Weaning from Mechanical Ventilation using SBT

March 18, 2020

Objectives

By the end of this course, you should be able to:

- Define SBT and weaning
- Describe the factors to assess weaning readiness
- Understand the types of Spontaneous Breathing Trials (SBT)
- Understand SBT Success/failure criteria
- Define weaning parameters used to predict weaning and extubation success
- Understand SBT on the CARESCAPE R860
- Understand how to measure P 0.1, NIF and Vital Capacity on the CARESCAPE R860

40%

The amount of time spent on weaning a patient from mechanical ventilation

Zein H, Baratloo A, Negida A, Safari S. Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review. *Emerg (Tehran)*. 2016;4(2):65–71

What is SBT and Weaning?

What is Spontaneous Breathing Trial and Weaning?

Weaning:

- The process used to describe the gradual decrease in ventilatory support

Spontaneous Breathing Trial (SBT):

- The mechanism used to assess the patient's ability to breath with minimal or no ventilatory support

Zein H, Baratloo A, Negida A, Safari S. Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review. *Emerg (Tehran)*. 2016;4(2):65–71

Assessing the Readiness to Wean

Assessing the Readiness to Wean[2]

4 Factor to assess weaning readiness:

1. Reversal of the indication for ventilatory support
2. Adequate gas exchange
   - PaO2 > 60mmHg,
   - FiO2 ≤ 50%
   - PEEP ≤ 8 cmH_20
   - pH > 7.25
   - Vd/Vt < 60%
   - MV < 12 L/min
3. Ability to initiate a breath
4. Hemodynamic stability
   - Minimal cardiovascular support
   - No cardiac ischemia
   - No unstable arrhythmia

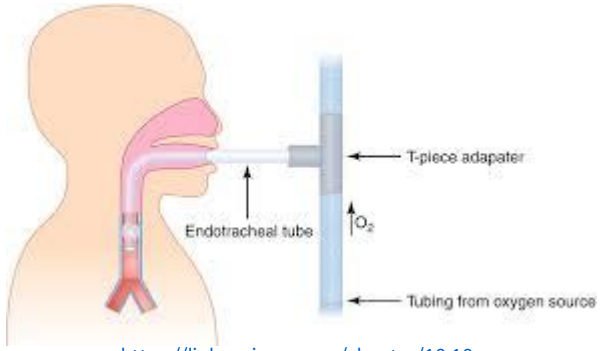
Table 1: Criteria of readiness for weaning trial[1]

Criteria
Subjective assessment
Adequate cough
No neuromuscular blocking agents
Absence of excessive trachea-bronchial secretion
Reversal of the underlying cause for respiratory failure
No continuous sedation infusion or adequate mentation on sedation
Objective measurements
Stable cardiovascular status
Heart rate ≤ 140 beat/minute
No active myocardial ischemia
Adequate hemoglobin level (≥ 8 g/dl)
Systolic blood pressure 90–160 mmHg
Afebrile (36◦ C < temperature < 38◦ C)
No or minimal vasopressor or inotrope (< 5 μg/kg/minute dopamine or dobutamine)
Adequate oxygenation
Tidal volume > 5 mL/kg
Vital capacity >10 mL/kg
Proper inspiratory effort
Respiratory rate ≤ 35/minute
PaO_2 ≥ 60 and $PaCO_2$ ≤ 60 mmHg
Positive end expiratory pressure ≤ 8 cmH_2O
No significant respiratory acidosis (pH ≥ 7.30)
Maximal inspiratory pressure (MIP) ≤ -20 – -25 cmH_2O
O_2 saturation > 90% on FIO_2 ≤ 0.4 (or PaO_2/FIO_2 ≥ 200)
Rapid Shallow Breathing Index (respiratory Frequency/Tidal Volume) < 105

1. Zein H, Baratloo A, Negida A, Safari S. Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review. *Emerg (Tehran)*. 2016;4(2):65–71.
2. Hess DR, Kacmarek RM. Ventilator Liberation. In: *Essentials of Mechanical Ventilation*. Fourth Edition. McGraw-Hill Education; 2019:167-175.

