough and swallow reflexes adequate?

#### **Strength**

20. Negative inspiratory pressure <-20 cm H<sub>2</sub>O

21. Positive expiratory pressure >+30 cm H<sub>2</sub>O

#### **Endurance**

22. Spontaneous tidal volume >5 mL/kg

23. Vital capacity >10 to 15 mL/kg

#### **Arterial blood**

24. pH between 7.30 and 7.45

25. PaCO<sub>2</sub> approximately 40 mm Hg (or baseline) with minute ventilation <10 L/min (evaluated while on ventilator)

26. PaO<sub>2</sub> >60 on FIO<sub>2</sub> <40%

#### IV CONCLUSION

From the review of above literature, we can conclude that our weaning process will be more successful if more weaning criterias are met by the patient. Moreover the patient's progress needs to be assessed continually and accordingly changes in the ventilator settings and treatment plan should be made to prevent weaning failure and facilitate better patient outcome.