



Strategies for Weaning from Mechanical Ventilation

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Learning Objectives



- ▶ Review key *terminology*.
- ▶ Emphasize the importance of *collaboration*.
- ▶ Summarize related research.
- ▶ Describe key points of guidelines and evidence related to SBT & weaning.
- ▶ Review *Inclusion* and *Exclusion* criteria.
- ▶ Summarize how patients should be *prepared & optimized*.
- ▶ Review and *debrief some cases*.
- ▶ Provide *additional resources*.



Key Terminology

- ▶ ***Spontaneous Breathing Trial (SBT):*** Simulate spontaneous breathing for patients with artificial A/Ws.
 - PSV set to overcome resistance
 - Use Tube-Compensation Mode
 - 30 – 120 minutes
- ▶ ***Weaning Parameters:*** Metrics used to determine readiness to wean and extubate.
 - Negative Insp. Force (NIF): *patients ability to suck-in*
 - S/B at least -20 to -25 cm H₂O
 - Vital Capacity (VC): deep breath in followed by a complete exhalation.
 - S/B a min. 15 mls/ kg or approx. 1.0 liter
- ▶ ***Sedation Holiday/Vacation:*** Reduce sedation (often in the AM) to assess ability to wean, follow commands, etc.
- ▶ ***Rapid Shallow Breathing Index (RSBI):***
 - = Spon. RR / VT in liters
 - S/B < 105



Key Terminology (cont.)



- ▶ ***Diaphragmatic Fatigue***– Imposing excessive WOB while weaning resulting in fatigue.
 - Often takes 24 hrs or more to recover.
- ▶ ***Diaphragmatic Atrophy***– Weakening of respiratory muscles due to lack of use via weaning.
- ▶ ***Alveolar De-recruitment***– May occur when a patient with an artificial A/W is breathing at low tidal volumes and/or low PEEP.
- ▶ ***Recruitment Maneuvers (RMs)***– Using short periods of high PEEP (30 cms for 30 seconds) or other “Open Lung” strategies to treat/prevent atelectasis.
 - Especially important for those weaning via trach collar.
 - Should be used cautiously for hemodynamically unstable patients.
- ▶ ***Wean Per Physician Order***– Weaning a patient outside of a designated weaning protocol. (e.g., 4 hrs PSV/ 4 hrs on AC).



Predictors of Successful Weaning



- ▶ Kallet, Zhuo, Yip, et al 2018. Cochrane Systematic Rev.
 - **Findings:** SBT's combined with conservative sedation practices were associated with both reduced ventilator days and ICU LOS.
- ▶ Burns, Lellouche, Nisenbaum, (2014).
 - **Findings:** Automated Weaning: Weaning with SmartCare™ significantly decreased weaning time, ventilator days and ICU stay.
- ▶ Baptistella, Sarmiento, da Silva (2018) Systematic Review:
 - **Findings:** *RSBI was the most frequently studied* and an important measurement tool in deciding whether to wean/extubate a patient.
- ▶ Kutchak, Rieder, Victorino, (2017)
 - **Findings:** *Inability to follow commands (hand grasping) independently predict extubation failure* in critically ill neurological patients.

