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RESPIRATORY THERAPIST TECHNIQUES: IMPROVING LUNG HEALTH AND FUNCTION

Ayidh Mohammed Alotaibi[1]
[1] Corresponding Author, Respiratory Therapist,
Aid-ksa1@hotmail.com, KFMC, Riyadh, SA

Abstract

Respiratory medicine comprises diseases that affect the lungs and airways. Common respiratory diseases include asthma, chronic obstructive pulmonary disease, and pneumonia. Currently, respiratory diseases assume a high economic weight in developed countries, leading to high hospital admissions and deaths/year (Moreira et al., 2022). In this context, epidemiological studies have shown that the presence of co-morbidities increases the severity of COVID-19 illness and the risk of critical clinical status. In patients with chronic respiratory diseases, and especially these at a higher degree, COVID-19 represents a greater risk of critical disease status. Globally, countries with older populations and high rates of respiratory diseases have needed a proportionately greater number deaths due to COVID-19. Pulmonary rehabilitation is an evidence-based, multidisciplinary, comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have a low health status. It entails a system of exercises, definition of care protocols, health education, and nutritional guidance that aims to improve patient awareness, improve respiratory function, and promote/maintain airway permeability, achieving in this way, the reduction of complications, length of hospital stays, mortality rates, re-admission risks, improvement of vital signs, oxygen saturation, blood gas values, as well as improvement of patients' daily activities ability and quality of life. Respiratory physiotherapy is a branch of physiotherapy that deals with the prevention and treatment of respiratory diseases through the application of physiotherapeutic techniques. This study presents an overview of techniques used in respiratory physiotherapy, focusing on promotion and maintenance of airway permeability, lung hygiene, increasing/normalizing lung functionality, and improving lung health for pediatric and adult patients (Mane & Memushaj, 2018). Pathologies that most require these techniques are: cystic fibrosis, broncho-pulmonary dysplasia, chronic obstructive pulmonary disease, pneumonia, acute respiratory distress syndrome, asthma, restrictive respiratory diseases, post-surgery treatments, lung transplants, and others. Respiratory physiotherapy is a technique that can be used in hospitals, polyclinics, and in the home environment. Usually, it is performed by certified physiotherapists trained in this field. The goals of respiratory physiotherapy are, among others: promoting/maintaining airway permeability to prevent airway obstruction and accumulation of secretions; promoting drainage of secretions from the lungs and airways; normalizing breathing in terms of frequency, depth, cycle, and rhythm; increasing the functionality of the respiratory system in terms of improvement and normalizing the vital capacity of the lungs; increasing oxygen saturation levels in the blood; preventing/reducing the effects of respiratory physiopathology and improving the general condition of the patient. Respiratory physiotherapy techniques have vital

importance in the treatment of pediatric patients with respiratory problems. These techniques are effective in improving the clinical condition of patients, reducing the number of days of treatment in hospitals and improving respiratory parameters.

Keywords

Pulmonary rehabilitation, Lung transplantation, Breathing exercises, Respiratory muscle training, Inspiratory muscle training, Exercise capacity. (Muelas-Gómez et al., 2023) Currently, respiratory diseases assume a high economic weight in developed countries, leading to high hospital admissions and deaths/year. In Spain alone, more than 40,000 deaths/year (Moreira et al., 2022) due to chronic obstructive pulmonary disease (COPD). It is at this point that pulmonary rehabilitation has assumed a priority need in society. Pulmonary rehabilitation consists of a set of medical, therapeutic and educational interventions aimed at improving patient awareness, and hence quality of life, while reducing the risk of complications, length of hospital stays, mortality rates, re-admission risks, etc. In view of the current COVID-19 pandemic, this patient profile has been expanded since severe infection by this virus most commonly leads to a series of impairments–mostly respiratory–which require pulmonary rehabilitation at all phases of recovery.

1. Introduction to Respiratory Therapy

Respiratory therapists are healthcare professionals who specialize in treating people with lung diseases and other conditions that affect breathing. Some of the common conditions they treat include chronic obstructive pulmonary disease (COPD), asthma, cystic fibrosis, bronchitis, pneumonia, and respiratory distress syndrome. Respiratory therapists work in a variety of settings, including hospitals, outpatient clinics, rehabilitation centers, and patients' homes (Moreira et al., 2022). Many respiratory therapy departments in hospitals offer advanced treatments and diagnostic procedures. Respiratory therapy is a medical treatment that alleviates or cures respiratory problems. Healthcare professionals trained to implement respiratory therapy treatments may be respiratory therapists, physicians, physician assistants, or nurses. This text will focus on techniques used by respiratory therapists that anyone can learn to perform at home. For people with chronic lung diseases, respiratory therapy is essential in ensuring the health of lungs and airways (Mane & Memushaj, 2018). However, many procedures used in respiratory therapy can be performed at home, either by caregivers, family members, or the patients themselves. This text aims to educate patients and caregivers on the most commonly used procedures in respiratory therapy so they can perform them at home.

