Role of Physical therapy in person during weaning ventilation
Role of Physical therapy in person during weaning ventilation

ประเด็นที่น่าสนใจ: (Clinical QUESTION?)

What is the most appropriate physiotherapy care for person who has planning for mechanical ventilator weaning?

หัวข้อบรรยาย:

1. Is the person ready to wean mechanical ventilator?
2. What can Physical therapy do with…?
3. What we concern?
QUESTION 1

Is the person ready to wean mechanical ventilator?
Role of Physical therapy in person During weaning ventilation

Figure 1. Schematic representation of the different stages occurring in a mechanically ventilated patient. ARF: acute respiratory failure; SBT: spontaneous breathing test.
7:00-8:00 am daily, Assess Patient for Spontaneous Breathing Readiness:
- SpO₂ ≥ 92%
- PEEP ≤ to 8 cm H₂O
- Fio₂ ≤ 0.4-0.5
- Minute ventilation is < 20 L/min
- Hemodynamic stability
  - HR > 50, <140 bpm
  - SBP > 90, < 180 mm Hg
- Patient initiates spontaneous inspiratory efforts
- Patient performs the following simple commands:
  - Open and close eyes
  - Open and close mouth
  - Cough
  - Perform forced vital capacity maneuver, achieving double the baseline tidal volume

**Meets All Readiness Criteria**

**Begin T-Piece trial with Fio₂ of .4-.5, wait 3 minutes, measure Rapid Shallow Breathing Index (RSBI)**

RSBI < 105 bpm/L
- Continue T-piece trial. After 60 minutes assess whether:
  - RR <35 bpm
  - SpO₂ > 92%
  - Change in HR <20%
  - Change in SBP < 20%
  - Patient is not agitated
  - Patient cough on command

RSBI ≥ 105 bpm/L
- Resume appropriate ventilator settings, allow patient to rest for 24 hours

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Criteria for initiating weaning from mechanical ventilator

➢ Original indication for mechanical ventilation resolved or improved

➢ Cardiovascular stability

➢ Adequate respiratory mechanics*

*Defend as one more of the following: maximal inspiratory pressure more negative than -20 cmH2O, spontaneous respiratory rate < 25/min, spontaneous tidal volume > 5 mL/kg predicted body weight (PBW), vital capacity > 10 mL/kg PBW, resting minute ventilation ≤ 10 L/min with maximal voluntary ventilation ≥ 2 x resting minute ventilation (See Chapter 73, Table 73.2, for PBW formulas.)

FiO2; fractional concentration of inspired oxygen.
Criteria for initiating weaning from mechanical ventilator

- **Neurologic function adequate**
  - spontaneous ventilatory efforts
  - satisfactory cough and swallowing

- **Adequate oxygenation**
  - \( \text{PaO}_2 \geq 60 \text{ mmHg} \) or \( \text{O}_2 \text{ saturation} \geq 90 \% \)
  - on \( \text{FiO}_2 \leq 0.5\% \)

*Defend as one more of the following: maximal inspiratory pressure more negative than -20 cmH2O, spontaneous respiratory rate < 25/min, spontaneous tidal volume > 5 mL/kg predicted body weight (PBW), vital capacity > 10 mL/kg PBW, Resting minute ventilation \( \leq 10 \text{ L/min} \) with maximal voluntary ventilation \( \geq 2 \times \text{resting minute ventilation} \) (See Chapter 73, Table 73.2 for PBW formulas.)

FiO2; fractional concentration of inspired oxygen.
QUESTION 2

What can Physical therapy do with...?
Role of Physical therapy in person during weaning ventilation

Fig. 1. The relationship between patient capabilities and demands. When demands outstrip the capabilities, the balance swings to the left and a high level of ventilatory support is required. As the patient recovers, the balance shifts rightward. The clinical challenges during this period are 2-fold: (1) recognize when ventilatory assistance is no longer necessary, and (2) provide appropriate levels of assistance until that happens. $C_{LT}$ = compliance of the lungs and thorax. $R_{aw}$ = airway resistance. $V_A$ = alveolar ventilation. $V_{CO_2}$ = carbon dioxide production. $V_{O_2}$ = oxygen consumption. $V_D$ = dead-space volume. (Adapted from Reference 1.)
Factor that increase work of breathing (WOB)

