



Problems

- Comorbidities
- Consequences
- Deconditioning

- Difficult weaning & Deconditioning
- Poor ventricular dysfunction & Heart failure
- AICD

Table 20-17: Physiology of Pulmonary Exercise Compared to Upright Treadmill Exercise

| TYPE OF EXERCISE | SYSTOLIC/DIASTOLIC BLOOD PRESSURE | | |
|------------------|-----------------------------------|----------------------------|--------|
| | VO ₂ | MYOCARDIAL VO ₂ | |
| Isometric | ↑ | ↑↑/↑↑ | ↑ |
| Isotonic | ↔ | ↔/↔ | ↔ |
| Supine | ↓ | ↔/↔ | ↓ |
| Erect | ↔ | ↔/↔ | ↔ |
| Upper extremity | ↑ | ↑/↑ | ↑ |
| Lower extremity | ↔ | ↔/↔ | ↔ |
| Treadmill | ↔ | ↔/↔ | ↔ |
| Ergometer | ↔ or ↓ | ↔/↔ | ↔ or ↓ |

↑ = increased; ↑↑ = very increased; ↓ = decreased; ↔ = unchanged.

| | | | | |
|--|---|---|---|---|
| Physiologic state | | | | |
| Exercise | ↑ | ↔ | ↑ | ↔ |
| Lying down | ↑ | ↔ | ↑ | ↔ |
| ↑ Sympathetic tone | ↑ | ↔ | ↑ | ↔ |
| Polycythemia | ↑ | ↔ | ↔ | ↑ |
| Hypoxia | ↑ | ↔ | ↔ | ↑ |
| Cold shower | ↑ | ↔ | ↑ | ↔ |
| Goodpasture syndrome | ↑ | ↔ | ↔ | ↑ |
| Hyperkinetic cardiac states | ↑ | ↔ | ↑ | ↔ |
| Minimally raised pulmonary venous pressures | ↑ | ↔ | ↑ | ↔ |
| Moderately raised pulmonary venous pressures | ↔ | ↓ | ↑ | ↔ |
| Severely raised pulmonary venous pressure | ↓ | ↓ | ↓ | ↔ |

Table 20-16: Alterations in the Diffusion Capacity of the Lung (DL_{CO}) and Physiologic Correlation

| | DL _{CO} | MEMBRANE DIFFUSION | ALVEOLAR BLOOD VOLUME | HEMATOCRIT |
|---------------------------------|------------------|--------------------|-----------------------|------------|
| Postprandial * | ↓ | ↔ | ↓ | ↔ |
| Erect posture * | ↓ | ↔ | ↓ | ↔ |
| Valsalva maneuver * | ↓ | ↔ | ↓ | ↔ |
| Cigarette smoking | ↓ | ↔ | ↓ | ↔ |
| Age | ↓ | ↓ | ↔ | ↔ |
| Expiration | ↓ | ↓ | ↔ | ↔ |
| Anemia | ↓ | ↔ | ↔ | ↓ |
| Medical condition | | | | |
| Asthma | ↔ or ↑ | ↔ or ↑ | ↔ | ↔ |
| Bronchitis | ↔ or ↓ | ↔ | ↔ | ↔ |
| Emphysema | ↔ or ↓ | ↓ | ↓ | ↔ or ↑ |
| Diffuse infiltrates | ↓ | ↓ | ↓ | ↔ |
| Restrictive disease (intrinsic) | ↓ | ↓ | ↔ | ↔ |
| Restrictive disease (extrinsic) | ↓ | ↓ | ↔ | ↔ |
| Loss of lung tissue | ↓ | ↔ or ↓ | ↔ or ↓ | ↔ |
| Low cardiac output * | ↓ | ↔ | ↔ | ↔ |
| Pulmonary edema | ↓ | ↓ | ↓ | ↔ |

↑ = increased; ↓ = decreased; ↔ = unchanged.

Immobilization syndrome

- Musculoskeletal system
- Cardiovascular system
- Respiratory system
- Digestive system
- Central nervous system
- Integumentary system

Pulmonary changes

- alterations in lung volumes and ventilation-perfusion parameters
- increased work of breathing
- ventilatory muscle weakness and decreased coordination
- increased atelectasis
- decreased cough effectiveness

Interventions

- Breathing exercise
- Chest toilet
- Inspiratory muscle exercise
- Early ambulation
- Re-assure

Mx of patient with difficult weaning

- Determine the cause
- Correct correctable problems
- development of weaning plan
- Team approach **
- Deal with psychological factors **
- optimizing the timing of weaning trials
- ensure adequate sleep
- preferred posture

Mx of patient with difficult weaning

- Optimizing pulmonary care **
- Nutritional support
- Minerals and electrolytes
- Acid-base status
- General care
- Ambulation **
- Home mechanical ventilation

Optimizing pulmonary care

- ventilator setting
- endotracheal tube size
- tracheostomy care
- bronchodilator therapy
- clearance of secretions
- respiratory stimulants
- respiratory muscle rest
- respiratory muscle training

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Figure 2-23 Factors associated with respiratory muscle fatigue.

- Retained secretions
- Altered patterns of breathing.
- Prolonged supine position.
- Increased abdominal pressure.
- Musculoskeletal or neurologic abnormalities.
- Restrictive defects.
- Surgery procedures such as open heart surgery.

Volume expansion techniques

- Incentive spirometry
- Intermittent positive pressure breathing (IPPB).
- Positive airway pressure (PAP).
 - CPAP
 - BiPAP

Incentive Spirometry

- Incentive spirometry: mimic natural sighing or yawning by encouraging the patient to take long, slow and deep breaths
- Using a device that provides patients with visual or other positive feedback
- Sustain the inflation for a minimum of 3 seconds.

Complications

- hyperventilation
- discomfort secondary to inadequate pain control
- exacerbation of bronchospasm
- fatigue
- Frequency :5-10 breaths per session every hour while awake

Ventilatory muscle training

- Purse-lip breathing
 - Improves ventilation
 - Decreases air trapping in the lungs
 - Decreases the work of breathing
 - Improves breathing patterns
 - Causes general relaxation

Respiratory Muscle training

- Improve strength and endurance
- Increase walk distance by increase in exercise capacity and decrease in dyspnea
- Expiratory muscle training tended to improve cough

Respiratory muscle training

- ความแข็งแรง (respiratory muscle strength)
 - Maximum static inspiratory pressure(MSIP)
 - diaphragmatic strength = maximum inspiratory pressure (MIP)
- ความทนทาน (respiratory muscle endurance) MV, RSBI, Compliance

- แรงการทำใหเกิดแรงดันโดยใช้เครื่องมือ
- แรงกดภายนอก
 - ทำให้ผู้ป่วยต้องใช้แรงประมาณร้อยละ 50 ของ MIP สำหรับในผู้ป่วยที่มีภาวะหัวใจวายแนะนำที่ร้อยละ 25-35