1.1. Definition and Scope of Respiratory Therapy

Respiratory therapy, also referred to as lung therapy or breathing therapy, encompasses a variety of approaches aimed at improving the health and function of the lungs. These procedures may be self-administered or carried out under the supervision of a medical professional, such as a respiratory therapist. The procedures typically involve the management, treatment, control, education, and preventive care of individuals with respiratory deficiencies or abnormalities. Inspired by the design of cardiopulmonary rehabilitation programs, lung health programs are being implemented across Canada as a proactive intervention for individuals at risk of developing chronic lung disease (Mane & Memushaj, 2018).

Respiratory therapy can entail a variety of methods tailored to address specific lung concerns. For asthma patients, breathing exercises can help manage symptoms and alleviate anxiety. Post-surgery patients may require respiratory therapy to avoid the risk of pneumonia and other complications. Certain individuals, such as those with cystic fibrosis, bronchectasis, or chronic obstructive pulmonary disease (COPD), may undergo respiratory therapy to clear mucus buildup in the lungs. In some cases, respiratory therapy can be effectively combined with medications to treat lung conditions.

2. Anatomy and Physiology of the Respiratory System

The respiratory system is a complex network of structures that work together to facilitate the exchange of gases between the body and the environment. This system is responsible for delivering oxygen to the body's tissues and removing carbon dioxide, a waste product of metabolism. The respiratory system can be divided into two main parts: the upper respiratory tract and the lower respiratory tract. The upper respiratory tract includes the nose, nasal cavity, sinuses, and pharynx, while the lower respiratory tract consists of the larynx, trachea, bronchi, bronchioles, and lungs.

The lungs are the primary organs of the respiratory system. They are located in the thoracic cavity and are protected by the rib cage. Each lung is divided into lobes, with the right lung consisting of three lobes and the left lung having two lobes. Within the lungs, the bronchi branch into smaller bronchioles that end in tiny air sacs called alveoli. Alveoli are surrounded by a network of capillaries, which allow oxygen and carbon dioxide to diffuse between the air and the blood. The exchange of gases in the lungs is driven by differences in partial pressure between the air in the alveoli and the blood in the capillaries (A. Hutchison et al., 2013).

2.1. Overview of the Respiratory System

The respiratory system is the organ system that enables breathing in which oxygen is transferred to and carbon dioxide is removed from the blood and body tissues. The basic unit of the respiratory system is the lung, which is a sac-like structure with highly vascularized epithelium folded in a way that increases the exchange surface area. Air travels through the respiratory tract that consists of various conducting and respiratory structures (A. Hutchison et al., 2013). The conducting structures humidify and warm the air and filter out harmful particulates. The respiratory structures contain the gas exchange surface. In mammals, the respiratory bronchioles are the smallest conducting airways that also contain alveoli, the terminal air sacs for gas exchange. Each lung consists of multiple lobes, which consist of multiple lobules containing branched bronchioles and alveoli. Alveoli are surrounded by a network of capillaries. Each lung is enveloped by a pleural membrane, and the thoracic cavity contains the lungs and heart. Breathing moves air in and out of the lungs. During inhalation, the diaphragm contracts and flattens, creating a negative pressure that draws air into the lungs. At rest, exhalation is passive, where elastic forces of the lung and thoracic wall return the diaphragm to its dome shape, compressing the lung and forcing air out (Moreira et al., 2022).

2.2. Key Structures and Functions

The trachea and the conducting airways (bronchi and bronchioles) are formed by the respiratory epithelium and the underlying mesenchyme in a budding growth process that begins in early embryonic development. The branching pattern of the conducting airways is determined by the

local structures such as the epithelial ridges and mesenchymal tips, as well as by the signaling pathways that mediate epithelial-mesenchymal interactions (C. Basil et al., 2020). The conducting airways are lined by a surface epithelium composed of ciliated cells, secretory club cells, and neuroendocrine cells, which differentiate from common basal stem cells in the epithelium. The conducting airways and the alveoli are formed by the respiratory epithelium and mesenchyme, involving complex morphogenetic changes, branching growth, and tissue patterning processes that are regulated by a variety of local growth factors. The lung airways, which divide into conducting and gas-exchange airways, are formed as an outgrowth from the foregut endoderm during embryonic development. The conducting airways play an important role in conditioning inspired air by secreting specific fluid and electrolyte compositions to maintain optimal epithelial surface liquid. The conducting airways are also involved in airway mucosal immunity and in preventing the entrance of noxious substances into the lung. Pathological alterations in the structure of the conducting airways are implicated in a variety of pulmonary diseases, such as asthma, chronic obstructive pulmonary disease (COPD), bronchitis, and cystic fibrosis (A. Hutchison et al., 2013).

