HARDWARE DESIGN FOR RESPIRATORY SUPPORT

Ronya Akınc, Sarya Akıncı, Mehmet Sirac Ozerdem

TED Diyarbakır College, Dicle University Engineering Faculty, Diyarbakır, Türkiye

1. Introduction

Unfortunately, our grandmother was diagnosed with rectal cancer and, sadly, she was a smoker. The doctor recommended using a triflo device to increase her lung capacity. However, due to her smoking habit, she couldn't move the balls using the device, which caused her motivation to decrease. Based on this situation, we decided to design a similar device. We remembered from our childhood that balloons stuck to our skin when we blew them up and when we tried to blow them up again, they burst due to high air pressure. Inspired by this experience, we tried pulling the air trapped inside the balloon by creating a vacuum. We observed that this caused the sticking substances to move. Then we realized that by gradually blowing air into the balloon and repeating this cycle, we could inflate the balloon without it bursting. Based on this experience, we decided to develop a device that could help increase lung capacity and facilitate the removal of secretions in the alveoli.

During the COVID-19 pandemic, we realized the need to find solutions for respiratory problems. Respiratory tract diseases, especially COVID-19, can have serious consequences by affecting respiratory functions. Therefore, with the respiratory device we designed, we aimed to provide a solution for patients' breathing problems.

Our developed respiratory device focuses on improving diaphragmatic breathing through respiratory exercises. Diaphragmatic breathing is a deeper and more effective breathing technique than chest breathing, aiming to utilize the lungs more. This way, we can increase lung capacity and improve respiratory functions.

Additionally, our device has a unique feature that involves vacuuming the air inside the balloon. This mechanism allows the movement of sticking substances and facilitates the loosening of secretions. When a vacuum is applied to the balloon, the effect of sticking substances decreases, and the movement of secretions becomes easier.

The use of this respiratory device aims to enhance patients' lung capacity, improve respiratory functions, and facilitate the elimination of secretions. It is particularly important to use this device in the early stages of upper respiratory tract diseases to prevent the progression of the illness and reduce the likelihood of patients in hospital settings requiring intubation.

This device is also designed to increase user motivation. Blowing air into the balloon little by little while using the device encourages active user participation and stimulates them to move the sticking substances with their movements. This increases motivation and enhances commitment to the treatment process.

Our designed respiratory device offers an effective method to both improve lung capacity and clear accumulated secretions in the alveoli. Additionally, it provides an interactive experience to enhance user motivation.

In conclusion, inspired by the triflo device that cannot be used in patients with reduced lung capacity due to smoking addiction, we have designed a similar respiratory device to move sticking substances

and improve lung functions. The use of this device can play a significant role in the treatment of respiratory tract diseases and improve patients' quality of life.

Existing respiratory exercise devices on the market, such as triflo, mainly focus on inhalation. However, we specifically aim to focus on exhalation and removing all the air present in the respiratory tract. In this way, by creating a vacuum effect, we will be able to create movement in the secretions present in the respiratory tract and have a chance to remove them. Triflo uses a vertical tube system, which requires the application of high-pressure air to counteract the force of gravity. This creates a difficult and challenging process for patients with respiratory difficulties. Additionally, patients may have negative effects on their motivation due to the fear of failure at the beginning of the treatment, and the treatment may not be continued consistently.

To minimize the impact on damaged respiratory tissues in patients, we will aim to use low velocity, low pressure, and a longer duration for exhalation. This way, the respiratory tissues that are already compromised will be less affected, and no harm will be done to them. Different colored sections will be created in the tube system to provide visual feedback to the patient. The helical tube system will be used to move the ball inside by vacuuming the open air pressure. This will be achieved through coloration of the tubes in the same visual feedback system. The air in the helical tube system will be heated using an external heater with the help of resistance. This way, the heated air will soften the secretions in the respiratory tract, facilitating movement.

2. Material and Method

The respiratory device we have designed is a system consisting of bi-directional helical glass or plastic tubes. One end of this tube system is used for exhalation, while the other end is used for inhalation. The purpose of the device is to support the patient's respiration and facilitate the elimination of carbon dioxide.

Inside the device, balls of different weights and colors are used each time. By blowing into the device, the movement of the balls is ensured. In this way, pressure is created in the patient's lungs, facilitating the removal of carbon dioxide. Then, by vacuuming the air from the other open end of the device, the air inside the system is refreshed.

Different colored areas are created in the tube system, and each color has its own meaning. These meanings are monitored by healthcare professionals and provide information about the patient's respiratory status. For example, the movement of a particular colored ball to a specific area may indicate that respiration is occurring properly.

In addition, in a version of the project designed for hospitalized patients or patients requiring a respiratory device at home, additional features are included. This version includes additional connection points in the device for oxygen input, nebulizer input, and nebulizer medication chamber input. This allows for the administration of oxygen to patients and the delivery of respiratory medications when necessary.

The designed respiratory device is a system used to support patients' respiration and regulate respiratory functions. However, for this device to be used in the real world, it needs to undergo clinical testing and obtain the necessary health approvals. The design of the proposed tool is shown in Figure 1.

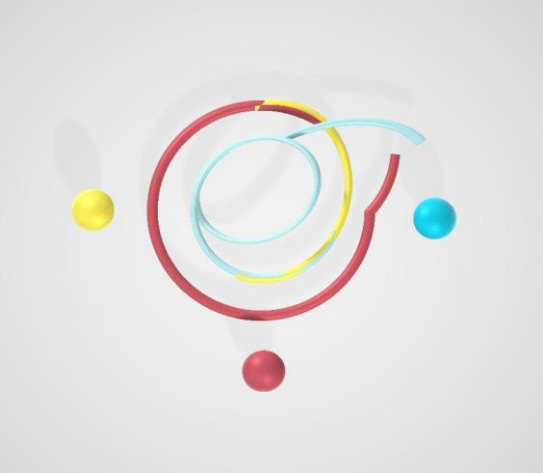

Figure 1. The design of the proposed tool

3. Results

The benefits of the proposed tool can be listed as follows:

- Visual feedback will be provided to the patient by creating different colored sections in the tube system.
- Patients with respiratory difficulties will have the opportunity to solve their problems at home.
- By using different weighted balls in our device, we will progress from easy to more challenging levels gradually, ensuring that the patient does not struggle excessively and their motivation does not decrease.
- The helical tube system used will allow the air to be delivered to and extracted from the respiratory tract at low velocity, low pressure, and for an extended period. It will also help improve diaphragmatic breathing.
- The horizontal orientation of the device eliminates the effect of gravity, making it easier for patients to use.

References

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