Types of SBT

Types of Spontaneous Breathing Trials[1]



https://link.springer.com/chapter/10.1007/978-3-319-89981-7_9

1. T-Piece Trial

- Humidified oxygen connected directly to the ET tube with a T-piece

2. CPAP Trial*

- CPAP level equal to current PEEP level

3. Low level of Pressure Support or Automatic Tube Compensation*

- Pressure support between 5-8 cmH_20

*Since the patient is attached to the ventilator you can maintain a precise FiO_2 and if the patient fails the trial they can be quickly placed back on the full ventilatory support.[2]

1. Zein H, Baratloo A, Negida A, Safari S. Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review. *Emerg (Tehran)*. 2016;4(2):65–71
2. Hess DR, Kacmarek RM. Ventilator Liberation. In: *Essentials of Mechanical Ventilation*. Fourth Edition. McGraw-Hill Education; 2019:167-175.

SBT Duration and Success/Failure Criteria

SBT Duration and Success/Failure Criteria

SBT Duration: 30-120 minutes, once per day.

Criteria of Successful Spontaneous Breathing Trials[1]	Criteria for Failure of a Spontaneous Breathing Trial[2]
• Respiratory rate < 35 breaths/minute • Heart Rate < 140/minute or heart rate variability of > 20% • Arterial oxygen saturation > 90% or PaO_2 > 60 mmHg on FiO_2 < 40% • 80 < Systolic blood pressure < 180 mmHg or < 20% change from baseline • No signs of increases work of breathing or distress • Good tolerance to Spontaneous breathing trial	• Respiratory rate > 35 breaths/minute • Use of accessory muscles • Dyspnea • Asynchronous movement of the abdomen and rib cage • SpO_2 < 90% • Heart Rate> 140/min or sustained 20% increase in heart rate • Systolic blood pressure > 180 mmHg and diastolic > 90 mmHg • Anxiety • Diaphoresis

If a patient fails a SBT, it is important to understand and correct what may have caused the failure prior to the next SBT

1. Zein H, Baratloo A, Negida A, Safari S. Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review. *Emerg (Tehran)*. 2016;4(2):65–71
2. Hess DR, Kacmarek RM. Ventilator Liberation. In: *Essentials of Mechanical Ventilation*. Fourth Edition. McGraw-Hill Education; 2019:167-175.

Weaning Parameters

Weaning Parameters

- Used to predict weaning readiness
- Weaning parameters are categorized into 3 groups
  - Evaluation of ventilatory drive
  - Ventilatory muscle capability
  - Ventilatory performance
- Rapid Shallow Breathing Index (RSBI) is the most accurate parameter for weaning success
- The best predictor for extubation readiness is a SBT
- V02 increase of 10% or greater is one of the best indicators of weaning failure.

Predictor	Value
Evaluation of ventilatory drive	
• P0.1	> -4cmH_20
Ventilatory muscle capabilities	
• Vital Capacity	> 10 mL/kg
• Maximum Inspiratory Pressure (MIP or NIF)	< -30 cmH_20
Ventilatory Performance	
• Minute Ventilation	< 10 L/min
• Maximum voluntary ventilation	>3 times $\dot{V}_E$
• Rapid shallow breathing index	< 105
• Respiratory rate	< 30/min

Hess DR, Kacmarek RM. Ventilator Liberation. In: *Essentials of Mechanical Ventilation*. Fourth Edition. McGraw-Hill Education; 2019:167-175

Weaning Parameter Definitions

P0.1: is a measurement of the airway occlusion pressure during the first 0.1 seconds after beginning an inspiratory effort against an occluded airway

- Helps to assess respiratory drive and inspiratory effort
- Reference value:
  - Healthy adults breathing spontaneously: ~1 cmH_20 (0.5-1.5cm H_20)[1]
  - For mechanically ventilated patients: > 3.5 cmH_20 were associated with increased effort[1]

Negative Inspiratory Force (NIF): is the maximum pressure that is generated against an occluded airway after a maximum inspiration.

- Helps assess inspiratory muscle function or diaphragmatic force[2]
- Reference Value[3]:
  - > -30 cmH_20 (NIF is limited to -20 cmH_20 on the CARESCAPE R860). The force produced should be at least – 20 or more negative for readiness to wean.