3. Common Respiratory Conditions

Respiratory disorders are one of the most common noncommunicable diseases worldwide. The Global Burden of Disease Study reported 3.0 million deaths from chronic obstructive pulmonary disease (COPD) in 2019, accounting for 5.47% of all deaths. In addition to COPD, asthma and pneumonia are among the top ten causes of death globally. Efforts to reduce the burden of respiratory diseases have been hampered by the COVID-19 pandemic. Severe COVID-19 infection leads to similar impairments as those typically seen in patients with COPD or other chronic respiratory diseases, including acute respiratory distress syndrome and lung fibrosis. Patients often need rehabilitative care to restore lung health and function after recovery from severe infection (Moreira et al., 2022). Respiratory rehabilitation programs can consist of several interventions focusing on improving lung health and function. Education on physiotherapy techniques for respiratory rehabilitation is important for caregivers, especially within a home care context. Caregivers should be able to implement the most basic techniques to benefit patients in their care. This training can provide knowledge and skills to care for patients with respiratory conditions. Understanding the respiratory system's structure and function and common respiratory conditions is fundamental to implementing rehabilitative techniques effectively (Josmy, 2015). To restore health and functionality in patients with respiratory conditions, caregivers should be trained on techniques to promote airway hygiene, permeability, and lung expansion.

3.1. Asthma

Asthma is a chronic inflammatory disorder characterized by recurrent respiratory symptoms, airways obstruction, and bronchial hyper-responsiveness (Privitera & Privitera, 2023). These periodic symptoms result from the small airways narrowing due to a combination of smooth muscle contraction, inflammation, and increased mucus production. Exposure to various triggers such as allergens, viral infections, cold air, exercise, and tobacco smoke can induce asthmatic symptoms. Asthma is a complex disease that involves the interaction of multiple genetic and environmental factors, leading to significant changes in lung structure and function. The altered developmental pathway in asthmatic subjects determines the dysregulation of multiple biological processes, contributing to several disease characteristics such as airway hyper-responsiveness, airway inflammation, and airflow limitation. Children with asthma are often physically limited in

movement, playing, and sport activities. Conditions are aggravated by asthma medications, especially inhaled corticosteroids and long-acting beta-agonists, which affect physical growth and development. The physical therapy program for asthmatic youth includes an evaluation of clinical status and the development of exercise protocols adjusted to individual and group treatment. The aim is to improve aerobic capacity, robustness against environment alterations, respiratory mechanics, and coordination of respiratory muscles. All proposed exercises focus on increasing pulmonary ventilation and maintaining proper posture and chest mobility.

3.2. Chronic Obstructive Pulmonary Disease (COPD)

Chronic obstructive pulmonary disease (COPD) is a progressive lung disease caused by long-term exposure to irritants that damage the lungs' airways and fill them with mucus. COPD makes it harder to breathe, and it more commonly occurs in individuals aged 40 years or older. The risk factors for COPD include smoking, environmental and occupational exposures, and a family history of COPD. COPD symptoms include shortness of breath, chronic cough, wheezing, chest tightness, and recurrent respiratory infections. While there is no cure for COPD, it can be treated to relieve symptoms and improve quality of life (Rafii et al., 2011).

COPD treatment mainly focuses on improving shortness of breath (dyspnea) and exercise tolerance, preventing disease progression, limiting or treating acute exacerbations, and improving survival. Most patients require bronchodilator therapy, so a stepwise approach similar to asthma management is not practical. Patients with COPD should be questioned about their respiratory symptoms with the modified British Medical Research Council dyspnea scale (mMRC) or the COPD assessment test (CAT) to help determine treatment choices.

3.3. Pneumonia

Pneumonia is an acute infection of the pulmonary parenchyma that is caused by viruses, bacteria, fungi, and other pathogens. Pneumonia can cause the alveoli to become inflamed, resulting in the accumulation of fluid or pus. Pneumonia is characterized by cough, fever, chills, and difficulty breathing. Other symptoms include nausea, vomiting, diarrhea, and loss of appetite (Liu et al., 2018).

