Critical Analysis on Review of Spirometry Research Work for Early Detection of Lung Diseases

Sujata Ambhore(✉), Vandana Bagal, and Ramesh Manza

Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurnagabad, Maharashtra, India
ambhoresujata2@gmail.com

Abstract. This paper presents the study of various spirometers and their techniques, which has been done before. Spirometry is nothing but a test that can be performed on those who have respiratory diseases. Handheld spirometers provide results for forced expiratory volume in one second (FEV1) and forced vital capacity (FVC), which can be manually compared to available estimated normal values. The most basic handheld spirometers offer one-second forced expiratory volume. Values of forced expiratory volume in one second (FEV1) and forced vital capacity in one second can be compared manually, using the normal available values.

Keywords: Spirometry · COPD · Cystic Fibrosis · Pulmonary Fibrosis · Forced Vital Capacity · FEV · Pneumotachometer · Arduino · Bluetooth

1 Introduction

A spirometry test may be recommended by our doctor if we have an issue with our lungs, such as trouble breathing. It is the most popular test. It determines the amount of air that can be pumped into the lungs (inhale) and expelled (exhale). It's a volume and flow meter [1]. The most common diseases on the rise are asthma, chronic obstructive 1pulmonary disease (COPD), cystic fibrosis, and pulmonary fibrosis. The most hazardous sickness with the potential to kill you. The flow and volume should be calculated using two of the most common parameters (Fig. 1).

- FVC (Forced Vital Capacity): This test reveals how much air we can intake and exhale in a specific length of time.
- Forced Expiratory Volume (FEV1): This statistic determines how well you can breathe.

2 Literature Review

(Vivek Agarwal & Ramchandran, N.C.S., et al., 2008). Spirometry is a test that is used to detect and diagnose a variety of lung diseases. It can also assist doctors in determining

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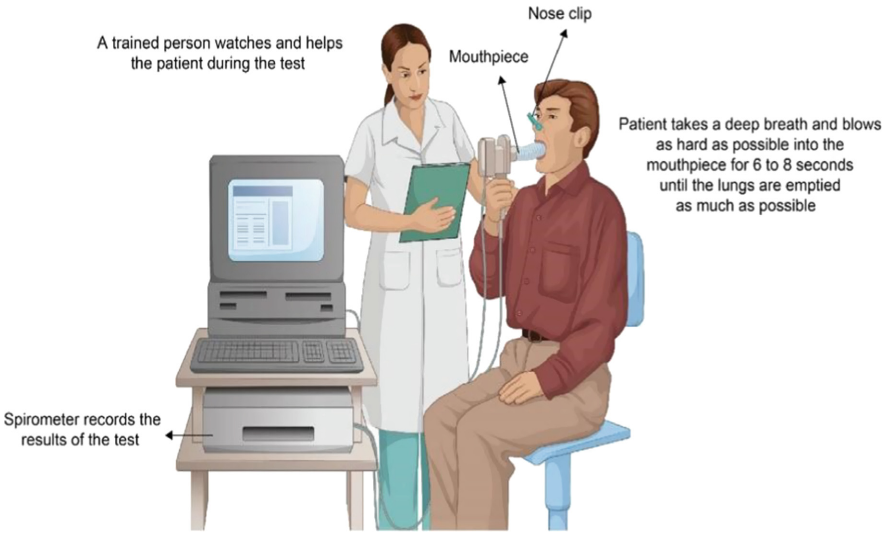

Fig. 1. Performing spirometry

whether or not the patient is receiving appropriate treatment. In this work, a MEMS pressure sensor is employed so that the patient does not have to travel to a faraway doctor [1]. In emergency situations, the patient can take an online exam and communicate immediately with the doctor. The spirometer is linked to the internet via web serverproposed unsupervised home spirometry technology, and it is also linked to the doctor by ethernet. These spirometers have a drawback in that they can only be used in conjunction with a computer.

(Jeremy Glynn and others) People with lung diseases cannot afford spirometers because of their high cost in middle and low-income countries [2], so the researchers tried to lower the cost of spirometers so that they are more accessible to people from all walks of life. In this paper, a fleisch-type pneumotachometer is used with a ZMD31014 iLite signal conditioner, and the internal capillary linearity is between $R2 = 0.98$. It makes the relationship between pressure and flow rate more linear. The software is utilized in Java. It calculates volume and flow. The patient's data is input into the graphical user interface, which calculates metrics like FVC, FEV1, PEF, and the FEV1/FVC ratio. The 3L syringe is used for calibration. It also shows a graph. The accuracy of the device can be increased.

