



Clearing the Air

Airway Clearance in the Hospital and Home

Introduction

- Dan Dunmire is a Registered Respiratory Therapist and the Director of Clinical Services at Movair, an Austin, TX based medical device company. Beginning at UPMC Presbyterian in Pittsburgh, he spent ten years at the bedside in adult critical care in cardiac and neurological ICUs. Dan has also worked in the DME industry. Upon the launch of the LUISA ventilator to the US market, he took on the role of lead clinician at Movair. A lover of all things adrenaline-producing, his hobbies include skydiving, off-road driving, ziplining, and anything else that most “normal people” think is crazy. Dan lives with his wife and three kids in the Pittsburgh area.

Objectives

By the end of this presentation, attendees should be able to:

- Discuss the history of airway clearance
- Understand the different methods available for therapy
- Review physiological airway clearance
- Identify patients who may benefit from therapy in the home
- Understand the challenges of airway clearance outside of the hospital

Airway Clearance Timeline

Manual CPT- Tale as old as time

Autogenic drainage- Developed in 1967

PEP/OPEP- Late 1970s, Switzerland

Interpumonary Percussive Ventilation (IPV) ~1985

Biphasic Cuirass Ventilation – Late 1980s

Air bladder vest- 1988

In-exsufflator (Cough Assist)- 1993

Portable, mechanical vest- Late 2000's

Airway Clearance Modalities

- Airway clearance devices are available in many different variations, and can be loosely classified as either manual or mechanical:

Manual



- ☐ Manual CPT
- ☐ Autogenic Drainage
- ☐ Handheld Devices

Mechanical



- ☐ Vest Therapy
- ☐ IPV/BCV
- ☐ Mechanical Cough Assist

Mechanisms of Action

Regardless of device classification, there are four ways that airway clearance devices work to aid the removal of secretions. These are:

Increase of expiratory flow

Oscillation of the airflow

Increase in lung volumes

Supplementing or simulating the cough reflex¹

1) S. Belli, et al. Airway Clearance Techniques: The Right Choice for the Right Patient. Frontiers in Medicine. 8. 2021.