The treatment of pneumonia patients is based mostly on the etiologic agent, age, and severity of the illness. With timely intervention, most mild cases of pneumonia clear up within 1 to 3 weeks. A broad-spectrum antibiotic is often prescribed for bacterial pneumonia. Antiviral drugs, if indicated, are used in cases of viral pneumonia. Patients with severe pneumonia necessitate mechanical ventilation, which results in a loss of lung protective ventilation strategies.

4. Diagnostic Techniques in Respiratory Therapy

The elderly population is expected to reach two billion people in 2055. Aging is associated with a gradual decline of lung function. Consequently, age-adjusted lung function impairment causes a broad spectrum of respiratory diseases, ranging from asthma, chronic obstructive pulmonary disease, lung cancer, to interstitial lung disease. Similarly, lung transplantation has become the mainstream treatment for advanced end-stage lung diseases. Therefore, the consistent monitoring and longitudinal assessment of lung function is in large clinical demand. To meet that need, a novel wearable ultrathin soft spirometer is presented, which is able to continuously monitor the lung

function of people under free motion. This spirometer is composed of a soft microprocessor and a wearable soft pneumotachograph. The wearable pneumotachograph consists of a breathable polyimide (PI) film-based microchannel and a flexible pressure sensor with breathable air holes, facilitating real-time recording of velocity and volume of lung airflow. Combining deep learning-based personalized algorithms can accurately extract spirometric parameters from the airflow signal. Soft spirometers can be fabricated in a fully soft manner for comfort, safety, and hygiene. Experimental results show that wearable spirometers can robustly characterize lung airflow and lung function under daily motions (Hammer & J. L. Newth, 1995).

4.1. Pulmonary Function Tests

Pulmonary function tests (PFTs), also known as lung function tests or respiratory function tests, are a series of non-invasive tests used to assess how well a person's lungs work. Specifically, they measure how much air a person can inhale and exhale, as well as how efficiently oxygen is transferred into the bloodstream (Ranu et al., 2011). There are many types of PFTs, including spirometry, body plethysmography, and diffusion capacity tests. The exact test or combination of tests performed depends on the information needed and the patient's medical history and physical exam.

Spirometry is the most common type of PFT. It is often performed in a primary care office or pulmonary function testing lab. During the test, a person breathes into a tube connected to a spirometer, which records the amount and rate of air that is inhaled and exhaled over a specific period of time. The person is first tested while breathing normally. Then, to get additional information, the person is asked to take a deep breath and force all the air out into the spirometer as quickly as possible. This is called a forced vital capacity (FVC) maneuver. Spirometry requires the cooperation of the patient. It can be difficult to perform this test on very young children and some people with disabilities or certain medical conditions.

4.2. Arterial Blood Gas Analysis

Arterial blood gas analysis (ABG analysis) is a useful tool for blood gas analysis. It is a common procedure in intensive care units that is often requested, interpreted, and acted upon by medical staff who are unfamiliar with the basic physiology. This misunderstanding can lead to confusion in interpretation and inappropriate actions that can prove harmful to the patient (Singh et al., 2013). In an effort to clarify this issue, a simple logical systematic approach is proposed that will make interpretation of blood gases simple and safe for all involved in patient care. Before discussing the technique of analysis, some basic concepts of acid-base physiology must be understood.

The blood provides a medium for the exchange of gases between environment and tissues, transport of nutrients, hormones and waste products and an effector system for homeostasis. It consists of Plasma (55%) and formed elements (45%). The formed elements include erythrocytes (RBCs), leukocytes (WBCs) and platelets. Erythrocytes are responsible for the transport of oxygen (O2) and carbon dioxide (CO2) between lungs and tissues. Haemoglobin (Hb) in Red Blood Cells binds O2 and CO2 and helps in the efficient transport of gases. Arterial Blood Gas (ABG) Analysis helps in monitoring the respiratory and metabolic functions of blood. pH, PaO2, PaCO2, bicarbonate (HCO3-) and Base Excess (BE) are the parameters measured in ABG Analysis (Peter Sylvester et al., 2020).

