INSPITARATORY MUSCLE TRAINING

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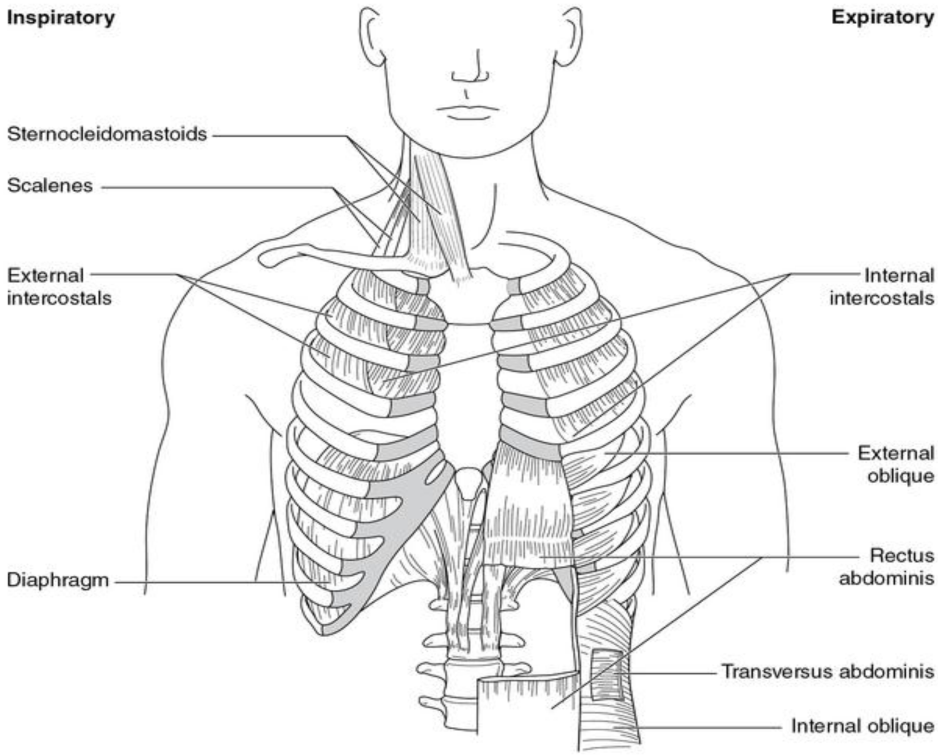
INSPIRATOR MUSCLE TRAINING

INSPIRATORY MUSCLE MECHANICS



Muscles of Respiration

Muscles of Inspiration

Muscles of Quiet Inspiration

Diaphragm

- Main muscle of inspiration
- Central tendon
- Accounts for 70-80% of volume change (quiet breathing)

- Dome shaped
- Optimal length tension characteristics
- Highly efficient (low oxygen consumption)

Intercostal Muscles

- Intercostal externi, intercostal interni and intercostal intimi
- ‘Scissors’ action
- Contraction elevates ribs during inspiration
- Stabilizes chest wall

Scalenes

- Elevate first and second rib during forced breathing.

Muscles of forceful Inspiration

Following muscles increase inthoracic volume during forceful inspiration

Sternocleidomastoid	Elevates sternum and upper ribs
Pectoralis minor	Elevates upper rib
Pectoralis major	Elevates middle ribs and sternum
Serratus anterior	Elevate the ribs

Serratus posterior	Elevating upper ribs and stabilizing lower ribs
Lattissimis dorsi	Elevates ribs

Work of Breathing

- Work is done by respiratory muscles to overcome
  - ➢ Elastic resistance
  - ➢ Non-elastic resistance
    - ✓ Viscous resistance
    - ✓ Airway resistance

Lung Compliance

- Lung compliance is the volume change (lung expansion) per unit pressure change
- It is the distensibility of the lung and the chest wall.

INSPIRATORY MUSCLE FATIGUE

- Muscle weakness and muscle fatigue need to be differentiated.