1.) Decreased Lung Compliance

1.1) Lung and related tissue

1.2) Other cause such as

- Abdominal distension
- Diseased of CNT
Factor that increase work of breathing (WOB)

2. ) Increased Airway Resistance

- Bronchospasm
- Endotracheal tube (prolonged use)
- Secretions
- Small-diameter tracheal tube
- Ventilator circuit
3.) Increased Respiratory Drive or Minute Ventilation

- End-stage liver or renal disease
- Excessive carbohydrate calories
- Fever, infection
- Metabolic acidosis
- High dead-space to tidal volume ratio (VD/VT)
Psychological and Emotional factors that hinder weaning

- Anger
- Anxiety
- Cognitive deficits
- Depression
- Distorted body image

- Fear
- Isolation
- Pain and dyspnea
- Sensory overload
- Sleep deprivation
General criteria that indicate person is Not ready to initiate Rehabilitation session

- Cardiovascular status
  - Heart rate
  - Blood pressure
- Respiratory Rate and Symptoms
- Mechanical Ventilation (MV)
General criteria that indicate person is Not ready to initiate Rehabilitation session

- Central nervous system
- Other
  - Alertness/Agitation and Cooperation
  - Invasive line
## Heart Rate
- > 70% age predicted maximal heart rate
- <40 beats/minute; >130 beats/minute
- New onset arrhythmia
- New anti-arrhythmia medication
- New MI by ECG or cardiac enzymes

## Blood Pressure
- SBP > 180 mmHg
- MAP < 65 mmHg; > 110 mmHg
- Continuous IV infusion of vasoactive medication (vasopressor or antihypertensive)
- New vasopressor or escalating dose of Vasopressor medication

## Respiratory Rate and Symptoms
- < 5 breaths/minute; > 40 beats/minute
- Patient feels intolerable DOE
- Pulse Oximetry /SpO2 < 88%

## Mechanical Ventilation (MV)
- Fio2 ≥ 0.60
- PEEP ≥ 10 cmH2O
- Patient-ventilator asynchrony
- Recent MV mode change to assist or pressure support
- Tenuous artificial airway

## Level of consciousness; Alertness/Agitation and Cooperation
- Patient sedation or coma (RASS = -3, -4, or -5)
- Patient agitation requiring addition or escalation of sedative medication (RASS >2)
- Patient refusal

### DOE, dyspnea on exertion
During Weaning: Should we do physical therapy program.

Mechanical ventilator mode for weaning:

The most common ventilator mode: Spontaneous with or without PEEP

: CPAP
Therapist driven protocols:

A consensus of medical knowledge and opinion that is summarized into a care plan or algorithm with changes in therapy directed by changes in objectively measurable patient's variables.

The daily plan of a TDP consists of recording functional activities: initial evaluation will include assessment of the patient and ventilator status and patient-ventilator synchrony. This evaluation is usually performed routinely every day and at each ventilator setting change.
Finally

Inter-Multidisciplinary team and
Patient and family planning.
Criteria that indicate person is Not ready to initiate Rehabilitation session.

Deconditioning stage that may limit mobilization.

- No.
- Yes

Re-assessment daily.

Notify PMR.

- Yes

Re-assessment daily.

- No.

Active Physiotherapy
- Encourage early mobilization

- Chest PT
- DBE, Manual assist, IMT, Intensive spirometer
- Chest mobilization, Relaxation exercise
- Postures (Positioning)
- Limb exercises (Passive, Active)
Muscle retraining:
- Respiratory muscle: Positioning, Passive chest movement
- Peripheral muscle: Electrical stimulation (ES)

Airway Secretions Management:
- Chest physiotherapy
- Manual hyperinflation
- Percussion and vibrations
- Suction**
- Devices** เช่น IPPB

** ขึ้นอยู่กับ Policy ของหน่วยงาน

Ref; Respiratory Medicine (2005) 99, 1096–1104
Mobilizations:

- Postures; Tilt table
- Limb exercises: Passive exercise
- Continuous rotational therapy