5. Therapeutic Interventions in Respiratory Therapy

Following the assessment, a detailed therapeutic intervention protocol addressing the identified needs will be designed or selected from the literature. The interventions may focus on achieving the physiological goals through behavioral modification or the use of specific devices. Possible goals may include improving lung ventilation, increasing inspiratory capacity, enhancing airway cleaning, reducing breathing work, and preventing or treating parenchymal damage. The intervention focus can be classified as general or specific. General interventions, which may be implemented by healthcare personnel or trained family members, concentrate on improving lung health without directly addressing specific diseases. Examples include changing body position, modifying breathing patterns, employing or avoiding sports activities, and using devices that promote respiratory exercises. General interventions are especially advisable for elderly and disabled patients who may have difficulty performing more complex tasks requiring higher cognition or mobility (Ides et al., 2012). On the other hand, specific interventions target the treatment of diagnosed lung diseases to assist in executing more complex intervention tasks, often requiring personnel with advanced education and training or specialized equipment. Implementation may require training patients and/or caregivers in using specific devices or performing techniques independently or, in some cases, in combination with other techniques. Initially, simpler self-applicable techniques are introduced, followed by more sophisticated ones and adjustments in execution based on ongoing assessment. The goal is to promote patients' ability to maintain good respiratory health independently, with periodic evaluations and adjustments by healthcare professionals as monitoring and guidance (Moreira et al., 2022).

5.1. Oxygen Therapy

Inhaled oxygen therapy represents an essential approach for the management of numerous respiratory conditions, and it is vital for the persistence of patients with chronic obstructive pulmonary disease (COPD). High-flow nasal oxygen (HFNO) therapy is a feature inlet for inhaled oxygen therapy, as it entails combining higher than normal flow with the effecting of conditioning the gas towards body temperature and 100% relative humidity. Whereas HFNO systems were traditionally mixed to deliver up to 60 L/min of oxygen-enriched gas flow, recent developments in new-generation devices now allow delivery rates up to 120 L/min. Initial experimental data demonstrated that HFNO at 120 L/min could achieve much more effective evidential increases in expired tidal volume (VT) than with lower flow rates throughout both at rest and metabolic endurancetask states. Further experimental investigations were then translated to the clinical context, wherein 120 L/min HFNO personnel patients demonstrated significantly improved lung function and reduced respiratory rate throughout recovery from water-exercise induced bronchoconstriction compared to treatment with 60 L/min HFNO or isotonic nebulized saline (Budweiser et al., 2008).

Nonetheless, important interstitial variations in the effectiveness of these techniques are present as a function of severity of airflow limitation, degree of phospholipid depletion, pre-treatment lung volume state, and prior medical management. Significant adjustments to the delivery of these techniques greatly improve their effectiveness and their overall robustness. Ultimately, the development of new inhaled drug delivery techniques will provide new pathways for improving pulmonary deposition, targeting distal airways or the alveolar region representations of the lung.

5.2. Bronchodilator Therapy

Bronchodilator therapy is common in patients with respiratory conditions characterized by luminal obstruction, such as asthma and chronic obstructive pulmonary disorder (COPD). Asthma is a heterogeneous disease that usually involves chronic inflammation and is associated with airway hyper-responsiveness and airflow limitation. Patients with asthma require long-term control (preventative) medication and quick-relief (rescue) medication. Quick-relief medications usually include short-acting β2-agonists (SABAs), while long-term control medications may include inhaled corticosteroids (ICS), leukotriene receptor antagonists (LTRA), long-acting β2-agonists (LABAs), or theophylline (M et al., 2012). COPD, a preventable and treatable disease, is characterized by airflow limitation that is not fully reversible. COPD is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung due to noxious particles or gases, most commonly cigarette smoke. Bronchodilators are the mainstay of the pharmacological management of COPD as recommended by the Global Obstructive Lung Disease Initiative (GOLD). Chronic bronchitis and emphysema are the two main forms of COPD. Patients with chronic bronchitis usually present with a chronic cough with sputum production, while patients with emphysema present with breathlessness on exertion (M Halpin, 2018).

5.3. Chest Physiotherapy

Chest physiotherapy is an effective therapy for removing airway secretions. It enhances sputum evacuation and improves gas exchange, oxygenation, and lung compliance (Ides et al., 2012). Especially in COPD patients, chest physiotherapy may improve lung health and function. Chest physiotherapy can be applied as a single technique or as a combination of techniques. A combined technique is intrapulmonary percussive ventilation (IPV), which combines high frequency percussive ventilation with an air pulse generator that creates positive pressure. In a randomized, controlled, cross-over study, the effect of IPV was compared with standard chest physiotherapy on sputum evacuation in COPD patients receiving lung resection. A total of 28 patients were randomly assigned to receive standard chest physiotherapy followed with IPV or vice versa. The order was reversed after 6 hours. Sputum objective parameters, cough and sputum subjective parameters, and vital signs were measured before and after each treatment. Sputum weight was measured hourly for 6 hours. No significant differences were found between both treatment techniques for any of the measured outcomes. However, IPV was significantly better in enhancing heart rate and respiratory rate compared to standard chest physiotherapy.