- In the respiratory system, fatigue is manifested by the inability of the inspiratory muscle to continue to generate the force required to maintain the necessary level of alveolar ventilation to meet the body's metabolic needs.
- Patient who are at risk of developing respiratory muscle fatigue are those in whom energy demand are increased, energy supply are compromised or whose neuromuscular chain of command has been disturbed
- The fatiguing diaphragm may generate sympathetic nervous system activity that restricts blood flow to the limbs.
- The effect of this would be to increase fatigue in the limbs and to intensify the metabolic and sensory events associated with exercise, thus contributing to exercise intolerance.

Causes For Inadequacy Of Respiratory Muscle Function

- Inadequacy of respiratory muscle function can be due to a number of causes, but principally:
- Weakness and or increased fatigability of the respiratory muscles induced structural/metabolic changes in the muscles themselves (e.g. muscular dystrophy)
- Failure of muscle activation by the nervous system (e.g., multiple sclerosis)

- Functional weakness induced by alterations in the mechanics of the respiratory system that induce an increased requirement for muscle force output (e.g., emphysema)
- A combination of these factors (e.g., chronic heart failure).

ASSESMENT OF FATIGUE

Signs Indicative Of Inspiratory Muscle Fatigue

- Tachypnea
- Decreased Tidal volume
- Increased $PaCO_2$ (late sign)
- Bradypnea and decreased minute ventilation

MEASUREMENT OF INSPIRATORY MUSCLE STRENGTH AND ENDURANCE

Maximal inspiratory pressure

- Maximal inspiratory pressure (MIP/ PImax) is the most widely used measure of respiratory muscle strength in patients with suspected respiratory muscle weakness.
- It is determined by measuring upper airway pressure (mouth for outpatients and trachea for intubated or tracheostomized patients) during a maximal voluntary inspiratory effort. The measured pressure is a composite of the pressure generated by the inspiratory muscles and the elastic recoil pressure of the lungs and chest wall.
- The measurement of MIP can be made with an analog or digital pressure manometer.

- Measurements are usually made with patients in a sitting position, with or without nose clips.
- Patients are asked to exhale to RV and then perform a maximal inspiratory effort, sustaining it for 1 to 2 seconds.

Sniff Nasal Inspiratory Pressure

- SNIP measures the joint activity of the diaphragm and other inspiratory muscles and accurately reflects esophageal pressure.
- In both normal subjects and patients with inspiratory muscle weakness the sniff nasal inspiratory pressure (SNIP) provides a reasonable estimate of inspiratory muscle strength.

Inspiratory mouth pressure

- Inspiratory mouth pressure (Pm) is measured with a pressure sensor attached to a mouthpiece or to a tracheal tube.
- It is usually used in three clinical situations. First, it is used as an indirect measure of Pes during a sniff, when esophageal catheters are not available or when esophageal catheter placement is not possible. In this situation, a limitation of Pm is that, for patients, its measurement is more difficult than that of SNIP. Its second use is in ascertaining the correct placement of the esophageal catheter, which is discussed later. Finally, Pm is also used in the measurement of P0.1, which is the pressure generated in the first 100 ms of an inspiratory effort against a closed airway, and it correlates better with the measurement of respiratory drive than with the measurement of MI

Transdiaphragmatic pressure

- Transdiaphragmatic pressure (Pdi) is the difference between gastric pressure (Pga) and Pes (Pdi = Pga − Pes and translates the force generated by the diaphragm rather than by the other respiratory muscles.

Electrical and magnetic phrenic nerve stimulation

- The use of non-volitional tests for measuring inspiratory muscle strength is recommended when patients have difficulty understanding or performing the maneuvers, generating low values during the volitional maneuvers (MIP, SNIP, or Pm); or when there is considerable variation in the measurements, which is probably secondary to different levels of effort.

Diaphragm ultrasound

- Diaphragm dome motion is measured with a (cardiac or convex) low-frequency (3-5 MHz) transducer, which is held against the highest point of the diaphragm (the diaphragm dome).

INSPIRATORY MUSCLE TRAINING

- Inspiratory muscle training is used in pulmonary rehabilitation to increase strength and endurance of inspiratory muscles.

