An Update in Lung Expansion and Airway Clearance Techniques

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What does Lung Expansion Therapy do

- Prevents or reverses atelectasis
- Aides in the mobilization of secretions
- Reduces air-trapping in asthma and COPD patients
- Optimizes the delivery of bronchodilator therapy
- Decreases work of breathing
- Improves inspiratory muscle strength
- Increases lung volumes
- Recruitment of collapsed alveoli by increasing FRC
- Creates a positive airway pressure gradient that will prevent premature airway closure and expand collapsed lung regions
Patients who will benefit from lung expansion therapy

- Postoperative patients (highest risk)
- Upper abdominal, thoracic, cardiac surgery
- Acute respiratory failure due to pneumonia
- Post traumatic ARF: Pulmonary contusions, Flail chest
- Neuro-compromised patients
- Heavily sedated patients
- Spinal cord injury
- Patients with reduced lung volumes and ineffective cough resulting from chest wall deformity, such as Scoliosis
- Respiratory muscle weakness or prolonged immobility
- Patients unable to take a deep breath
Traditional Lung Expansion Modalities

Incentive Spirometry (IS) or Sustained Maximal Inspiration (SMI)

- Most widely used form of lung expansion therapy.
- Mimics a natural sigh by encouraging the patient to take a deep breath.
- Helps avoid atelectasis and pneumonia.
- Limitations include poor patient effort due to improper teaching techniques and patient coordination with the IS procedure.
- There has been growing controversy due to the overuse of the procedure.
Traditional Lung Expansion Modalities

Positive Inspiratory Pressure (PIP)

- Better known as Intermittent Positive Pressure Breath or IPPB
- 1st introduced around 1947

Bird Mark-7

Bennett PR-2
Traditional Lung Expansion Modalities

IPPB

- Pneumatic devices that involves the patient triggering the delivery of a positive inspiratory pressure breath.
- Once triggered, the IPPB machine will deliver a positive inspiratory breath to the patient based on the set peak airway pressure.
- Drawback of IPPB is that the patient must create a tight seal around the mouth piece in order for the machine to cycle off.
- Has fallen out of favor in recent years due to Volumes, flow rates, pressures, duration and frequency of therapy, and associated medication have not been standardized for the treatment of any condition.
Newer Lung Expansion Modalities

- Positive Expiratory Pressure (PEP)
  - Fixed orifice flow resistors

[Images of TheraPEP, Ez-PAP, and Threshold PEP]
Patients exhales through a fixed orifice flow resistor.
The patient is taught to exhale actively but not forcefully through the flow resistor.
This positive expiratory pressure (5-25 cmH2O) helps to keep the airways open through exhalation, thus lengthening the expiratory phase.
PEP therapy does not utilize a pressurized gas source, it is dependant upon the expiratory flow rate of the patient.
Can accommodate virtually any patient’s lung capacity.
May be used with a mask or mouthpiece.
May be used with a nebulizer for bronchodilator therapy.
Main limitation is patient cooperation and ability to follow directions.
Traditional Airway Clearance Modalities

- Chest Physiotherapy or CPT
  - Postural Drainage
  - Chest Percussion
  - Chest Vibration
  - Turning/Positioning
  - Deep Breathing Exercises
  - Coughing

- CPT consists of 2 separate mechanisms
  - Mucociliary Clearance
  - Cough Clearance
Patients who benefit from Chest Physiotherapy

- Cystic Fibrosis
- Neuromuscular Diseases
- COPD
- Pneumonia
- Bronchiectasis
- Post Operative
- Adventitious breath sounds suggestive of secretions in the airways which persist after coughing.
- Abnormal chest x-ray that shows signs of consolidation, infiltrates or mucus plugging.
- Any patients unable to clear their own retained secretions.
Traditional forms of Chest Physiotherapy (CPT)

- **Manual CPT**
  - Performed by either hand, palm cups or pneumatic percussor.
  - Requires proper positioning of the patient in order to facilitate secretion removal.
  - The main concern of manual CPT is when placing the patient in trendelenburg, there is a possibility of the patient aspirating.
  - There are new CPT modalities available to us that do not require placing the patient in trendelenburg, thus virtually eliminating the possibility of the patient aspirating.
Airway Clearance Therapy

Manual Chest Physiotherapy Devices

- Palm Cups
- FLUID Flo 2500
- G5 Flimm-Fighter
- Electro Flo 5000
- Vibramatic
Intrapulmonary Percussive Ventilation (IPV)

The patient breathes through a physiological interface called a Phasitron® delivering high flow mini-bursts of air into the lungs at rates of from 100-300 times a minute.