6. Ventilator Management

For patients with chronic respiratory failure who use long-term mechanical ventilation (LTMV), either invasively or noninvasively, successful ventilator weaning is a major goal of treatment. Although successful weaning may not be possible in a small percentage of patients, most patients can be completely or partially weaned from ventilatory assistance, provided they receive appropriate treatment. Despite contradictory results from some studies, several approaches to improve lung function and increase the chance of weaning from ventilator assistance have been proposed; these include lung recruitment maneuvers, the administration of bronchodilators, and the optimization of patient positioning during ventilation (Ambrosino et al., 2015).

In patients with chronic respiratory failure not on long-term mechanical ventilation, the progressive application of a more demanding level of respiratory support in parallel with an

appropriate rehabilitation program based on physical exercise, nutritional support, and patient education has been proposed as a strategy to avoid a deterioration in the ability to carry out activities of daily living.

6.1. Types of Ventilators

Ventilators are widely used devices in health care systems to assist breathing or to provide mechanical ventilation support to patients. A ventilator is a mechanical device that is capable of delivering a predetermined tidal volume, a mixture of oxygen and air, at a pre-set frequency into the lungs of a patient. There are two categories of ventilators based on their function: positive pressure ventilators and negative pressure ventilators. There are three common types of positive pressure ventilators: Volume-cycled ventilators, Pressure-cycled ventilators, and Time-cycled ventilators (Scala, 2004). These ventilators can deliver either controlled or assist modes of ventilation. Controlled ventilation is a mode in which the ventilator controls the frequency, tidal volume, and the FiO2 (fraction of inspired oxygen) independent of the patient's respiratory effort after setting up the ventilator parameters. In assist mode ventilation, the patient is allowed to breathe spontaneously, and the ventilator assists to deliver a preset tidal volume when the patient initiates a breath.

6.2. Indications for Mechanical Ventilation

Prolonged unconsciousness resulting from drug overdose, stroke, brain injury, seizure, or coma, leading to respiratory failure or arrest. Double vision, drooping of one side of the face, slurred speech, difficulty swallowing, trouble walking or loss of balance, weakness or numbness of the arms or legs on one side, all resulting from stroke, leading to respiratory failure or arrest. Severe asthma attack not responsive to medications, leading to respiratory failure or arrest. Severe Co2 retention due to chronic lung disease, resulting in respiratory failure or arrest. Severe respiratory insufficiency or arrest, secondary to a sleep study showing the need for continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) therapy, or finding severe central apneas on the sleep study. Severe obstructive sleep apnea, resulting in respiratory arrest, with a sleep study arrangement needed post-intubation (Rouby & Lu, 2005).

7. Pediatric Respiratory Care

Pediatric lung concerns, including asthma and apnea, are very different from lung disease in adults. Pediatric pulse oximeters are designed to take smaller measurements compared to pulse oximeters that work on adults for improving lung health and function. These pulse oximeters are designed to work on smaller fingers or ears. Pediatric respiratory care requires special training and education to efficiently take care of newborns and very small children. The gathering vitals and data process requires special tools and techniques to improve lung health and function in pediatrics.

To obtain just the right measurements and interpret them correctly, staff must have education and training for improving lung health and function in pediatrics. It is important that parents and care givers are educated on lung health and function in pediatrics too. When treating or taking care of pediatrics having chronic problems with lungs like asthma or apnea, education of parents is essential for improving lung health and function (Benito-Ruiz et al., 2022). Having clear information of disease, medication and technique will lead to better outcome and increase cooperation with kids.

Having good assessment, troubleshooting and interventions on lung care in education and training of staff is essential for good management of pediatric population with lung disease (Hammer & J. L. Newth, 1995). Designing a pediatric approach to management is essential but requires a lot of different consideration compared to adults. Small changes in treatment or actions can have major impacts on outcomes in pediatrics. Putting together pediatric specific standard operation procedures and protocols for improving lung health and function is essential.

7.1. Unique Considerations in Pediatric Patients

Pediatric patients have unique considerations when it comes to respiratory therapist techniques. In hospital settings, a wide range of ages is encountered from neonates to late adolescents. This creates a situation where patients have entirely different respiratory anatomy and physiology, yet often require the same treatments (A. Hutchison et al., 2013). Several different approaches are often needed to treat small children versus adults. Smaller hand sizes, smaller equipment, and different techniques are commonly employed. When nebulizing medications, standard adult equipment will usually underdose small children due to the higher dead space and tidal volume of the devices. It is important with all medications given using small equipment, that the therapist visualize the administration of the medicine to assure that proper technique is employed (Benito-Ruiz et al., 2022).