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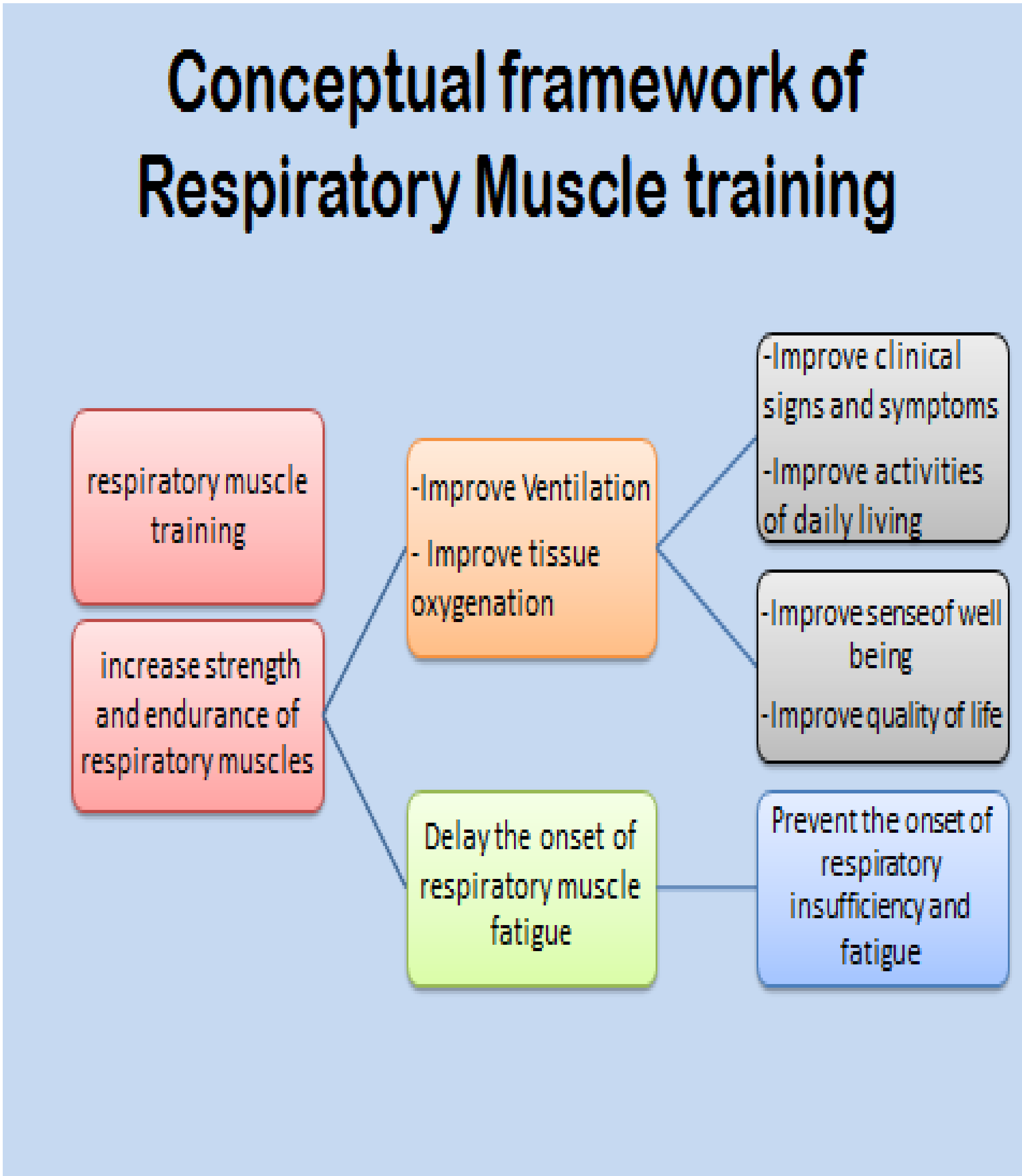
Conceptual framework of Respiratory Muscle training
respiratory muscle training
increase strength and endurance of respiratory muscles
-Improve Ventilation
- Improve tissue oxygenation
Delay the onset of respiratory muscle fatigue
-Improve clinical signs and symptoms
-Improve activities of daily living
-Improve sense of well being
-Improve quality of life
Prevent the onset of respiratory insufficiency and fatigue

Principles of Training

Overload Principle

- To train a muscle to improve its functional ability, the muscle must be subjected to stress greater than its usual load

Specificity

- The training must be directed at developing specific functional attributes

Reversibility

- The training must be maintained or function will revert back to pertaining levels.
- Gains in inspiratory muscle function are lost 12 months after cessation of the IMT program.