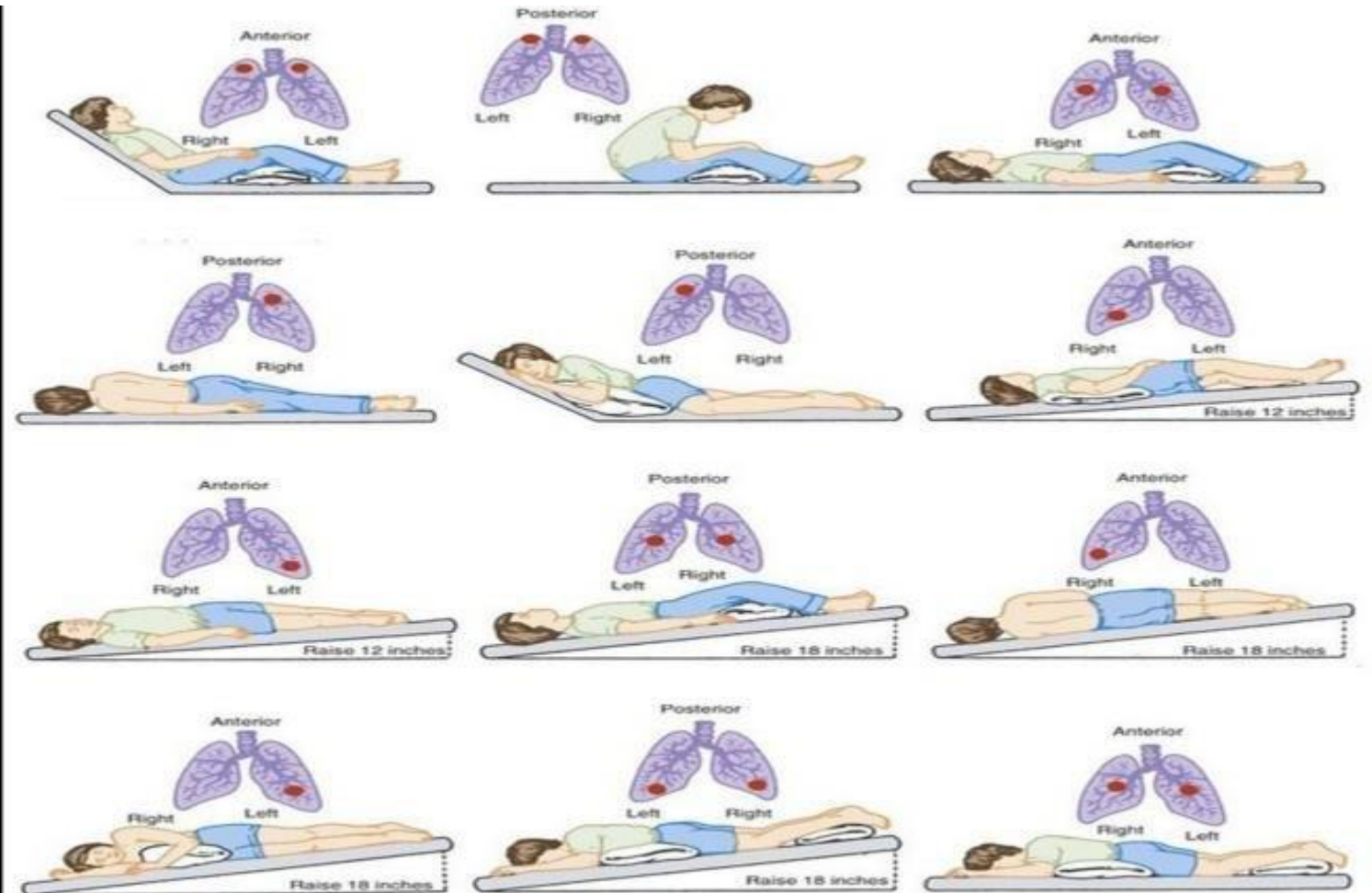
Manual CPT

- First described in literature in 1915, manual CPT can be accomplished by hand, with percussion cups, or with a mechanical percussor.
- This “gold standard” therapy has driven many of the innovations to follow and does show short-term benefits to patients with retained secretions, although long-term benefits are more difficult to prove.
- Manual CPT has historically been coupled with postural drainage for enhanced secretion clearance.

Postural Drainage

- Postural drainage is a patient positioning technique where lobes of the lungs are sequentially cleared of secretions.
- This is accomplished by changing the patient's physical position, rolling, and isolating different lobes of the lung.
- Manual CPT is then applied to those areas of the lungs, assisting in secretion clearance.

Postural Drainage Positions



Autogenic Drainage

First developed by Jean Chevaillier in 1967, AD is a complex system of breathing control designed to loosen and mobilize secretions.¹

AD is broken down into three phases: the “un-sticking” phase, the collective phase, and the evacuation phase.

This is a method of airway clearance that requires extensive training, breathing control and mobilization of secretions.

1) P. McCormack, et al. Autogenic Drainage for Airway Clearance in Cystic Fibrosis. Cochrane Database Systematic Review. Oct. 2017.