**ขึ้นอยู่กับ Policy ของหน่วยงาน**

Ref: Respiratory Medicine (2005) 99, 1096–1104
Muscle retraining:

- **Respiratory muscle**: DBE, Manual assist, IMT, Intensive spirometer
- **Peripheral muscle**: Chest mobilization, Relaxation exercise

**Airway Secretions Management:**

- Coughing and Huffing training
- ACBT

**Mobilizations:**

- Postures
- Limb exercises

**Ref; Respiratory Medicine (2005) 99, 1096–1104**
Muscle retraining:

**Respiratory muscle**

Controlled mechanical ventilation in the ICU may lead to the development of selective and rapid diaphragmatic atrophy.

*Atrophy of diaphragm fibers …after only 18 hours of mechanical ventilation and complete diaphragmatic inactivity*
**Figure 2.** Physical therapy interventions. Asterisk (*) indicates technique was omitted after the initial intervention.
Early ambulation
Physiotherapy:

Posture and Early ambulation

** Inter-Multidisciplinary team and Patient and family planning. **
Limb exercises
Physiotherapy:
Limb exercises

** Upper extremity

** Inter-Multidisciplinary team and Patient and family planning.
Physiotherapy:
Limb exercises

Lower extremity

** Inter-Multidisciplinary team and Patient and family planning.**
Safety Considerations:

Deconditioning stage that may limit mobilization of ICU person*
Deconditioning stage

- Cardiovascular status
- Respiratory
- Neurological
- Other
<table>
<thead>
<tr>
<th>System Status</th>
<th>Deconditioning stage **</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiovascular</strong></td>
<td></td>
</tr>
<tr>
<td>MAP (mm Hg)</td>
<td>&lt;65</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>&lt;40 or &gt;130</td>
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<tr>
<td>Hemodynamic</td>
<td>Administration of a new presser agent</td>
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<tr>
<td>Cardiac status</td>
<td>Active bleeding</td>
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<tr>
<td></td>
<td>New myocardial infarct</td>
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<tr>
<td></td>
<td>Dysrhythmia requiring new medications</td>
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<tr>
<td></td>
<td>Active cardiac ischemia</td>
</tr>
<tr>
<td>System Status</td>
<td>Deconditioning stage **</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td><strong>Respiratory</strong></td>
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<tr>
<td>$\text{SpO}_2$</td>
<td>$&lt; 88%$</td>
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<tr>
<td>RR (breath/min)</td>
<td>$&lt;5$ or $&gt;40$</td>
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<tr>
<td>Ventilator issues</td>
<td>Increased positive end expiratory pressure</td>
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<tr>
<td>Ventilator asynchrony</td>
<td>change in ventilator mode</td>
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<tr>
<td>Unsecure airway</td>
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<tr>
<td>Pressure-control ventilation</td>
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<tr>
<td><strong>Fio2</strong></td>
<td>$&gt;60%$</td>
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<td>System Status</td>
<td>Deconditioning stage **</td>
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<td>-------------------</td>
<td>-------------------------</td>
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<tr>
<td><strong>Neurological</strong></td>
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<tr>
<td>Patient status</td>
<td>Severely agitated, distressed, or combative</td>
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<tr>
<td>ICP</td>
<td>Significantly increased</td>
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<tr>
<td><strong>Other</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intermittent hemodialysis</td>
</tr>
<tr>
<td></td>
<td>Unstable spinal-cord injury or vertebral Fracture</td>
</tr>
</tbody>
</table>
QUESTION 3

What we concern...?
Mechanical effects of positive pressure ventilation on cardiopulmonary circulation

The **Valsalva effect**: increased intrathoracic pressure on the right heart

Mechanical effects of positive pressure ventilation on cardiopulmonary circulation

- Diminishing venous blood return
- Increasing right ventricular (RV) afterload
- Decreasing left ventricular (LV) filling and depressing CO and overall organ perfusion
Mechanical effects of positive pressure ventilation on cardiopulmonary circulation.

