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The Effect of Positioning on Oxygenation in Pulmonary Rehabilitation

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ABSTRACT

Purpose: The study was compiled to report the effect of positioning on oxygenation in individuals requiring pulmonary rehabilitation (PR). **Method:** This article was compiled from current study results and aims to benefit caregivers of patients requiring pulmonary rehabilitation from evidence-based practices. **Findings:** Sitting positions are generally reported to provide better lung function and oxygenation. Furthermore, lateral positioning is recommended to prevent atelectasis and secretion accumulation. Orthopnea allows the lungs to expand within the chest cavity and take in more air, increasing saturation and reducing dyspnea. Prone positioning reduces lung pressure, reducing alveolar distension and collapse, thereby improving oxygenation. **Conclusion:** When developing a rehabilitation program, nurses should consider the patient's general condition and respiratory problems and be able to evaluate the program's outcomes.

1. INTRODUCTION

Pulmonary rehabilitation (PR) is an evidence-based, multidisciplinary care program designed to help individuals with respiratory disease-related disabilities maintain their health-related quality of life at the best possible level. Conditions such as obstructive, restrictive, and malignant lung diseases and pulmonary hypertension are indications for PR. However, it should not be administered to patients with arthritis, severe neurological, cognitive, or psychological disorders that prevent participation in exercise, or to individuals with comorbid conditions that prevent continued exercise (severe pulmonary hypertension, unstable cardiovascular disease, etc.) [1-2].

PR reduces the complications of bed rest, dependence on mechanical ventilation, symptom burden, anxiety, and hospitalization time. It improves the patient's exercise capacity, muscle strength, endurance, self-efficacy, knowledge, and participation in activities of daily living. It helps patients acquire long-term health behaviors by improving quality of life [3-4]. It plays an important role among nonpharmacological treatments for individuals with respiratory problems whose activities of daily living have been reduced [5-6]. Pulmonary rehabilitation is an effective, low-risk, low-cost, noninvasive procedure to improve oxygenation in patients with lung disease [7-10]. Proper positioning of patients requiring pulmonary rehabilitation improves respiratory function and quality of life (Evidence A) [5,11-13].

Nurses, who play an active role at every stage of the rehabilitation process, are the patients' greatest supporters. The nurse's responsibilities include implementing the PR program, ensuring patient compliance, assessing treatment response, educating patients and their families, and coordinating with team members [14]. Positioning the patient in pulmonary rehabilitation is an independent nursing intervention [8]. Proper positioning increases lung volume, reduces heart rate, facilitates mucociliary clearance, and improves ventilation/perfusion (V/Q) compatibility, affecting blood oxygen saturation levels. Understanding these position-related changes in lung function is important for improving patient care, especially in clinical settings [8,15]. The effect of patient positioning on oxygenation varies depending on different postures and clinical situations [15].

The purpose of positioning is to reduce lung compression, recruit dorsal lung fields to respiration, and increase oxygenation and the

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ventilation/perfusion ratio. However, if the heart rate changes by 10 beats/min with each new position compared to the previous position and SaO_2 decreases by more than 10%, the patient should be returned to the previous position [16]. Correct positioning resulting in a change in diaphragm position, affects lung mechanics and gas exchange, thus improving vital capacity, functional residual capacity, and total lung capacity [15].

Table 1. Diseases indicated for pulmonary rehabilitation

Obstructive Lung Disease	Restrictive Lung Disease	Other Lung Disease
Interstitial Lung Disease	-Asthma	-Malignancies
-Sarcoidosis	-Bronchiectasis	-Pulmonary Hypertension
Interstitial Pulmonary Fibrosis	-Cystic fibrosis	-Pre and post-lung transplantation
-Occupational Diseases (asbestosis, silicosis, pneumoconiosis)		-Ventilator-dependent patient
-Collagen Tissue Diseases (Sjögren's, scleroderma, lupus)		-Obesity-associated lung diseases
-Acute Respiratory Distress Syndrome		
-Hypersensitivity Pneumonitis		
Chest Wall Pathologies		
-Ankylosing Spondylitis		
-Kyphoscoliosis		
-Thoracoplasty		
Neuromuscular Pathologies		
-Amyotrophic Lateral Sclerosis		
-Multiple Sclerosis		
-Spinal Cord Injury		
-Duschenne Muscular Dystrophy		
-Postpolio Syndrome		
-Guillain-Barré Syndrome		
-Myotonic dystrophy		
-Myasthenia gravis		