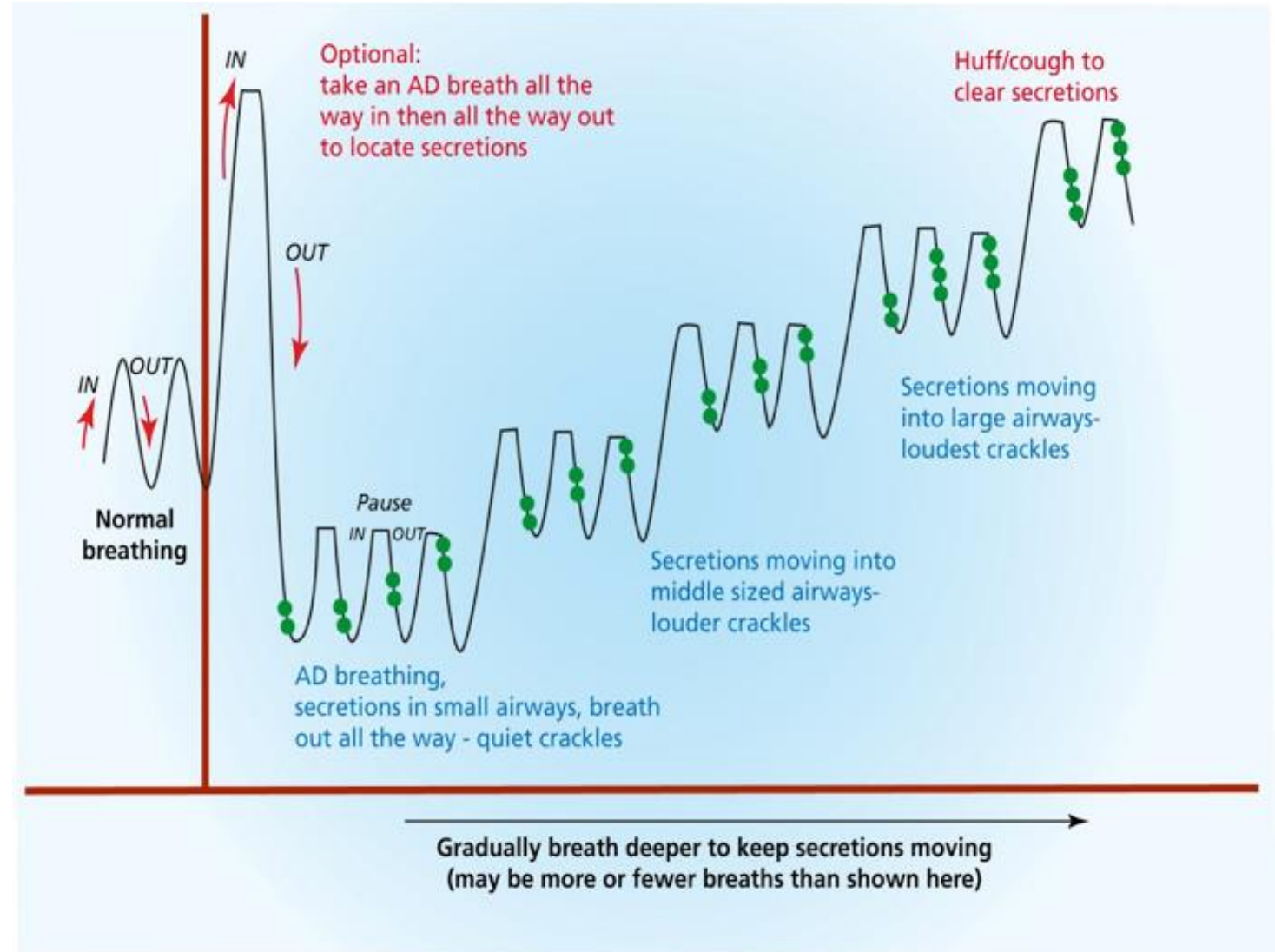
Autogenic Drainage

Autogenic drainage is a complex technique that requires a steep initial learning curve

Pros: Can be individualized for different patients, no equipment needed, huff coughing may be more comfortable than forced coughs

Cons: Steep learning curve, complex technique, not statistically more effective than less complicated techniques.

