adjunctive respiratory therapies

general

- Most critically ill patients are unable to effectively clear secretions that accumulate in the central and peripheral airways. This can be due to factors such as:
(i) increased secretion production,
(ii) impaired cough reflex,
(iii) weakness, and
(iv) pain.
- Adjunctive respiratory therapy addresses many of these concerns to prevent and treat respiratory complications that are encountered in the critically ill patient.

general techniques

Methods to Improve Pulmonary Mucociliary Clearance
Chest physiotherapy
Percussion
Postural drainage
Chest vibration
Suctioning
Oropharyngeal suctioning
Nasopharyngeal suctioning
Endotracheal suctioning
Continuous lateral rotation
Positive expiratory pressure devices
Forced expiration
Closed chest oscillation
Bronchoscopy
Manual hyperinflation
Bronchodilators
Mucoactive agents

Methods to Improve Lung Expansion
Deep breathing
Incentive spirometry
Intermittent positive ventilation
Optimum body position
Methods to Improve Oxygenation and Ventilation
Inhaled vasodilators
Nitric oxide
Prostaglandins
Helium-oxygen (heliox)

aerosol therapies

general:
- The aerosolization of medications is an effective method for drug delivery directly to lungs. The two most common methods of delivery are via nebulization or via metered-dose inhalers (MDIs).
- The theoretical advantage of this form of therapy includes direct delivery and activity at the site of pathology and the ability to deliver high concentrations with minimal systemic absorption and toxicity.
- The most common aerosolized therapy is the administration of bronchodilators. Other medications that can be administered directly to the lungs include corticosteroids, antibiotics, antifungal agents, surfactant, mucolytic agents, and saline.

(i) Nebulization:
- the process of using a high flow of gas (usually 6 to 8 L/min) to produce small respirable particles of the liquid medium containing the medication of interest.
- in the spontaneously breathing patient approximately 10% reaches the lower respiratory tract/small airways. In mechanically ventilated patients, 1% to 15% is delivered to the lower respiratory tract.

(ii) MDIs
- pressurized canisters with the drug suspended in a mix of propellants, preservatives, and surfactants.
- Factors that influence the efficacy of aerosol delivery in the mechanically ventilated patient include:
1. Position of administration in the circuit: the MDI should be closer to the endotracheal tube at the Y-piece with a chamber, compared with a pneumatic nebulizer, which should be at least 30 cm from the Y-piece.
2. Humidification: this can decrease aerosol delivery to the respiratory tract because of greater deposition in the ventilator circuit. Higher doses may be required to achieve the desired effect.
3. Timing of delivery: the aerosol should be delivered during the inspiratory phase to maximize drug delivery.
4. Flow rates: slower inspiratory flow rates (and therefore longer inspiratory time) increase delivery of nebulized medications. A decelerating flow pattern can also increase delivery to the lower airways.
5. Tidal volumes: larger tidal volumes greater than 500 mL ensure optimal delivery.
6. Endotracheal tube size: tube sizes less than 7.0 mm reduce delivery.
7. Density of inhaled gas: low-density gases such as helium-oxygen mixtures increase deposition to the lower airways by increasing laminar flow and producing smaller respirable particle size.

Bronchodilators:
- Bronchodilators are the most frequently administered aerosolized therapy in the critically ill patient and are generally well tolerated in the critically ill patient.
- In mechanically ventilated patients, the use of nebulization is either equally as good as or less effective than an MDI with a spacer. MDI administration has the advantage of easier use without the risk of bacterial contamination and need for adjustment of flow rates.

Antibiotics
- Theoretical advantages of aerosolized antibiotics include direct therapy at the site of infection at higher concentrations with a lower risk of systemic absorption and side effects.
- The role for aerosolized or instilled (via the endotracheal tube) antibiotics as an adjuvant for the prevention or treatment of pulmonary infections in the ICU remains to be defined with better clinical studies.

Mucoactive agents:
- Induce bronchospasm and probably have no role

Adrenaline:
- Racemic epinephrine has been used as a therapy for acute upper airway obstruction secondary to inflammation

methods to improve lung expansion

- Atelectasis is a common complication encountered in the critically ill patient. This is often secondary to prolonged supine body position and retained secretions obstructing airways.
- Lung expansion techniques mimic normal sigh maneuvers to help reverse and prevent atelectasis and include:
(i) Deep breathing and incentive spirometry
(ii) Intermittent positive-pressure breathing

methods to improve mucociliary clearance

1. Percussion:
- percussion of the chest can aid in secretion clearance.
- It is performed by clapping cupped hands over regions of the thorax that are affected in a rhythmic fashion or using mechanical devices that mimic the same action.