8. Geriatric Respiratory Care

Respiratory issues can remain dormant for years, only to rise dramatically due to aging, increased inactivity, or other stressors. Common respiratory diseases, which have no cure, can nevertheless be managed through various approaches. Nonetheless, the biggest respiratory problem is often simply the lack of activity in most older individuals. The number of elderly patients is growing rapidly, and rehabilitation plays an essential role in respiratory care. Modeling and applying reasons and models of care can improve learning and prepare for practical situations. It is paramount to understand the disease and its consequences, the group needing care, and the appropriate type of care. Group care is incredibly effective, especially when involving peer patients and using careful models with clear goals (Moreira et al., 2022).

Patient assessments are crucial for targeting the correct group of patients. A well-functioning team must uphold clearly designed and well-known tasks. Documentation of all events, deviations, illnesses, and conclusions is essential. This ensures learning and avoids repeating mistakes, as often settings are new or have been updated. Patients with the same, or very similar, diagnoses must be grouped together. These care models focus only on these conditions and their consequences. A widely prevalent group respiratory disease focused on is obstructive respiratory disease, mainly Chronic Obstructive Pulmonary Disease (COPD) (N et al., 2018). This is usually caused by years of smoking; however, it can also derive from other exposure, genetics, or asthma. Patients with these diseases often neglect the situation until it is too late. Informing patients about the disease's consequences and providing preventative steps is essential.

8.1. Unique Considerations in Geriatric Patients

Considerations specific to elderly patients are also included in this chapter. Asthma management is complicated in elderly patients due to high death rates and misdiagnosis (Iwanaga et al., 2017). Artificial airway management indicates the key points as aging results in narrowing of the trachea

with increased rigidity and decreased compliance, leading to greater change in airway pressures and decreased tidal volume. Furthermore, due to changes in dentition, the elderly patient is more likely to be edentulous, complicating the sealing of a facemask (N Johnson et al., 2015). In elderly patients with respiratory disease, preoxygenation with 100% oxygen is recommended to avoid desaturation during intubation. After induction, the elderly patient will usually require less neuromuscular blocking agent due to decreased hepatic clearance, and the dose should be adjusted based on train-of-four monitoring. To limit adverse outcomes, preoperative optimization of respiratory function is particularly important in the elderly, which can be achieved by practicing incentive spirometry. On the other hand, a geriatric-focused technique is needed to perform prone positioning because the elderly are at higher risk for hemodynamic instability during lateral positioning.

9. Pulmonary Rehabilitation

Pulmonary Rehabilitation (PR) is defined as a comprehensive intervention based on a thorough patient assessment, individualized treatment prescription, and ongoing monitoring. It comprises exercise training, education, and behavioral intervention, all aimed at improving adherence to healthy lifestyles. PR should be considered a disease-modifying therapy, not simply a symptomatic service. It is controversial that the roots of pulmonary rehabilitation lie either in the development of techniques to enhance the effectiveness of ventilation or in the resolute opposition to viciously objectifying patients with respiratory diseases (Rosa Güell Rous, 2021). It is said that "the history of knowledge is also the history of ignorance." In accordance with the then political trends of the times, knowledge was systemically obscured or ignored, for there was resistance to labelling people as sick.

The earliest documented attempts at intervention for respiratory disease were made in ancient Egypt around 3000 B.C. It was suggested that patients with respiratory complaints be treated with mountain air, incense and aromatic oils, and pomegranate juice. Three hieroglyphic inscriptions on papyrus scrolls describing treatment with herbs, ingestion of fumes, breathing exercises, and hymns are known. Recommendations that patients with respiratory maladies should avoid smoky air and certain foods have also been found noted in ancient Greek literature. Nevertheless, it was indeed the Romans who established the first systematic public health policies aimed at limiting the spread of contagious diseases (Vaishali et al., 2019).

9.1. Components of Pulmonary Rehabilitation Programs

Health care professionals become respiratory therapists after an intensive college curriculum and clinical training program, but anyone can learn most respiratory therapist techniques. Some other health care professionals employ these techniques, but most do not. Hospitals and skilled nursing facilities often push to reduce respiratory therapist staff, so patients may benefit from being more knowledgeable about respiratory therapist techniques.

These techniques may improve lung health and function and reduce reliance on complex and expensive respiratory medications. These techniques are important for both patients with diseases that directly affect the lungs (e.g., COVID-19, chronic obstructive pulmonary disease, cystic fibrosis, pneumonia) and patients with heart diseases that secondarily affect the lungs (e.g., congestive heart failure). Secrets to lung health and function technique success are critical public

health knowledge that health care professionals must learn in school and training programs (S. Al Moamary et al., 2014).