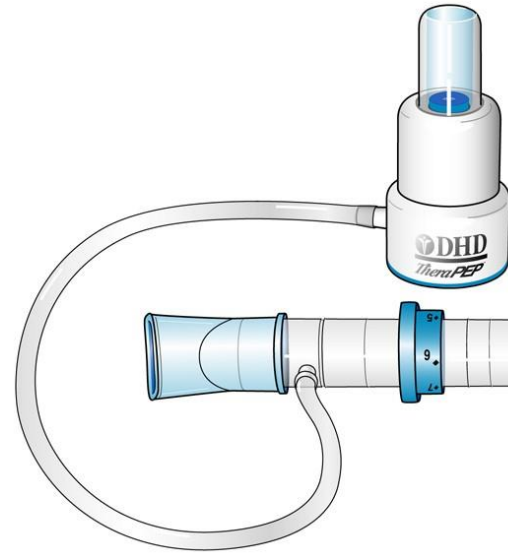
Autogenic Drainage Example



Handheld Devices

- Handheld airway clearance devices are utilized both in and outside of the hospital, and come in different shapes and sizes.
- Some handheld units can be connected to a nebulizer for the addition of bronchodilator or mucolytic treatments.
- Handheld devices are billed under code E0484, and a one-time purchase for patients in the home.

Handheld Devices



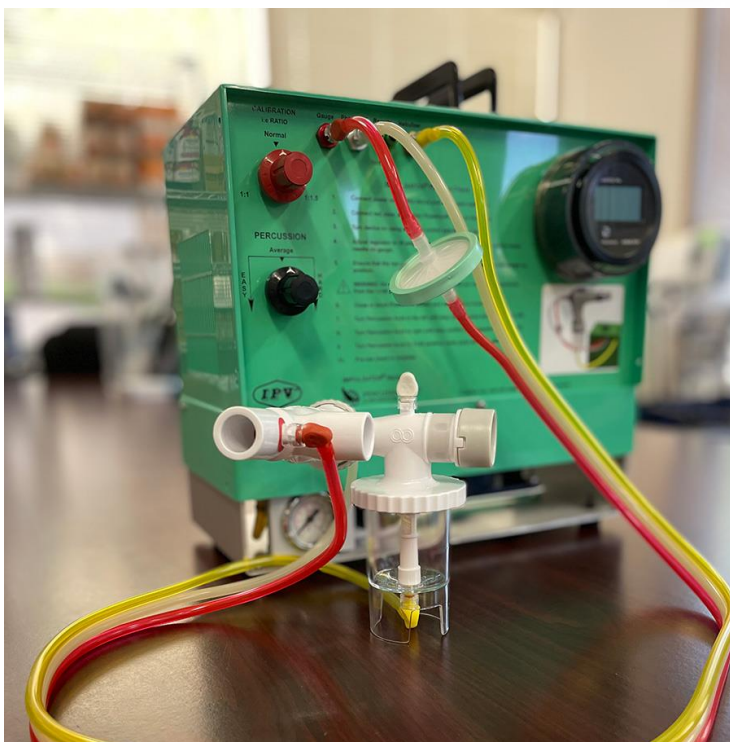
IPV/BCV

Intrapulmonary Percussive Ventilation (IPV) and Biphase Cuirass Ventilation (BCV) are less common modes of airway clearance

While IPV uses high frequency micro-pulses to get behind and loosen secretions,¹ BCV provides rapid negative pressure cycles to help achieve the same goals. With either method, the goal is to mobilize secretions or assist in moving mucus from the small airways to larger airways, where they can be expectorated.

1) G.Reychler, et al. Intrapulmonary Percussive Ventilation as an Airway Clearance Technique in Subjects With Chronic Obstructive Airway Diseases. Respiratory Care. May 2018, 63 (5) pgs 620-631.

IPV/BCV



Vest Therapy

While it is safe to say that manual CPT was the first form of airway clearance, mechanical secretion removal techniques proliferated in the 1980s, when The Vest airway clearance system was created in Minneapolis, MN, and IPV/BCV therapies arrived on scene.

Since the invention of The Vest, other mechanical airway clearance systems have been manufactured. These are typically separated as air bladder style or portable designs, although they operate under the same principles.

