Physical, Chemical Science and Engineering

THE ROLE OF SPIROMETER IN EARLY DIAGNOSIS OF COPD

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Abstract: Spirometry is the standard respiratory function test to diagnose COPD. The diagnosis guidelines of COPD are based on the ratio between measurement of forced expiratory volume in one second (FEV) and forced vital capacity (FVC). As well as the presence of symptoms is a significant indicator promoting the early diagnosis of COPD and improve the successful management.

I. Introduction

Chronic obstructive pulmonary disease (COPD) is one of the most common disease related to lung function. COPD can be defined as chronic inflammatory disease affects human lung and prevent complete airflow. Leading to partially irreversible airway obstruction which makes limitation and difficulty to perform ideal emptying air of the lung. COPD is linked to other different clinical complications including increase the risk of heart diseases and lung cancer. Mainly, Emphysema and chronic bronchitis are the two main conditions influencing COPD developing. Chronic bronchitis is inflammation of the bronchial tubes, which carry air to and from the air sacs (alveoli) of the lungs. While emphysema leading to destroy alveoli at the end of bronchioles. Unfortunately, COPD symptoms don't appear until significant damages of lungs have occurred. Particularly, symptoms including wide variety of clinical indications such as; shortness of breath, wheezing, chest tightness, chronic cough and mucus. The World Health Organization (WHO) declared that the main cause of COPD in developing countries is smoking. While exposed to fumes from burning fuel in industrial countries is the main reason for COPD. In addition to that, research

studies showed that COPD can affect not only adult, but also infants and children. Around 1% of COPD cases resulted from genetic disorders associated with low level of certain type of protein known as alpha-1-antitrypsin. Moreover, other factors play a significant role in to influence COPD. Smoker people with asthma usually are at higher risk to develop COPD, as well as, workers who exposed to dust and chemical compounds for long time regarding to their occupational job are considered at high risk to irritate and inflame their lungs. Also, aging factor contribute to develop COPD slowly over years [1].

Consequently, patients with COPD are suffering from different types of clinical complications. COPD patients are associated to develop respiratory infections more likely than normal people. Leading to make treatment of infection much harder and difficult. Therefore, it is recommended to take annual vaccination of flu. On other hand, the risk of cardiac problems and lung cancer may increase with the presence of COPD. Also, pulmonary hypertension may occur regarding that COPD increase blood pressure in lung arteries. Furthermore, difficulty in breathing and dealing with chronic pain among COPD patients leading to prevent doing physical and social activities and may affect patient life negatively. Therefore, COPD is associated in some cases to hopelessness and depression.

Hopefully, most patients with COPD can achieve excellent

amount of exhaled air blown out as fast as possible.

symptom control and good quality of life by proper management and medication [2].

II. Methodology

Diagnosis of COPD based on full review of medical history and symptoms combined with medical instrumentation of pulmonary function test by spirometer. Lung function tests are used to diagnose COPD based on measurement of the amount of air during inhalation and exhalation. Spirometer measures the amount of air that can be hold in lungs during respiration process. The patient will be asked to blow fast and completely into a specific tube connected to sensor. The resulted measurement of spirometer detects the volume of exhausted air in one second and the total amount of exhale air in one forced breath. After that the resulted measurement are compared to standard chart according to patient age. Beside that, chest X-ray image can be useful to diagnose infections or lung cancer. Also, blood tests can be performed to determine any other clinical conditions that may produce similar symptoms of COPD.

II. Discussion

Spirometry technique is the most common diagnosis tool for COPD as shown in figure 1. Spirometer measurements cover all pulmonary function tests including the following:

FEV which is the forced expiration volume per one-time unit (one second).

FVC, the forced vital capacity of lung that represents the maximum

VC, the vital capacity which is related to the maximum volume of air that can be blown out as fast as possible.

PEFrepresents the maximum flow of exhaled air when blown out at steady rate.

IVC, inspiratory vital capacitance represents the maximum volume of air that can be inhaled after full expiration.