The techniques are easy to perform, inexpensive to implement, and often require no additional equipment. Simple household items, such as a kitchen pot, salt, and a prescription for antibiotics, can create a do-it-yourself lung health and function technique "sick soup" inhalation therapy that rivals anything a hospital can provide.

10. Emerging Trends in Respiratory Therapy

Recent advancements in respiratory therapy education, clinical practice, research, and professional development that may impact the profession, practitioners, and patients down the line are discussed. Trends within and outside the profession of respiratory therapy that could have ramifications for the profession and its patients in the short or long-term are also explored. Important emerging trends that warrant attention and consideration include the potential for the respiratory therapist profession to develop advanced practice roles in pulmonary and critical care and the need to address knowledge and research gaps within the profession.

The development of advanced practice roles for respiratory therapists in pulmonary and critical care is examined. Support for such development from within the profession is presented, as well as consider the implications, challenges, and next steps if the profession were to pursue this development. The outcome of a study that revealed significant knowledge and research gaps related to the profession of respiratory therapy, as perceived by some of its researchers, is also discussed (Zaccagnini et al., 2024). Considering the knowledge and research gaps, strategies and processes to enhance and support respiratory therapy research are explored.

10.1. Telehealth in Respiratory Care

Telemedicine, or the use of audio, text, and visual telecommunication technologies to deliver remote medical care to patients, has become more widespread in the past two decades (Simeone et al., 2022). Telemonitoring refers to the use of telecommunications technology to record and transmit patients' vital signs and symptoms reports to providers remotely, while telemedicine consultation refers to remote patient-physician encounters. Telerehabilitation refers to rehabilitation services mediated over audio-visual interfaces. Prior to the COVID-19 pandemic, telemedicine was deployed to increase accessibility across healthcare systems. The frequency of telemedicine encounters has increased significantly, with a reported 50% increase in telehealth visits in the first quarter of 2020 compared to the same period in 2019.

Given the increased patient burden during the COVID-19 pandemic, there is increasing interest in shifting provider-patient encounters into patients' homes. In March 2020, the World Health Organization declared COVID-19 a global pandemic caused by the rapid spread of SARS-CoV-2. COVID-19 primarily causes respiratory infection and can lead to severe pneumonia and acute respiratory distress syndrome, particularly in elderly patients and those with pre-existing co-morbidities such as chronic respiratory diseases. According to the 2017 Global Burden of Disease Study, chronic respiratory diseases result in 3.91 million deaths globally each year, with 2.6 million deaths from COPD alone (C Sanchez-Ramirez et al., 2022). The rapid emergence of COVID-19 has led to concerns that healthcare systems would be overwhelmed with a sudden

influx of affected patients. In anticipation of dwindling resources, many hospitals began to limit routine treatment of patients with chronic respiratory diseases.

11. Ethical and Legal Considerations in Respiratory Therapy

Respiratory therapists (RTs) often face ethical dilemmas due to conflicting opinions on life-support measures, do-not-resuscitate orders, and the role of technology in patient care. The application and methods of therapy can have a direct impact on the patient's quality of life and the outcome. Consequently, RTs must consider the legal implications of their actions, as malpractice lawsuits can be financially devastating to therapists and institutions, and can ruin professional reputations. It is crucial to understand the laws that govern and protect respiratory practice to avoid allegations of negligence (Keene et al., 2015). To delve deeper into the topic, it is essential to identify ethical dilemmas faced by respiratory care practitioners, compare personal beliefs with those of others, and explore how education and experience influence perceptions of ethical dilemmas. Additionally, the importance of patient education regarding legal rights in respiratory therapy should be emphasized. Finally, the focus will be narrowed down to legal considerations in respiratory therapy, highlighting the patient's right to refuse treatment, the therapist's obligation to inform the physician, and the possible consequences for the therapist if the physician fails to act on the refusal.

11.1. Patient Confidentiality and Informed Consent

To ensure respect for the confidentiality of all patients, information that could identify a patient will not be shared outside of this professional relationship without the patient's consent except as required by law. As a patient you have the right to know what information is collected about you and how it will be used. Your consent must be obtained before any assessment or treatment begins. You have the right to refuse consent and treatment. A patient has the right to withdraw consent at any time. All requests for Personal Health Information (PHI) must be made in writing and given to the Manager of Medical Records. PHI will be released only to the patient or their legal guardian (Zagami et al., 2015). A fee may be charged for retrieval, preparation and transcription of PHI at 25 cents/page. All patient information will be kept in a secure location and there will be limited access to this information.

12. Conclusion and Future Directions

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