Vest Designs

Stationary Air Bladder



Portable



Mechanical Insufflation- Exsufflation

- Mechanical insufflation-exsufflation, more commonly known as cough assist, works by applying a degree of positive pressure, followed by a degree of negative pressure and then a pause.
- The theory is much the same as other airway clearance devices- positive pressure moves air behind the secretions, while negative pressure (in this case, machine generated) helps to move the secretions out of the airway.

Cough Assist Devices



Reviewing Pulmonary Mechanics

What is Normal?

Pulmonary Mechanics

The basic physiology of secretion clearance is straightforward, but worth reviewing for our conversation today:

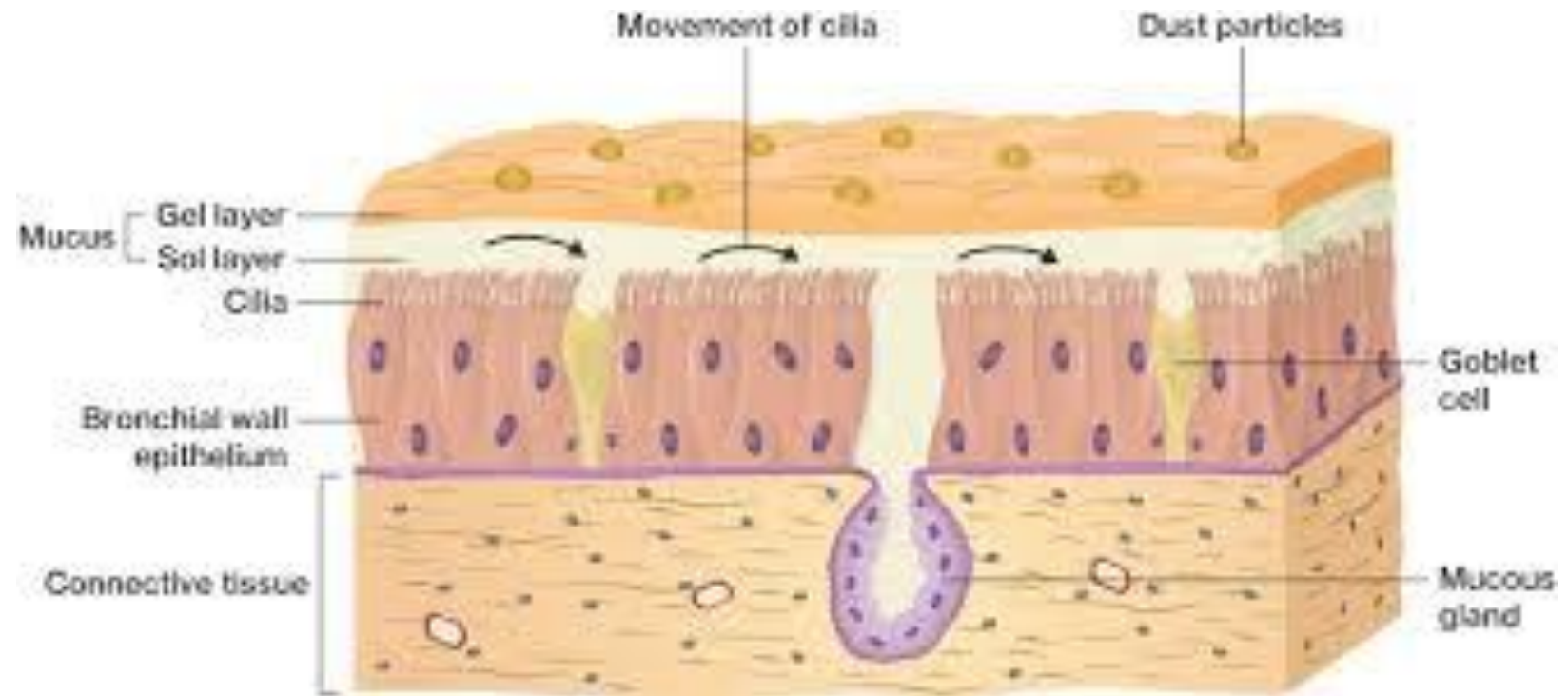
- In a patient's alveoli, macrophages engulf dangerous particle and destroy them.
- In healthy patients, secretions move from the small airways to the larger upper airways. This occurs due to the movement of the cilia, which beat in wavelike motions, mobilizing secretions to where they can be coughed out.
- In patients with impaired pulmonary mechanics, any part of this system can break down, causing increased secretions, pooling, and increased risk of infection.