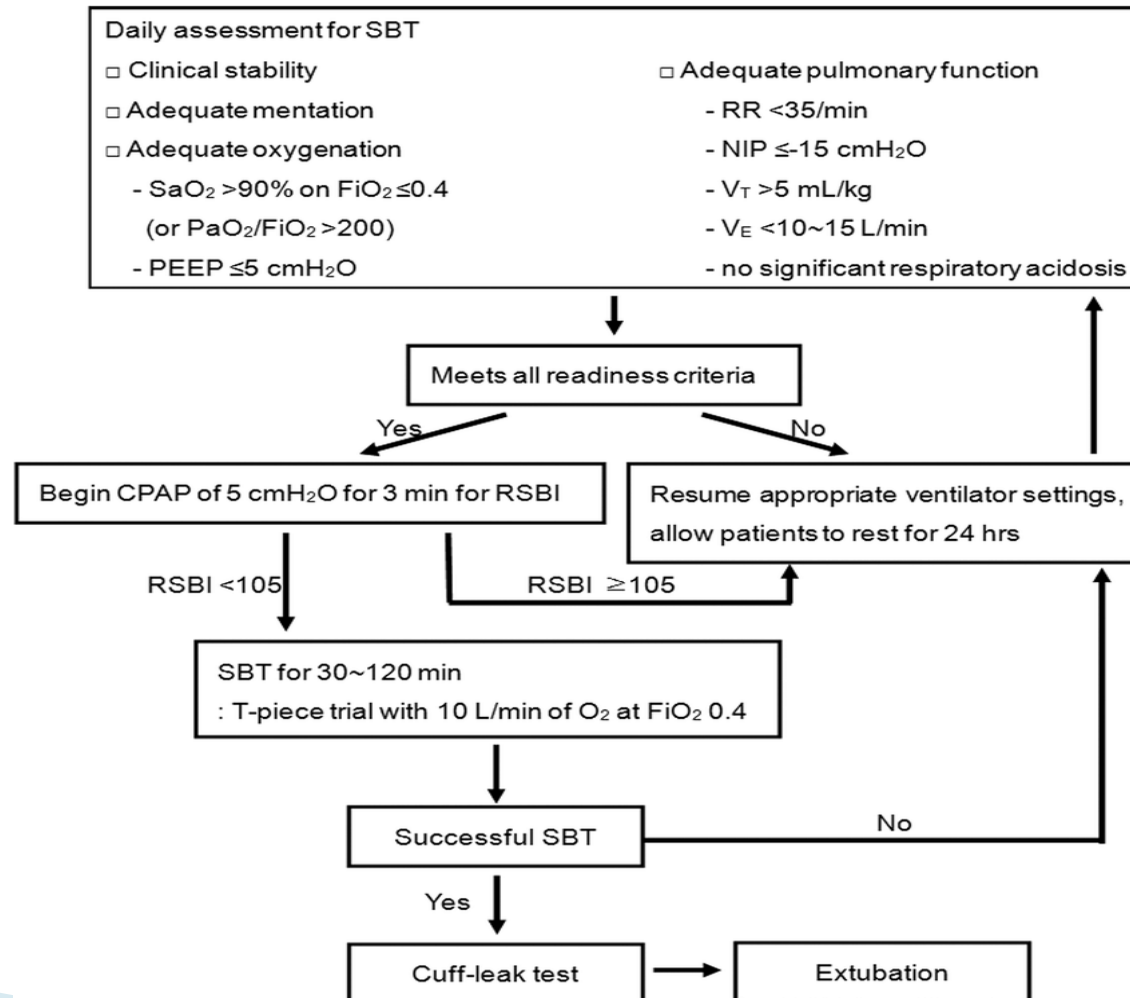


Weaning Protocol (excerpts)

- ▶ The patient should be assessed daily for *Readiness to Wean*.
 - SBT with PSV set to overcome resistance: $Raw = \frac{\text{Peak AW Pres} - \text{Plateau}}{\text{Flow in L/sec}}$
 - 30 - 120 minutes
- ▶ **Criteria**
 - 1. $V_e = 5-12$ lpm
 - 2. Spont VT 5 ml/kg of ideal body weight (IBW): ex. 70 kg IBW X 5 = 350 mls VT
 - 3. RR < 35
 - 4. HR < 140
 - 5. SpO₂ > 90%
 - 6. Rapid Shallow Breathing Index (RSBI) < 105
- ▶ **Extubation Criteria (in addition to above)**
 - 1. NIF > -20
 - 2. Deliberate Cuff Leak > 110 ml



Spontaneous Breathing Trial (SBT) Example



“Optimizing” to Facilitate Weaning

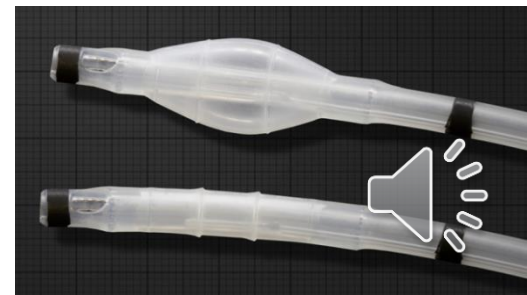
- ▶ Sedation: Lighten and consider switching to “kinder” form of sedation e.g., Precedex
- ▶ Fluid balance
- ▶ Proper Nutrition (macro and micro nutrients).
- ▶ Permit adequate recovery time from prior failed weaning attempts. (min 24 hours of rest on AC).
- ▶ Adjunctive Respiratory Care: Bronchodilators, bronchial hygiene, sx'ing
- ▶ Airway optimization: Mucous shavers.
- ▶ Adequate staffing/resources.