The detrimental mechanical effects of positive pressure ventilation on cardiac hemodynamics include:

1. Decreased venous return due to external pressure on the inferior vena cava with resultant decrease in its caliber;
2. Increased right ventricular dilatation with septal shift (white arrows) as a result of the elevation on the right ventricular afterload;
3. Decreased left ventricular filling and cardiac output.

Cardiopulmonary effects of invasive positive pressure ventilation (PPV). CO, cardiac output; LV, left ventricular; RV, right ventricular.
Consequences of the transfer from mechanical ventilator of spontaneous breathing on cardiovascular system

- **Increase** respiratory muscle activity: Increase global oxygen demand.
  - **Increase** work of breathing (WOB)
    • Lead to myocardial ischemia
    • Hypoperfusion of critical organs.
  - **Decrease** intrathoracic pressure:
    • Risk of pulmonary edema formation

Weaning-induced cardiac dysfunction; B. Lamia, X. Monnet, and J.L. Teboul
Consequences of the transfer from mechanical ventilator of spontaneous breathing on cardiovascular system

- Increase sympathetic tone
  - Increase systemic arterial pressure and LV after load
  - Increase myocardial oxygen demand

Weaning-induced cardiac dysfunction; B. Lamia, X. Monnet, and J. L. Teboul
General Criteria for Terminating a Patient’s Rehabilitation Session

Changes in Heart Rate

- > 70% age predicted maximal heart rate
- > 20% decrease from resting heart rate
- < 40 breaths/minute: > 130 breaths/minute
- New arrhythmia
General Criteria for Terminating a Patient’s Rehabilitation Session

**Changes in Blood Pressure**

- SBP > 180 mmHg
- > 20% decrease in SBP/DBP
- Orthostatic hypotension with presyncopal symptoms
General Criteria for Terminating a Patient’s Rehabilitation Session

Changes in Pulse Oximetry/SpO₂

- Decrease > 4%
- < 88% - 90%

Changes in Respiratory Rate and Symptoms

- >40 breaths/minute
- Patient feels intolerable dyspnea

BP, blood pressure; DOE, dyspnea on exertion; ECG, electrocardiogram; Fio₂, fraction of inspired oxygen; IV, intravenous; MAP, mean arterial blood pressure; MI, myocardial infarction; MV, mechanical ventilation; PEEP, positive end-expiratory pressure; RASS, Richmond Agitation and Sedation Scale. *Maximal heart rate = 220- age SBP/DBP, systolic/diastolic blood pressure; SpO₂, saturation of arterial oxygen by pulse oximetry.
Criteria Used in Several Large Trials1 to Define Tolerance of a Spontaneous-Breathing Test

**Objective Measurements Indicating SBT Tolerance/Success**

- Gas exchange acceptability
  - \( \text{SpO}2 \geq 85 – 90\% \),
  - \( \text{PaO}2 \geq 50–60 \text{ mm Hg} \),
  - \( \text{pH} \geq 7.32 \)
  - \( \text{PaCO}2 \) increase < 10 mm Hg)
Criteria Used in Several Large Trials to Define Tolerance of a Spontaneous-Breathing Test

**Objective Measurements Indicating SBT Tolerance/Success**

- Hemodynamic stability
  - Heart rate < 120–140, heart rate not changed > 20%
  - Systolic blood pressure < 180–200 mm Hg and > 90 mm Hg
  - Blood pressure not changed > 20%, no vasopressors required
- Stable ventilatory pattern
  - Respiratory rate ≤ 30–35 breaths/min
  - Respiratory rate not changed > 50%
### Criteria Used in Several Large Trials to Define Tolerance of a Spontaneous-Breathing Test

#### Subjective Clinical Assessments Indicating SBT Intolerance/Failure

- Change in mental status (e.g., somnolence, coma, agitation, anxiety)
- Onset or worsening of discomfort
- Diaphoresis
- Signs of increased work of breathing (use of accessory respiratory muscles, thoracoabdominal paradox)
- SpO2 = oxygen saturation measured via pulse oximetry
Reference:


• Eur Respir J 2007; 29: 1033–1056

• RESPIRATORY CARE • FEBRUARY 2005 VOL 50 NO 2.

• The Intensive Care Unit Manual second edition; page 218.


