Weaning from Mechanical Ventilation in the 21st Century

Kimberly Santiago, RRT
Specialty Hospital of Central Jersey
AcuteCare Health System

PURPOSE

- Purpose of weaning and extubation
- Rationale of predictive indices in weaning
- Application of weaning parameters
- Impediments to weaning
- Newer weaning strategies

DEFINITION

- Gradual withdrawal of mechanical support is not always necessary
- Short-term intubation and ventilation for surgical procedures under GA should simply be discontinued when patients have sufficient neurologic function and muscular strength to breathe on their own
Morbidity Associated With Prolonged Intubation and Mechanical Ventilation

- Vocal cord granulomas
- Ulceration of the vocal cords
- Stenosis of trachea
- Risk factor for nosocomial pneumonia (VAP)

The assessment of weaning proceeds in two phases:

Phase 1: To ensure that certain basic criteria regarding initial reason for mechanical ventilation are satisfied

Phase 2: Determine whether weaning is likely to succeed on the basis of specified criteria

READINESS FOR VENTILATOR WEANING

Major determinants of ability to wean can be classified into three categories:

- Oxygenation
- Ventilatory function
- Mental status / sedation vacation
**OXYGENATION**

- **Criteria of Adequacy**
  \[ \text{PaO}_2 > 60 \text{ mmHg on FIO}_2 < 0.35 \text{ at minimal PEEP}, \]
  \[ \text{PaO}_2/\text{FIO}_2 > 200 \]

- **Selected causes of failure**:
  - Hypoventilation: neurologic injury or drugs
  - V/Q mismatch: dead space, severe CHF
  - Disease process not fully resolved

**VENTILATION**

- **Criterion of Adequacy**
  \[ \text{PaCO}_2 < 50 \text{ mmHg or within 8 mmHg of baseline} \]

- **Selected causes of failure**
  - \( \downarrow \) respiratory drive: sedation, obesity/hypoventilation syndrome
  - \( \downarrow \) respiratory bellows function: diaphragm weakness, Neuro-muscular disease
  - \( \uparrow \) CO$_2$ production *without* compensatory \( \uparrow \) in alveolar Ve:
    - fever, hypermetabolism, carbohydrate overfeeding
  - \( \uparrow \) dead space ventilation *without* compensatory \( \uparrow \) alveolar Ve:
    - PE, bullous emphysema

**Mental status**

- **Criteria of adequacy**
  Awake, alert, cooperative, with intact gag and swallowing

- **Selected causes of failure**
  - Cerebrovascular accident
  - Sleep deprivation/ICU psychosis
  - Drug therapy
  - Depression
  - Psychological dependency on ventilatory support
Assessment of Readiness to Wean

- RR, VT, VE
- ABG
- BP, HR
- NIF
- VC
- RSBI

RSBI

- Rapid Shallow Breathing Index
- One minute test
- Rate/Vt in Liters

RR 20 / Vt .400L = 50
RR 30 / Vt .150L = 200

RSBI<100 is Predictive of Weaning Success

Yang & Tobin in 1991 showed that Pts with a RSBI<100 were weaned at an 80% probability. 95%>100 were not ready to be weaned

Threshold values of indexes used to predict weaning outcome

<table>
<thead>
<tr>
<th>INDEX</th>
<th>VALUE</th>
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<tbody>
<tr>
<td>Minute ventilation (liters/min)</td>
<td>≥ 15</td>
</tr>
<tr>
<td>Respiratory frequency (breaths/min)</td>
<td>≤ 38</td>
</tr>
<tr>
<td>Tidal volume (ml)</td>
<td>≥ 250</td>
</tr>
<tr>
<td>Tidal volume (ml) / patient's wt (kg)</td>
<td>≥ 4</td>
</tr>
<tr>
<td>Maximal inspiratory pressure (cm H₂O)</td>
<td>≤ -15</td>
</tr>
<tr>
<td>Dynamic compliance (ml/cm H₂O)</td>
<td>≥ 22</td>
</tr>
<tr>
<td>Static compliance (ml/cm H₂O)</td>
<td>≥ 33</td>
</tr>
<tr>
<td>PaO₂/PaO₂ ratio</td>
<td>≥ 0.35</td>
</tr>
<tr>
<td>Frequency / tidal volume ratio (breaths/ min/liter)</td>
<td>≤ 105</td>
</tr>
<tr>
<td>CROP index (ml breath min)</td>
<td>≥ 13</td>
</tr>
</tbody>
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NONRESPIRATORY PARAMETERS AFFECTING ABILITY TO WEAN