2. High-frequency chest compression (HFCC):
- relies on rapid pressure changes to the respiratory system during expiration to enhance movement of mucus in the peripheral airways to the central airways for clearance. This method employs a vest worn by the patient that is attached to an air-pulse generator. It is difficult to apply this technique to most critically ill patients because the size of the vest covering the thorax may prevent adequate monitoring.

3. Manual hyperinflation
- Typically, the lungs are inflated slowly to one and one-half to two times the tidal volume or peak airway pressures of 40 cm H2O as measured by a manometer.
- It is held at end inspiration with an inspiratory pause to allow for filling of alveoli with slow time constants.
- The goal of manual hyperinflation is to recruit atelectatic lung regions to improve oxygenation and improve clearance of secretions.
- Contraindications include hemodynamic compromise and high intracranial pressure.
- There is also a risk of barotrauma because of preferential inflation of open lung regions that are highly compliant compared with collapsed regions.

4. Positioning & mobilization:
- Mobilization of patients in the ICU either through active or passive limb exercises may improve overall patient well-being and in the long term may lead to better patient outcomes.
- Positioning also plays an important role. Position of the patient with the head of the bed elevated at least 30 degrees significantly reduces the risk of aspiration and ventilator-associated pneumonia.
- Positioning of selected individuals with unilateral lung disease on their side with the affected side up can lead to improved ventilation-perfusion matching (by gravitational increased perfusion to the dependent "good" side).
- If atelectasis secondary to retained secretions is the cause, having the affected side up leads to postural drainage.

5. tracheal suction
- Used in conjunction with other techniques to mobilize secretions from the peripheral airways to the central airways, suctioning is an effective way of removing secretions to improve bronchial hygiene.
- Because of the anatomic arrangement of the large central airways, the suction catheter most often enters the right mainstem bronchus compared with the left mainstem bronchus.
- Complications with suctioning include hypoxemia, especially in the setting of a ventilator disconnect, increased intracranial pressure with vigorous stimulation of the airways, mechanical trauma to the trachea, and bacterial contamination.
- All patients should be preoxygenated with 100% oxygen for 1 to 2 minutes before suctioning.
- To reduce the risk of agitation, the patient should be informed before tracheal suctioning is performed. The suctioning should be limited to 15 to 20 seconds. The suction port on the catheter should be opened and closed intermittently and not closed for more than 5 seconds at a time.

6. Continuous rotational therapy
- extends the practice of regular 2 hourly repositioning of patients from one side to the other by placing the patient on a bed that moves to pre-programmed angles on a more frequent basis or through the use of air mattresses that deflate alternatively from side to side to provide the continuous postural position changes.
- Most studies on various patient populations demonstrate a lower incidence of nosocomial pneumonia or atelectasis but no overall improvement in other clinically significant outcomes such as duration of mechanical ventilation, length of stay in the ICU, or mortality.

7. Assisted coughing
- Techniques include "huffing" in the setting of an open glottis where in expiration the patient forcibly exhales quickly several times. Other maneuvers include abdominal or thoracic compression on expiration to generate high intrathoracic pressures mimicking a cough.

8. Positive expiratory pressure therapy (PEP)
- involves the use of a facemask or mouthpiece that provides a resistance to airflow of 10 to 20 cm H2O on expiration. After repeating this maneuver a number of times, mucus in the peripheral airways is mobilized and moved toward the larger airways to be coughed or expelled with other techniques.

9. Bronchoscopy
- Fiberoptic bronchoscopy has the advantage of providing direct visualization of the airways and permits suctioning of specific segments where secretions may be retained, causing problems such as atelectasis.
- Bronchoscopy can be considered as an adjunctive therapy for the treatment of atelectasis or removal of secretions.
- Being an invasive procedure, bronchoscopy is not without risks, including complications associated with sedation required for the procedure, transient increases in ICP, hypoxemia, and hemodynamic consequences/arrhythmias.