The percussive burst of gas helps loosen and mobilize retained secretions from the lungs.

Can administer bronchodilator therapy.

Can be used with mouthpiece, mask or ventilated patients.

In some circles it is viewed as a superior method of secretion removal over conventional CPT modalities.
High-Frequency Chest Wall Oscillation (HFCHQ)  
- Designed to provide airway clearance through high frequency chest wall oscillations.  
- Consists of 2 components:  
  - Air pulse generator  
  - Inflatable vest or wrap  
- The air pulse generator inflates and deflates the vest rapidly against the chest wall creating HFCHQ.  
- This in effect increase the mobilization of secretions from the smaller airways to the larger airways where they can be removed by either coughing or suctioning.  
- Unlike manual CPT, HFCWO therapy does not require special positioning of the patient, thus eliminating the need to place the patient in trendelenburg and decreasing the risk of aspiration.
High-Frequency Chest Wall Oscillation (HFCHO)

The Vest by Hill-Rom

The SmartVest by Electromed
Advantages of High-Frequency Chest Wall Oscillation (HFCHO) compared to conventional forms of airway clearance:

- Freedom to do other things during treatment, because no special position or breathing techniques are required.
- Treats all lobes of the lung at once, so treatment time is shorter than manual CPT.
- More consistent therapy.
- Clinically proven effective therapy.
- Programmable settings used to adjust to your patients individual treatment needs.
Combined Lung Expansion/Airway Clearance Modalities

- Positive Expiratory Pressure and High Frequency Oscillations
  - Oscillatory fixed orifice flow resistor PEP Therapy
  - aka: Flutter valve

The Flutter

Acapella
Combined Lung Expansion/Airway Clearance Modalities

- Combines PEP therapy with high frequency oscillations.
- This combination allows for both lung expansion and airway clearance in one device.
- Lung expansion is achieved by the patient exhaling through a fixed orifice flow resistor creating a positive expiratory pressure.
- Airway clearance is achieved by vibrating the large and small airways thinning and dislodging secretions facilitating mucus clearance.
- Can accommodate virtually any patient’s lung capacity.
- May be used with a mask or mouthpiece, or Nebulizer.
- The main limitation is patient cooperation and ability to follow directions.
Pneumatic Lung Expansion/Airway Clearance Modalities

MetaNeb

- One of the newest lung expansion airway clearance devices.
- Combines 3 therapies in one device
  - Lung Expansion (CPEP)
  - Airway Clearance (CHFO)
  - Medication Delivery
- MetaTherapy consists of alternating between CPEP and CHFO.
- MetaTherapy maximize treatment efficacy and minimize clinician time.
Lung Expansion Therapy

Pneumatic Lung Expansion/Airway Clearance Modalities

MetaNeb

- Consists of a disposable single patient use circuit.
- Can be used with virtually any patient, including those patients with artificial airways and neuro-compromised patients.
- Has been FDA approved for use on mechanically ventilated patients using the CHFO mode as a airway clearance modality.
- Therapy:
  - 2.5 min. in CPEP → 2.5 min CHFO → 2.5 min CPEP → 2.5 CHFO
  - Total therapy time = 10 min
  - During the 10 minute treatment, the patient has received lung expansion therapy, airway clearance therapy and bronchodilator therapy in one modality.
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Conclusion

- Airway clearance and Lung expansion therapy is a vital tool to aid in the mobilization of secretions, improve gas exchange, help prevent infection, prevent or reverse atelectasis as well as decreasing hospital stay.

- Not everyone will use the same airway clearance and lung expansion technique but it is important to realize its importance.

- Remember being proactive is the key, we must tackle the problem head on to stay ahead of the game.
THE END

Any Questions?