Figure 1: Spirometer for Lung Function Tests

Electronic spirometer shown in figure 1 measure the speed of air flow by ultrasonic transducer, the device consists of tube and oblique channel. cross sectional figure 2 shows the two ultrasonic sensors inside the tube mounted in opposite direction. Ultrasonic pulses with short intervals generated by patient breath and measure directly by the two ultrasonic transducers as emitted and receiving pulses in both directions.
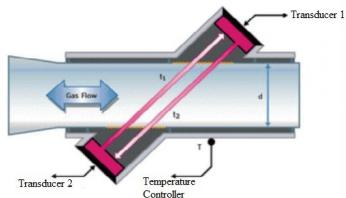

Figure 2: Cross-sectional View of Ultrasonic Transducers

Consequently, the obtained measurement of lung function is compared to reference values. Usually, the reference values which will be used to diagnose COPD are obtained via researches studies by one of the following: National Health and Nutrition Assessment Survey (NHANES III), European Community of Steel and Coal (ECSC), and Global Lung Initiative (GLI). However, these reference values are categorized according to height, weight, age, sex, ethnic origin, smoking habits, environment, working conditions and physical fitness. The below figure shows a resulted graph of spirometer for normal and abnormal patient [1].
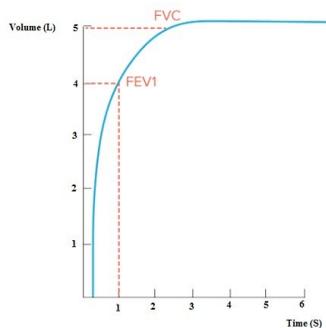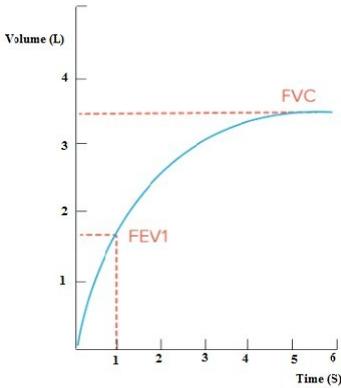

Figure 3: a- Spirometer graph for Healthy Patient

b- Spirometer graph for Non-Healthy Patient

Figure 3: a- Spirometer graph for Healthy Patient b- Spirometer graph for Non-Healthy Patient

In addition to that, FEV measurement is used to predict normality of lung functions. The ratio of 80% or higher represents healthy patients. While the ratio between (50%-79%) predicts moderate conditions. As well as, ratio below 30% predicts sever conditions as shown in below table [2].

FEV %	Prediction
> 80	Healthy
70-79	Mild
50-69	Moderate
30-49	Sever
≤ 30	Very Sever

Table 1: Prediction of COPD according to Forced Expiratory Volume (FEV1) %

Pulmonary obstruction is characterized by limitation in air flow resulted from poor muscle contraction, inflammation, mucus or airway collapse. Regarding spirometer measurements there will be decrease in

In addition to that, restriction of lung is described as loos in lung volume due to pulmonary fibrosis, oedema, obesity and chest wall disorder known as kyphoscoliosis. It characterized by decreasing in FVC value and high ratio of FEV/FVC. Besides that, mixed conditions based on spirometer measurement may be resulted when patients are heavy smokers and have fibrotic disease. Making it harder to interpret the measurements of spirometer. Therefore, further lung tests are recommended to obtain the correct diagnosis.
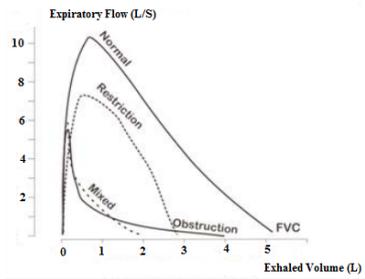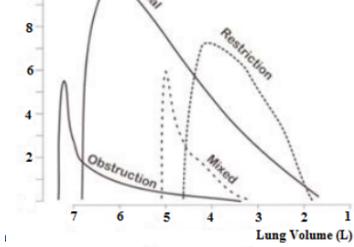
FEV, VC, FVC and FEV/FVC ratio [3].

Figure 4: Spirometer graph for Healthy, Restriction, Obstruction and Mixed pattern of COPD [4].

The above figure illustrates four examples of resulted graph by spirometer, showing four possible diagnosis based on spirometer measurements.

IV. Conclusion

Spirometer is a significant tool to perform measurement of lung function tests. Promoting the detection of early symptoms or indications for COPD. The correct utilization of spirometer leads to correct diagnosis and improve treatment options. In addition to that, early diagnosis is a key point for ideal management of COPD.

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