1) B. Buttons. Structure and Function of Mucus Clearance System of the Lung. Cold Spring Harb Perspect Med. 2013 Aug; 3(8): a009720.

Components of a Healthy System

- The mucociliary escalator consists primarily of:
- Goblet cells- Columnar epithelial cells secreting mucus
- Mucus- Made up of a thicker gel layer and thinner sol layer, surrounding the cilia
- Cilia- Small, hairlike projections that beat in a wavelike motion to move mucus toward the pharynx

Mucociliary Transport



Impaired Mucociliary Clearance

- There are many diseases that may affect proper clearance of secretions. These include:
- Chronic respiratory diseases
- Diseases of hypersecretion
- Neuromuscular disorders
- Patients with ineffective cough reflex

Disease States and Treatments

The Right Therapy for the Right Patient

Devices by Disease State

- Depending on the disease state causing impairment, the devices used to provide airway clearance can be wide-ranging.
- If a patient is able to participate in therapy, handheld devices may help to mobilize secretions.
- If patient's disease is more involved, more advanced airway clearance may be necessary.
- Autogenic drainage may be useful in some patients, if they can actively participate.
- Manual CPT and AD can be used in absence of more advanced equipment.

What is Appropriate?

Because of the vast number of devices, the decision of what device for which patient can be difficult. It may help to ask:

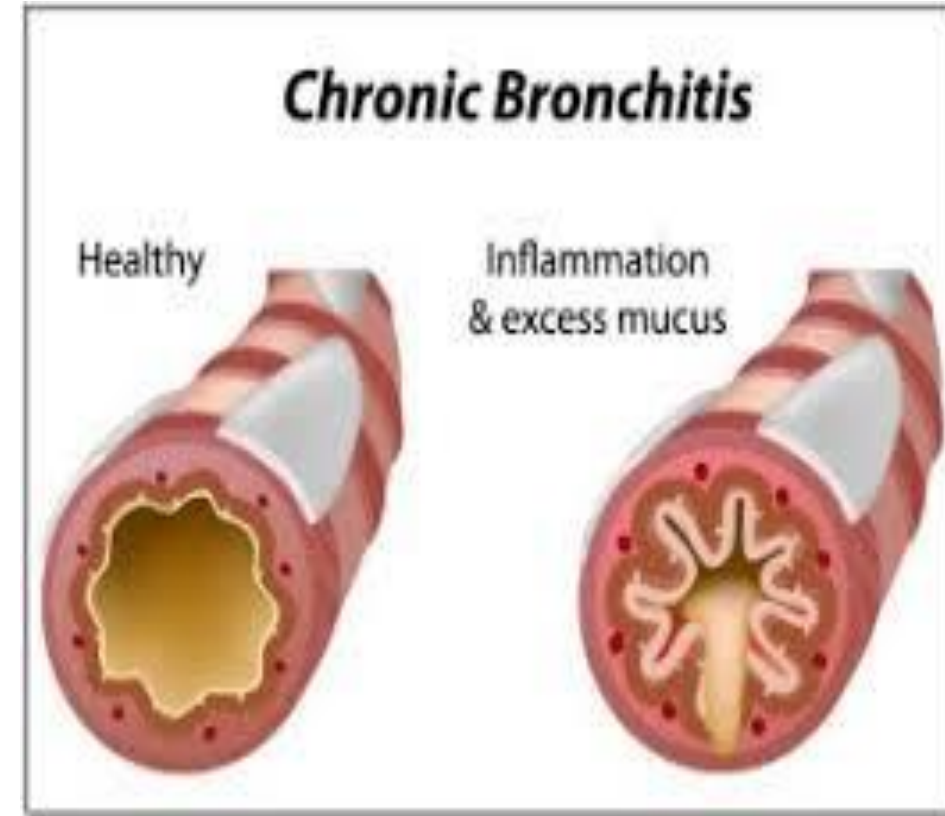
- **What are my goals for this patient?** Are we looking to move secretions from the peripheral airways? Does the patient have an absent or diminished cough reflex?
- **Is the patient an active participant?** Neuromuscular disease, quadriplegia, age, MVA, etc can cause patients to be unable to participate, leading to a more advanced device.