- Nutritional status
- Fluid balance
- Metabolic and acid-base derangements
- Cardiac Function
- Renal function
- Pharmacologic therapy
- Neuropsychiatric factors

NUTRITIONAL STATUS

Malnutrition has adverse effects on the respiratory system

- ↓ respiratory muscle strength and function
- ↓ diaphragmatic mass and contractility
- ↓ endurance

NUTRITIONAL STATUS

Over nutrition may impede weaning

- High Ve
  Produced by excessive Carbohydrate metabolism

- Other causes of increased CO₂ production: fever, sepsis, shivering, seizures, and inefficient ventilation due to ↑ dead space, PE
WEANING METHODS

SIMV to T-piece weaning
SIMV to CPAP + PSV weaning
AC ventilation to T-piece
CMV to AC ventilation to T-piece
Newer weaning strategies

New Strategies for 21st Century

- ATC
- Smart Care
- Adaptive Support Ventilation
- PRVC with Auto-mode
- NAVA- Neurally Adjusted Ventilatory Assist

Adaptive Support Ventilation

- Galileo – Hamilton Medical AG
- Based on ideal body weight, % of minute ventilation desired, maximal inspiratory pressure tolerated.
- Ventilator determines compliance and resistance automatically
- Optimizes inspiratory pressure and respiratory rate based on formula of “Otis”
- Automatically titrates pressure support level to deliver the desired % of minute ventilation
- Therapist reduces the level of % of minute ventilation
Studies supporting ASV

- Randomized controlled study by Sulzer ET AL. in 2001
- Post cardiac surgery (49) patients
- SIMV w/PS versus ASV
- Extubation was shorter with the ASV group 3.2 to 4.1 hours
- Advantage was that patients were switched to PS ventilation quicker than control group

How does our LTACH wean?

- There are 3 types of LTACH patients
  - “Easy weaners” – these patients are ready and will wean quickly and easily
  - “Roller coaster weaners” – these patients need a little more time. Some good weaning days and some bad weaning days, but eventually they wean
  - “Never Gonna weaners” – these patients may never wean despite using everything in our arsenal.

Where to start?

- Not necessarily ALL about weaning
- It’s about improving quality of life
- If we can make it possible for a patient to wean off the vent and speak to their family or eat again – even if for only a short time – we’ve done our job.
**SHCJ’s Weaning Protocol**

- Protocol is RT driven
- Very aggressive
- Constant assessment and re-assessment
- Not every patient fits this “cookie cutter” protocol
- Look at each patient individually and cater weaning towards their needs
- Throw out the textbooks!
Complications that arise

- Airway/trach issues
  - Tracheal malacia
  - Tracheal stenosis
  - Granulomas (most common)
  - TE fistula
  - TI fistula

Interventions may include: trach changes or surgery

Complications

- Anxiety – feeling SOB is scary!
  - Multiple failed weaning attempts create more anxiety for some patients
  - Manage anxiety with meds and coordinate weaning around times of med administration.

- Causes of the initial respiratory failure return or new problems arise
  - Each problem should be addressed and weaning should continue as soon as possible

What can the RT do to increase weaning?

- The LTAC setting is often the last chance for these patients to wean
- Stay focused on improving quality of life
- Stay positive!
- Patients with multiple co-morbidities can still wean.
- You NEVER know what can happen unless you try.
- Throw everything you’ve got at them – you only have 29 days to make a difference in someone’s quality of life.
What can the RT do to increase weaning?

- Every patient deserves the same quality and aggressive care – no matter if they're an “Easy weaner” a “Roller coaster weaner” or a “Never gonna weaner”.
- Very often, a patient will surprise you. Someone who looked like a “Never Gonna Weaner” becomes an “Easy weaner”.
- For this reason, we never give up. We wean everyone.
- Always remembering, a patient’s quality of life may be in our hands.