Vital Capacity: is a measurement of a patient's largest expired tidal volume over a 30 second period

- Helps assess a patient's ventilatory reserve
- Reference value[3]:
  - > 10 mL/kg

Rapid Shallow Breathing Index (RSBI)[3]: is calculated by dividing respiratory rate by the tidal volume in liters (RR/Vt)

- Best predictor to assess weaning success or failure
- Reference value:
  - ≤ 105 probability of successful weaning is high. If >105 probability of weaning failure is high

1. https://coemv.ca/airway-occlusion-pressure-p0-1/
2. Edgar C R, Katherine PB & Ferrán AA. Negative Inspiratory Pressure as a Predictor of Weaning Mechanical Ventilation. J Anest & Intern Care Med. 2017; 3(1) : 555602. DOI:10.19080/JAICM.2017.03.555602
3. Hess DR, Kacmarek RM. Ventilator Liberation. In: *Essentials of Mechanical Ventilation*. Fourth Edition. McGraw-Hill Education; 2019:167-175

Is using weaning protocols better than no protocol at all?

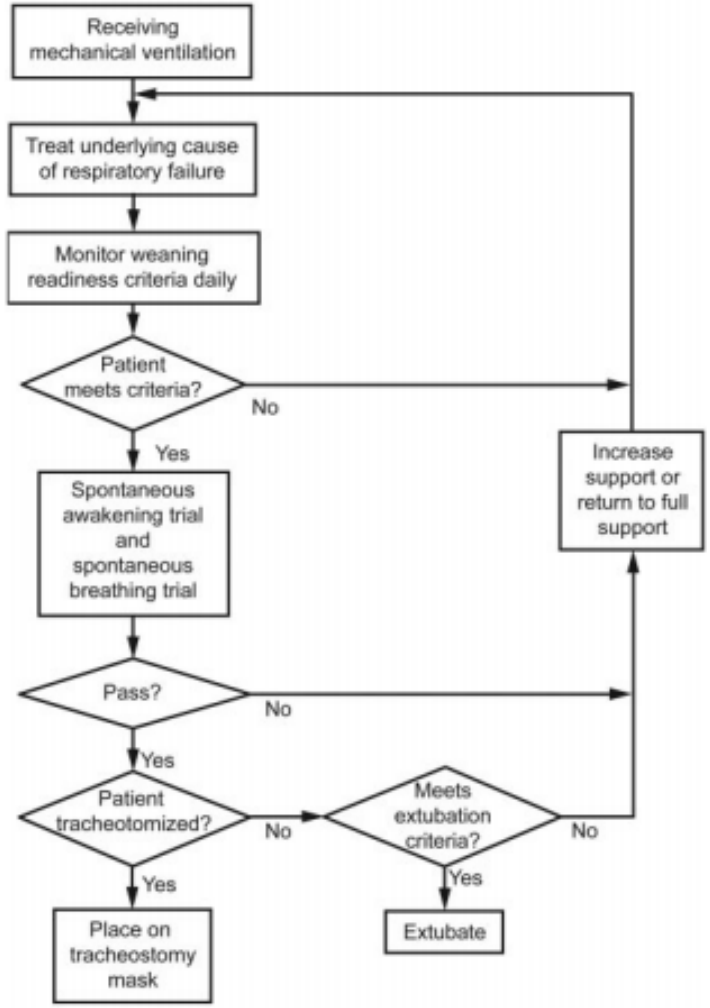
78%

Weaning time reduction when standardized weaning protocols were used

Blackwood B, Alderdice F, Burns K, Cardwell C, Lavery G, O'Halloran P. Use of weaning protocols for reducing duration of mechanical ventilation in critically ill adult patients: Cochrane systematic review and meta-analysis. *BMJ*. 2011;342:c7237. Published 2011 Jan 13. doi:10.1136/bmj.c7237

Weaning Protocols

- Consist of 3 parts[1]:
  1. Objective criteria to judge weaning readiness
  2. Guidelines to decrease support gradually
  3. Criteria to assess readiness for extubation
- Protocols implemented by Respiratory Therapists or Nurses result in shorter weaning times and shorter lengths of mechanical ventilation[2,3]
  - May also contribute to a decrease in length of stay in the ICU, hospital costs and ventilator associated pneumonia[3]
- Reason for protocol success[2]:
  - Developed by multidisciplinary teams
  - Nurses and Respiratory Therapists empowered to make clinical decisions
- Protocols may not have as important an impact where standard of care already incorporates evidenced-based elements into weaning and where the clinician to patient ratio is high[3]



1. Zein H, Baratloo A, Negida A, Safari S. Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review. *Emerg (Tehran)*. 2016;4(2):65–71
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CARESCAPE R860
SBT