(Cristina Ramos Hernadez et al. 2018) compares two spirometers, an air smart spirometer device, and a traditional spirometer device, in two different hospitals, in terms of FEV1, FEV, and FEV1/FVC ratios to determine the eligibility of the air smart spirometer, which is a small portable device that can connect to a mobile device via Bluetooth [1] and analyses the obstruction in both devices. To determine the values of (PPV) and (NPV) meanings (LR +, LR-), the Kappa Index is employed [3].

After matching, the intraclass correlation coefficient (ICC) and the personal correlation coefficient (r) were used to compute the FEV/FVC ratio. Limiting these studies can be done under the supervision of respiratory specialists or nurses so that other people can benefit from them.

(Maeceij Kupczyk et al. 2019) proposed unsupervised home spirometry measurement. Among asthma patients, 86 patients performed a spirometry test on Air- Care mobile spirometer system for 7 days. Of that, 96% of patients used these devices correctly [4]. Some patients cannot handle the spirometry test so, they need to repeat the test. A 90% result is good. Home spirometry is effective for in-home monitoring in emergency cases of asthma.

(Ping Zohu, Liu Yang, and Yao-Xiong Huang, et al., 2019) developed a spirometer that has a flow sensing unit which is made up of a Lilly-type pneumotachometer with a differential pressure sensor that takes the respiratory signal and produces the data to a smartphone or mobile terminals via Bluetooth [4]. A spirometer is eligible to check flow rates, which are ranging from 0–15 L/s and are equivalent to 4 mL/s [5]. It goes through parameters that are FV, FVC, and FEV1 [4]. The test was performed on 12 people, 8 males, and 4 females in the range of 20–65 years. As compared to laboratory spirometers if able to fulfill all the requirements of (ATS/ERS). And it is affordable, handheld, with less use of power. Through this device, it is the easiest way for both doctors and patients and can monitor patients at home, lilly people 20–65 years. Patients.

(D.M. Maree et al. 2001). The Diagnosa is a comprehensive system that can determine spirometry, ECG, blood pressure, and body composition. Data can be sent in real-time. The internet is routed through a remote receiving center. The main goal of the study was to conduct biological testing on the component of spirometry in people with a normal and pulmonary function that is abnormal [6]. A team of researchers used a variety of methods to come up with A total of 45 patients (average age 43.3 years, 30 men) who were tested, both in the Diagnosa and the Jaeger Masterlab as per the guidance of American Heart Association's guidelines, which is followed by spirometer [5]. The Thoracic Society is a non-profit organization dedicated to improving health. Each of the three subgroups had 15 individuals. Spirometry normal, obstructive, and restricted airflow limits were chosen. All measures were successful. Conducted with the Diagnosis (FVC, FIVC, FEV1, PEF, FEF25, FEF50, and FEF75) had a strong correlation ($r = 0.92$–0.99) with those who worked with. Between study was health.

(M.Udin Harun Al Rasyid Kemalsari, et al. 2018) proposed an E-Spiro device that calculates flow and volume data through an e-spiro app on mobile through Bluetooth connection. It measures FVC, and FEV1and is effective in the diagnosis of COPD. This research develops an android messaging, JavaFX desktop, and website-based information system that is integrated with a portable spirometer. To determine the pressure during FVC, the MPX5100DP sensor is used, as well as Spirometry test tracking and maintenance with an Arduino nano [7].

(Stefania Zanconato et al. 2005) compare children's specialist offices and laboratory tests with a handheld spirometer. The test was performed on 109 children aged 6–15 with the help of a turbine flow sensor in the PF laboratory FVC, FEV1and FEF between 25% & 75% [8]. The repeatability Coieffiecient was 0.26L for FEV1 0.30L, health FVC 0.58 & FEF 79%. Both primary care specialists and laboratory centers are recommended for effective training & quality assurance.

(Lizarezu Maulidil Li Kharis et al. 2020) developed a spirometer by using MPXV7002DP sensor and build with graphical display lung condition on a Nexation TFT LCD. The goal of lung function is FVC, FEV1, and VC. The sensor is present in the mouthpiece on the venturi meter law using an Arduino. By VC measurements obtained with the MPXV7002DP sensor to those obtained with a typical spirometer device utilizing a 3-L spirometer Kalibrator Media [9]. VC's maximum error value is 1.58%, according to the data. The limit of value is below 5% error tolerance.

(M.Kumar et al.) Spirometry is not available in rural areas in this condition they developed a tele-spirometer device it can be monitored remotely and can be easily installed in an ambulance. The data can be recorded and stored in a web server and sent to the doctor through a telemedicine application [10]. The test was conducted on 366 people 95% of people were satisfied. It is cost-effective and very useful for the rural area for monitoring.