INSPIRATORY MUSCLE TRAINING DEVICES

- The purpose of IMT is to improve inspiratory muscle strength and endurance, thereby having a potentially positive effect on symptoms, exercise capacity and health-related quality of life outcomes for people with chronic respiratory diseases.

There are three types or categories of inspiratory muscle trainer:

- Non-targeted inspiratory resistance trainers
- Targeted inspiratory resistive or threshold trainer
- Normocapnic hyperpnoea trainers

Non-targeted inspiratory resistance trainers

- These devices don't provide a target or means of controlling the patient's breathing pattern.
- Without either of these features, it isn't possible to ensure the patient attains the necessary training intensity.
- It small device with a mouthpiece and a circular dial.
- Turning the dial varies the size of the aperture through which the patient is to breathe.
- The smaller the aperture, the greater the intended resistance on inspiration.

Targeted Inspiratory Resistive Trainers

- Targeted inspiratory resistive trainers provide a target intensity for the patient to strive towards.
- Targeted inspiratory resistive trainers provide visual feedback to pace the breathing pattern
- An adjustable resistance is placed in-line at the mouthpiece.

Inspiratory Resistive trainer

The Threshold Trainer

- The Threshold trainer is a small handheld device.
- It includes a mouthpiece and a calibrated spring loaded valve.
- The valve controls a constant inspiratory pressure training load and the patient must generate the inspiratory pressure in order for the inspiratory valve to open and allow inhalation of air.
- The valve is calibrated and can be adjusted according to a percentage of the patient's maximum inspiratory pressure (PImax).

The Threshold inspiratory muscle training device

Normocapnic Hyperventilation Trainer

- The apparatus provides a visual target and uses a rebreathing system with oxygen infusion to maintain constant levels of arterial CO_2 .
- The patient is required to achieve a supernormal target ventilation for 15-20 minutes while of arterial CO_2 is kept constant.
- The training intensity is set at a percentage of the patient's maximum voluntary ventilation
- Not easily available for use of patients.

Recommended Training Protocol For Inspiratory Muscle Training

Mode

- Type of IMT

  Targeted inspiratory resistive trainer or threshold-type trainer.

Frequency

- Number of training sessions per day

  1–2 training sessions per day, depending on patient exercise capacity.

- Number of days per week

  4–6 days of training sessions per week according to patient tolerance.

Intensity

- Percentage of PImax is the most common method for setting the intensity. A range of 30–70 % PImax is described in the literature. A lower initial intensity is recommended for people with severe COPD. Progression: up to 5% per week of PImax as tolerated. Retesting: PImax should be measured at least monthly and training intensity adjusted accordingly.

Parameters To Monitor During Training

- Signs of exercise intolerance

  Blood pressure, heart rate, respiratory rate, distress or inability to tolerate exercise load.

- To avoid hypercapnia

  End-tidal CO_2 . Arterial oxygen saturation, Signs of headache or confusion.

- To avoid inspiratory muscle fatigue

  Dis-coordinated chest wall movement.

  Excessive dyspnoea during training.

  Long-lasting complaints of fatigue after training session.

- To avoid muscle injury

  Signs of delayed onset muscle soreness

  Reduced strength

  Reduced endurance

Effect Of IMT On Respiratory Muscles

- Effect of strength training on inspiratory muscles include increase in number and size of muscle fibers and decrease in degradation

- Effect of endurance training of inspiratory muscles promote an increase in fatigue resistant fibers in diaphragm, increase in metabolic capability of muscle and reduction in susceptibility of muscle fibers to deleterious effect of exercise.

Thus, IMT is useful in many conditions in patients with chronic respiratory diseases or diseases affecting respiratory muscles. Literature indicates the benefits of IMT in improving strength and endurance of respiratory muscles thus leading to reduced dyspnea and improved quality of life.

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