Endotracheal Tube (ETT) Mucus Shavers



- ▶ Evidence has shown that biofilm begins building up in ETT lumen within 24 hours after placement.
- ▶ The biofilm reduces interior lumen and contains harmful microbes.
- ▶ Pincirolì, et al (2016)
 - *Findings:* The *endOclear mucus shaving device is safe* and can prevent ETT luminal occlusion.
- ▶ Bardes, et al (2017)
 - *Findings: Comparison of the endOclear® group and controls demonstrated a trend toward a higher pneumonia rate in the former.* Additionally, the device achieved very small, clinically insignificant, changes in ventilator settings, and no difference was seen in Vent Days.
- ▶ Scott, et al (2017)
 - *Findings:* ETT scraping can reduce AW resistance but *did not impact SBT success.*



Categories of Patients in Relation to Weanability

- ▶ 1. ***Quick-Wean*** => Extubate — Wake them up, assess and extubate.
 - e.g., patients being *recovered* from OR in ICU
- ▶ 2. ***Delayed Quick-Wean*** – Slow to clear sedation...No Spon. Breaths in the morning...Re-Assess/SBT/Wean? in the afternoon.
 - e.g., post complex surgery
- ▶ 3. ***Weaning*** but ***extubation contraindicated***.
 - e.g. diaphragmatic atrophy due to extended MV, lack of optimization.
- ▶ 4. ***Marginal extubation candidate*** but trach/PEG are immanent.
 - E.g., Repeated resp. failure–Extubate to BiPAP or HFNC.
- ▶ 5. ***No Wean--No Reassessment***--Patients who should not be weaned ***nor reassessed*** the same day.
 - e.g., respiratory failure, sepsis, hemodynamic issues, alcohol W/D



Contraindications to Weaning and SBT

- ▶ Inadequate Oxygenation and Spontaneous Ventilation
 - PEEP > 10 cm H₂O
 - RSBI > 100–105
- ▶ Unstable Clinical Status
 - Non-reversal of reason for intubation
 - Hemodynamic instability
 - Significant anemia and/or abnormal blood chemistry
 - Sepsis
 - Head (or other) trauma
- ▶ Pharmacologic paralysis
- ▶ Immanent major surgery



Many Reasons Why Patients Tolerate Weaning *but Not Extubation*:

- ▶ Trauma patients who are stabilized but *scheduled for surgery immanently*.
- ▶ Patients *on MV for extended time periods*...with diaphragmatic atrophy.
- ▶ Patient *unable to protect airway* but with favorable RSBI.
 - e.g. vocal cord paralysis, status post stroke.
- ▶ Patient with *insufficient or absent ETT cuff leak*.
- ▶ *Neuromuscular patients* with marginal weaning parameters.
- ▶ *Supportive Care Issues*: Marginal fluid balance, nutritional concerns...



Patients Who Fail AM SBT and Whose PM SBT is Not Warranted

- ▶ General: Pt. recently intubated (main cause for intubation not resolved)
- ▶ Specific Examples:
 - ***Persistent Respiratory Failure:***
 - Oxygenation Resp. Failure”: Pt.s requiring high oxygenation settings, FIO₂ > 60%, Peep > 12.
 - Ventilatory Respiratory Failure: RSBI > 105
 - ***Poor Acid–base status*** critical or not improving (pH , 7.25)
 - ***Hemodynamic instability*** (low BP, unstable HR, arrhythmias)
 - ***Significant anemia and/or abnormal blood chemistry***
 - ***Intentional heavy sedation*** (alcohol/drug withdrawals or seizure protocols)
 - ***Pharmacologically paralyzed*** or recently coming of the paralytics.



Enhancing Extubation Success

- ▶ **Pre Extubation Assessment**
 - Adequate oxygenation and ventilation
 - Ability to Protect airway
 - No absolute contraindications
 - Poor weaning parameters
 - Inadequate cuff leak
 - Poor clinical status (CBC's, fever, CXR, excessive secretions, etc)
 - Can't follow commands nor protect airway
- ▶ **Pre-Extubation Optimization**
 - Reversal of clinical reason for original intubation and mech. vent.
 - Fluid balance
 - Nutrition
- ▶ **Post Extubation Augmentation**
 - Extubate to HFNC
 - Marginal oxygenation
 - Extubate to BiPAP/NIPPV
 - Marginal ventilation



High-Flow Nasal Cannula (HFNC)

Some Evidence:

- ▶ Ni, Lou, Yu, BMC Pul. Med (2017).
 - *Findings:* After extubation, HFNC is a reliable alternative of NIPPV to *reduce rate of reintubation* compared with conventional O2 therapy.
- ▶ Dhillon NK, Smith EJT, Ko A, J Surg. Res (2017)
 - *Findings:* Ventilated patients at risk for recurrent respiratory failure have *reduced reintubation rates when extubated to HFNC.*



Non-invasive Positive Pressure Ventilation

- ▶ Zhu, Wang, Liu, Jia & Jia, Chim Med J (2013)
 - **Findings:** NIPPV can reduce the need of re-intubation and improve clinical outcome as compared with invasive ventilation.
- ▶ Bhatti, Ramdass, Cury, et al, Clin Respir J.
 - **Findings:** Clinician dependent factors linked to NIPPV failure.
 - Inappropriate utilization of NIPPV in respiratory failure is associated with higher mortality.