(Lia Andriani et al. 2019) The objective of the spirometer is to assess lung function FVC and FEV1 in order to discover problems in the lungs. FVC error of 0.98 percent 5, FEV13.83 percent, and FEV1/FVC2.50 percent are the results of the Arduino micro-controller, LCD, and SD Card memory, as well as the MPX5100DP gas pressure sensor [11]. This spirometer is reasonably priced.

(Marial et al. 2015) In order to illustrate how to use a spirometer and employ honeywell ASDX Series Pressure Sensor, developed a low-cost spirometer [13].

(Reginald Waston et al. 2019) Utilizing an Arduino Nano, a spirometer was developed. Also described how to build a spirometer with an MPX5010DP air pressure sensor [14].

(M. Laghrouche et al. 2016) developed a spirometer that uses a platinum hot wire sensor with MEMS technology and transmits data to the hospital over a GSM network using Bluetooth.

(E-J. Maalouf et al. 2018) In this study, the asthma irritant monitoring system(AIM)prototype is described. The AIM is a little sensor that senses its surroundings.Irritants around the patient to look for any indications of asthma attacks or possibly harmful surroundings as a result, asthma patient can determine whether the environment is healthy around them will enable them to take the proper action. In order to monitor a patient, the device also has the capability of communicating the data to the doctor. DHT22 and BMP180 sensors are utilised with the Raspberry Pi. [15] The patient's case and a display showing the state of the patient's surroundings. Additionally, the AIM shows data that has been rearranged in the daily testing enabling the patient and the doctor to review the result of earlier days improvement.

(Marielle W. Pijnenburg et al. 2015) the goal is to superwise asthmatic children. This ERS Task Force's objectives were to describe the current. The most reliable research on how to monitor asthmatic kids. [16] The literature was examined by 22 clinical and scientific professionals. Four Task Forces, a modified Delphi methodology, and Consensus was reached through meetings Table 1.

Table 1. List of various authors and their used techniques are given below in the table.

Sr No	Author Name	Lung Function Test Parameter	Sensor	Device	Result
1	N.C.S Ramchandra n	NA	MEMS pressure sensor	Web-server based spirometer	NA
2	Jeremy Glynn	PEF, FVC, FEV1	ZMD31014 Ilite signal conditioner	Fleish type pneumotachometer	$R^2 = 0.988$
3	Cristina Ramos Hernadez	FEV1, FVC, FEV1/FVC	NA	Air-Smart spirometer	NA
4	Maciej Kupeayk	FEV1, FVC, PEF	NA	Aio-care	P = 0.013
5	Ping zohu	FV, FVC and FEV1	NA	Lillytype pneumatometer	NA
6	D.M.Maree	FVC, FIVC, FEV1, PEF, FEF25, FEF50, and FEF75	NA	Diagnosa	(r = 0.92–,0.99)
7	M.udin Harun Al Rasyid Kemalsari	FVC, FEV1	MPX5100DP	E-Spiro	NA
8	Stefania Zanconato	FVC,FEV1, FEF	Turbine flow sensor	Microloop	+ –1.96
9	Lizarazu Maulidil Li Kharis	NA	MPXV7002 DP	NA	NA
10	M.Kumar	NA	NA	Tele Spirometer	NA
11	Lia Andriani	FVC, FEV1, FEV1/FVC	MPX5100DP gas pressure sensor	Spirometer	0.98% of 5
12	Reginald Waston	FVC, FEV1, FEV1/FVC	MPX5010DP air pressure sensor	Spirometer	NA
13	Marial	FVC, FEV1, FEV1/FVC	ASDX Series PressureSensor	Spirometer	NA

(*continued*)

Table 1. (*continued*)

Sr No	Author Name	Lung Function Test Parameter	Sensor	Device	Result
14	M. Laghrouc he	FVC, FEV1, FEV1/FVC	Platinum hot wire sensor	Spirometer	NA
15	E-J. Maalouf	Humidity, Temprature, smoke, pressure	DHT22 and BMP 180	AIM	NA

3 Conclusion

Spirometers and technique of various varieties were utilised in the investigation. Different types of sensors are employed, as well as a variety of parameters. The acronyms FVC, FEV, FEV and FEV are used. Spirometry is a powerful tool for detecting early illness changes and confirming diagnoses using physiological evidence. It can be used to assess disease progression and therapy response when done correctly. It can now be done with the development of portable meters. Anyone with the ability to perform it everywhere and by anyone with the ability to perform it good education.

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