COPD, Chronic Bronchitis

- In patients with chronic respiratory disease, a number of options may be useful.
- Front line devices are often self-use, such as flutter valve, PEP or Acapella devices.
- If a patient has progressing or more severe disease, vest therapy, manual CPT, etc may be useful.

COPD/Bronchitis

- Particularly when COPD is caused by chronic bronchitis, pooling of secretions and excess inflammation may lead to the need for airway clearance.
- Increased mucus production also increases infection risk, prioritizing the need for appropriate therapy.



Mucous Hypersecretion

- In diseases such as cystic fibrosis, bronchiectasis and other pulmonary impairments, patients may create too much mucus, or mucus may be too thick for cilia to move effectively (such as in cystic fibrosis.)
- Another potential problem is loss of smooth muscle tone, causing secretions to accumulate in pouches in the airway, as in bronchiectasis.
- These patients can be treated both pharmacologically and with airway clearance devices such as handheld devices and vest therapy. Manual CPT/AD may also be options.

Bronchiectasis

- Typically, handheld devices, cough training, and vest therapy can be prescribed for patients with bronchiectasis in the home, but certain procedure must be followed.
- Patients are required to try and fail handheld devices or other therapies prior to being prescribed a vest.¹
- Bronchiectasis **must** be confirmed by CT scan, and patients must also exhibit one of the following:
 - a) Daily productive cough for at least 6 continuous months; or
 - b) Frequent (i.e., more than 2/year) exacerbations requiring antibiotic therapy.

1) High Frequency Chest Wall Oscillation Devices- Medicare LCD, CMS.

Neuromuscular Disease

- In patients with neuromuscular disease, muscle or nerve impairment may prevent the proper removal of secretions.
- Due to muscle weakness, impaired gag/cough, etc, patients may be prone to frequent infections.
- Mechanical insufflation-exsufflation (cough assist) may be useful to help move secretions, either via mask or via tracheostomy.