Case 1 – Interprofessional Collaboration to Get it Started

- ▶ 47 YO ♂ post trauma patient with multiple orthopedic injuries is intubated and ventilated on AC mode. All anticipated surgeries have been completed and the patient is now clinically stable. An attempt at a SBT is not successful because the patient is not initiating breaths over the set rate apparently due to heavy sedation. The physicians are not in the unit.
- ▶ What steps are the appropriate next steps for the RT and RN?



Case 2– Wean, Don't Extubate

- ▶ A 39 YO ♀ post-head trauma patient is recovering from her injuries and during a sedation holiday and SBT. She is now initiating 20 breaths/min at a VT of 330. Her overall clinical status is stable, however she is unable to follow commands.
- ▶ What is her RSBI?
- ▶ What factors would influence your recommendation regarding weaning & extubation?



Case 3– Wean but Extubate to Adjunctive Device?

- ▶ A 69 YO ♂ on MV for 10 days for an COPD exacerbation. RSBI during a morning sedation holiday is 102 on + 6 PSV. SPO2 is 94% on FIO2 of 40% and PEEP of +8. The patient has an adequate cuff leak of 150 mls. Clinical status is otherwise stable. ENT is scheduled to assess for tracheostomy over the next 2 days.
- ▶ Is this patient potentially a candidate for weaning?
- ▶ If they successfully wean all morning on + 8 PSV, should extubation be considered?
- ▶ If extubation is considered, are there any special considerations regarding enhancing success?



Case 4 – No Wean in the AM – No PM Weaning Assessment Warranted

- ▶ 47 YO ♂ chest trauma patient is mechanically ventilated. CXR reveal bilateral ground glass appearance, PO₂ is 65 on 80% and PEEP of 14 (P:F = 78) . PAW are 32 cm (low compliance).
- ▶ Should this patient be assessed for ability to wean?
- ▶ Should they be weaned and why/why not?
- ▶ Should they be re-assessed for ability to wean in the afternoon?
- ▶ What other therapies should be considered?



Case 5 – Excessive Weaning & Diaphragmatic Fatigue

- ▶ A patient with marginal weaning parameters (e.g., RSBI = 102) has been weaning on + 10 PSV X 9 hours. Over the past 3 hours, his RR has been climbing into the low 30's, HR inc from 105 to 130 and he is diaphoretic, despite sx'ing, bronchodilators and other respiratory interventions.
- ▶ Pain and anxiety have been ruled out as the main cause of distress.
- ▶ What immediate actions should be taken?
- ▶ What are some potential considerations for weaning over the next few days?



Case 6– Trach Collar Wean and Decruitment

- ▶ Patient with a spinal injury at C-4 and 5 is intermittently weaning on T/C during the day. Patient has repeatedly had episodes of hypoxemia after 4–6 hours of T/C. CXR shows signs of bi-basilar atelectasis which is unchanged over several days.
- ▶ What factors predispose this patient to hypoxemia and atelectasis?
- ▶ What recommendations might help this patient's weaning *and* overall respiratory status?





Take Home Messages

- ▶ SBT and weaning are *important tools* in optimizing vent–patient care.
- ▶ However, they involve *interprofessional collaboration* & communication.
- ▶ SBT & Weaning are *resource dependent*.
- ▶ No single method for weaning and liberation from ventilation is infallible and the *data are mixed*.
- ▶ However, some methods have *stronger supportive evidence* than others.
 - SBT Guidelines, RSBI, diaphragmatic issues, de–recruitment considerations.
- ▶ Use what evidence we have and stay tuned as more research emerges!



Selected Resources

- ▶ Schmidt, Girard, Kress, et al, Official Exec Summary of ATS...Guideline: Liberation from Mechanical Ventilation in Critically Ill Patients, 2017.
- ▶ Heuer, AJ. Clinical Assessment in Respiratory Care, ed 9, 2021.
- ▶ Kacmarek, Stoller, & Heuer, Egan's Fundamentals of Respiratory Care, ed 12th ed, 2021.
- ▶ Kallet, Zhuo, Yip, et al: Cochrane Systematic Rev. Respir Care. Jan;63(1):1-10, 2018.



Thank You!!!

Questions?