CARESCAPE R860 SBT

- A procedure intended to evaluate a patient's ability to breathe spontaneously during a specified duration of time
- Not intended to be used for long term ventilation beyond the set duration time
- During SBT mode, the patient initiates spontaneous breaths and the ventilator maintains a set PEEP level and provides pressure support
- Prior to SBT evaluation set the mode ventilator settings, duration of the trial and the stop criteria

Category	Setting
Main Parameters	FiO2
	PEEP
	PS
Patient Synchrony	Insp Trigger
	Exp Trigger
	Bias Flow
	PS Rise Time
Safety	Pmax
Stop Criteria	RR
	MVexp
	Apnea Time

SBT Ends

Successful Completion of SBT

- Once the SBT is complete, an alarm message stating, “ SBT Completed Successfully” will be displayed
- The previous ventilation mode will resume

Reaching Stop Criteria

- If stop criteria are reached, the alarm message, “SBT ended” displays and the previous ventilation mode resumes
- Select the current mode to confirm current ventilation mode or to resume SBT

SBT View

- Shows graphical and numerical data and trends related to the ongoing trial
- Data may be used to see the patient's progress during the SBT or following the trials completion
- Previous SBT data may be reviewed if it was obtained within the last 12 hours
- If desired, select Guide and select one of the following data to plot on the timeline:
  - RR
  - MVexp
  - VTexp
  - RSBI
  - EtCO2
  - VO2

Lung Mechanics on the CARESCAPE R860

P0.1

P 0.1 is a respiratory measurement used to evaluate the patient's readiness to be weaned from the ventilator. P 0.1 is a measurement of the airway occlusion pressure 0.1 second after beginning an inspiratory effort against an occluded airway. P0.1 helps to assess respiratory drive and inspiratory effort.

- To measure P 0.1:
  - Select Menu > Lung Mechanics > P 0.1.
  - Select Start.
    - The P 0.1 measurement will display along with a timestamp.
    - The P 0.1 procedure will end when the measurement is completed or when Stop is selected. If the measurement is not available, a red X will display indicating a failure

Negative Inspiratory Force (NIF)

Negative Inspiratory Force is a weaning measurement that is used to evaluate the patient's readiness to be weaned from the ventilator. NIF is used to determine the patient's ability to take a deep breath and to generate a cough strong enough to clear secretions.

To measure NIF:

- Select Menu > Lung Mechanics >NIF.
  - Set NIF Time.
    - Use the Trim Knob to select a NIF time up to 30 seconds.
  - Instruct the patient to fully exhale.
  - Select Start and instruct the patient to fully inhale.
    - When the patient inhales the most negative airway pressure is recorded and displayed along with a timestamp.
    - The procedure will end when the measurement is completed or when Stop is selected. If the measurement is not available, a red X will display indicating a failure.

Note: The patient will not be ventilated during a NIF procedure.

Vital Capacity

Vital Capacity is the measurement of a patient's largest (VTexp) expired Tidal Volume over a 30 second period.

During a Vital Capacity measurement, Pinsp and PS are set to zero.
When the Vital Capacity measurement is complete Pinsp and PS return to the previous setting.

During the Vital Capacity procedure, VTinsp and VTexp for each breath will display in the Splitscreen view.

When the Vital Capacity procedure is complete, the largest Vtexp value is displayed with a timestamp in the Lung Mechanics window.

To measure Vital Capacity:

- Select Menu > Lung Mechanics > VC.
- Select Start.
- Instruct the patient to fully inhale and exhale.
    - The procedure will end when the measurement is completed or when Stop is selected. If the measurement is not available, a red X will display indicating a failure.

Note: The patient will not be mechanically ventilated during a Vital Capacity procedure.

Conclusion

This concludes the Weaning from mechanical ventilation using Spontaneous Breathing Trials course.

In this course, you learned about:

- SBT and weaning definitions
- The factors to assess weaning readiness
- The types of Spontaneous Breathing Trials (SBT)
- SBT Success/failure criteria
- Weaning parameters used to predict weaning and extubation success
- SBT on the CARESCAPE R860
- How to measure P 0.1, NIF and Vital Capacity on the CARESCAPE R860

Disclaimers

Always refer to device manufacturers user reference manual for specific application of your CARESCAPE R860.
Use this information as guidance and each patient may require clinical decisions not covered in this information.
Ensure proper clinically appropriate alarm limits are set and monitored.

Imagination at work