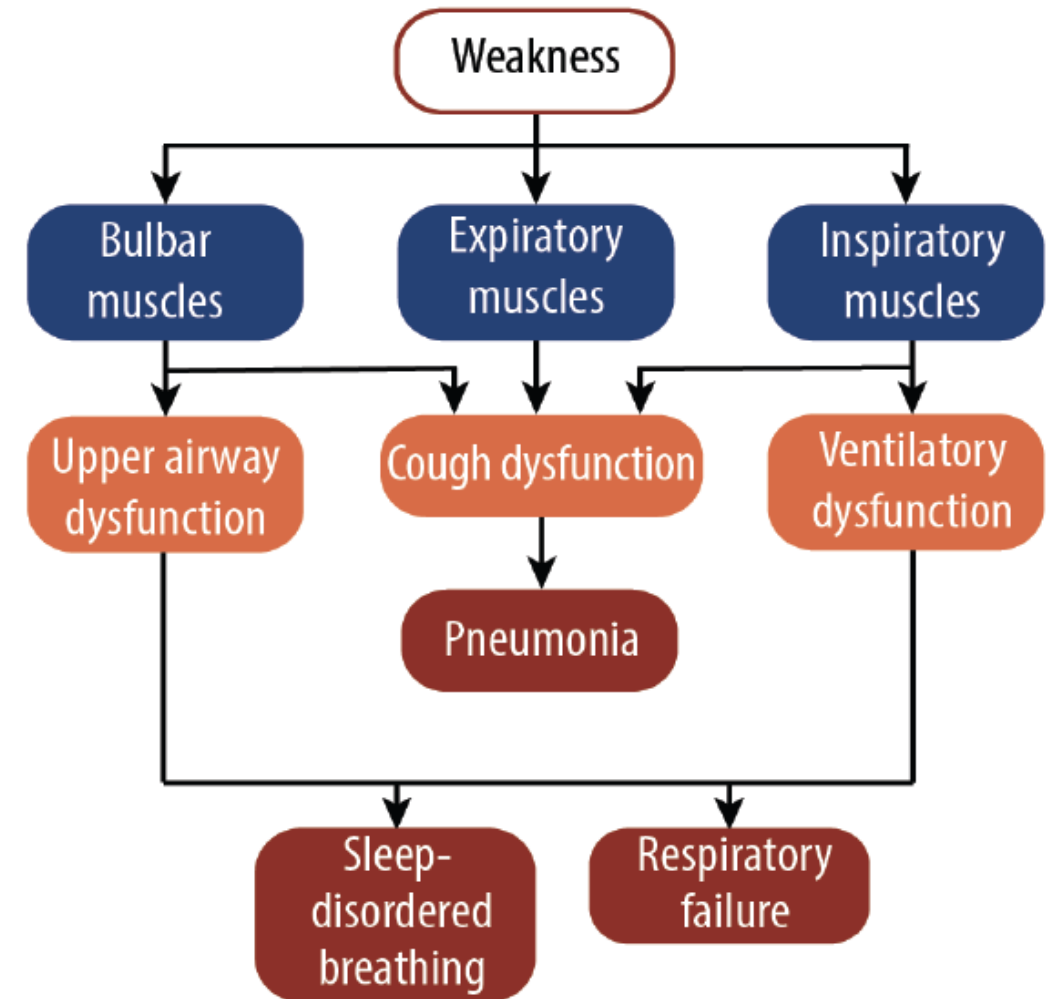
Neuromuscular Patients

- In this subset of patients, whether due to progressive disease or traumatic injury, artificial airways are often present.
- Managing secretions with an invasive airway present is more straightforward and can often be accomplished by direct suction.
- When a gag or cough reflex is impaired or absent, cough assist devices (MI-E) can be used to simulate a cough and move secretions to a point in the airway where they can be removed.
- When a cough reflex is present, vest therapy is often useful to move secretions from the small to large airways, and suction is less necessary.

Muscle Weakness

Since different disease processes target different muscles, airway clearance regimens cannot take a one-size-fits all approach.

Inspiratory muscle dysfunction may be aided by ventilation, while cough stimulation and enhancement techniques may help treat expiratory muscle impairment.¹



1) H. Metjian, et al. Respiratory Therapy for Neuromuscular Disorders. The Neurology Hub. Jul/Aug, 2022.

Hospital vs. Home

- As with other practices in respiratory care, the differences between care in the hospital and in the home can be stark.
- Airway clearance in the outpatient setting is regulated by diagnosis codes, qualification and insurance company coverage.
- Depending on the diagnosis, certain types of treatments may or may not be covered.
- Documentation plays a key role in homecare. Testing, patient's H&P and progress notes written by physician's are required before equipment can be authorized and dispensed.

Conclusion

- While there are many different types of secretion clearance devices available (and this is not a comprehensive review,) there are important considerations when deciding what to use.
- Manual techniques typically require more initial education and caregiver participation, but can be used in the absence of equipment.
- Self-use devices and mechanical airway clearance remove certain barriers to effective treatment.
- There are a number of chronic respiratory disease processes that have an increased secretion load or impaired clearance.
- As with other practices in respiratory care, challenges exist transitioning effective therapy from the hospital to home.