2. POSITIONS GIVEN IN PULMONARY REHABILITATION

2.1. Fowler/Semi-Fowler Position

Sitting positions generally result in better lung function and a significant increase in oxygenation [3,8,15-18]. Promsarn and Pankratuk (2023) reported that sitting positions of 30-45 degrees generally improve lung function compared to supine positions [15]. It has been reported that in a sitting position greater than 30 degrees from the horizontal plane, the increase in abdominal pressure increases the capacity of the chest wall to expand and oxygenate, is effective in reducing the work of breathing, and contributes to balancing the increase in functional residual capacity. Patients in the supine position have lower spontaneous tidal volumes than those in the upright position. Therefore, raising the head of the bed by 30 degrees or placing the patient in a semi-sitting position facilitates ventilation efforts [3]. In a study conducted to monitor changes in SpO_2, heart rate, and blood pressure in the supine, right lateral, left lateral, and semi-recumbent body positions at an angle of 30-45 degrees, it was determined that the best oxygenation was in the supine position [17]. In another study examining the best oxygenation and hemodynamic parameters in individuals with right, left, and bilateral lung disease, it was reported that patients with right lung disease lying in the 90-degree supine position, patients with left lung disease lying in the 45-degree right lateral or 45-degree supine position, and patients with bilateral lung disease lying in the 45-degree right lateral position provided optimal oxygenation [8]. In contrast, in a study monitoring the effects of the supine, left lateral, right lateral, and Fowler positions on respiratory and cardiac parameters, it was reported that position changes did not lead to clinically significant changes in respiratory mechanics, hemodynamic parameters, and oxygenation [19].

2.2. Lateral Position

Due to the effect of gravity, blood flow and ventilation in the underlying lung are increased in the lateral position, thus maintaining the ventilation/perfusion (V/Q) ratio [8]. Lateral positioning can be used to prevent atelectasis and secretion accumulation. There is evidence that positioning the patient in 40-degree lateral rotation reduces the risk of ventilator-induced

pneumonia [16]. Lateral positioning has been reported to reduce overdistension and collapse in patients with respiratory distress due to COVID-19 [20].

2.3. Orthopnea Position

Orthopnea positioning facilitates breathing and circulation in patients with impaired heart and lung function. Few studies have been found on its effect on hemodynamic parameters. Orthopnea positioning is a sitting position in which the arms are supported on pillows or the armrest of a chair, and the patient leans over the bedside table or chair backrest. Orthopnea positioning causes the organs in the abdominal cavity to move away from the diaphragm due to gravity. This allows the lungs to expand within the chest cavity and take in more air with each breath. When all positions were compared for patients with chronic obstructive pulmonary disease (COPD) and advanced respiratory problems, it was reported that patients experienced a decrease in the average severity of dyspnea and an increase in O_2 saturation at 15 minutes in the orthopnea position [21].

2.4. Prone Position

Prone positioning has been reported to improve oxygenation in patients with acute respiratory distress syndrome (ARDS) [15]. Before the pandemic, although cases were limited to influenza patients and immunocompromised patients, it had positive results in terms of improved tolerance and oxygenation [22]. Today, this approach has expanded, and prone positioning is recommended for 12-16 hours per day for elderly patients with moderate and severe ARDS in intensive care units. Prone positioning reduces lung compression in patients and allows lung mechanics to better adapt to transpulmonary pressure [3,23]. By reducing alveolar distension and collapse, it increases oxygenation and reduces mortality. Prone positioning for 2 hours every 12 hours is recommended for patients with mild ARDS.

However, it is important to prevent pressure sores, plantar flexion contractures, and brachial plexus injuries caused by prone positioning [4]. Although some study results contradict this, there is consistent evidence that hypoxemic patients requiring advanced respiratory support and treated in intensive care settings benefit greatly from being able to remain in the prone position for several hours [22, 24]. In ARDS patients, 135-degree prone positioning has been reported to result in a modest increase in arterial oxygenation compared to 180-degree prone positioning [25].

Although prone positioning improves oxygenation, caution should be exercised regarding potential complications. Pressure sores, brachial plexus injuries, and plantar flexion contractures can occur due to positioning [26]. The most significant complication is nerve compression injuries, especially when the prone position is maintained for extended periods. Brachial plexus injuries are reported to be common after prone positioning in patients receiving invasive mechanical ventilation. Careful patient monitoring, including monitoring oxygen saturation and blood pressure, is necessary [22,27].

Regarding patient positioning time, the general approach is to change the patient's position at least every two hours [16]. Kişial and Erden reported that arterial oxygen saturation was statistically significantly higher in patients placed in the left lateral, right lateral, and semi-Fowler (30-degree) positions every two to four hours compared to the control group (routine semi-Fowler position of 20-45 degrees) and contributed to improved oxygenation [28]. One study concluded that the semi-sitting position (Semi-Fowler) was the best at improving oxygen saturation one hour after positioning compared to other positions [29].

When providing pulmonary rehabilitation, the nurse should convey hope that not only treating a disease but also actively listening, demonstrating empathy, building trust, and involving patients in decision-making processes will benefit the individual [30]. Furthermore, the nurse is responsible for measuring and evaluating hemodynamic and oxygenation outcomes from pre- to post-rehabilitation [31].

3. Conclusion

The pulmonary rehabilitation program should be planned according to each patient's respiratory problems. Each patient's condition should be assessed, particularly regarding cognitive status, respiratory, cardiovascular, and musculoskeletal functions. Patient tolerance, oxygenation, and hemodynamic parameters should be recorded and compared with pre- and post-positioning values. Consequently, nurses caring for patients with lung disease should utilize the body position that best impacts peripheral oxygenation based on the patient's condition and minimize adverse effects.

Conflict of Interest

No conflict of interest is declared by author. In addition, no financial support was received.

Author Contributions

Conception and design of the study: NA; Data collection: NA; Data analysis: NA; Data Interpretation: NA; Drafting the article and/or its critical revision: NA; All authors have read and agreed to the published version of the manuscript.

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