THE ROLE OF SPIROMETRY AND ITS BENEFIT TO ASSESS RESPIRATORY SYMPTOMS IN THE SEMERU VOLCANIC ERUPTION COMMUNITY SERVICES

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ABSTRACT

Spirometry is a standard diagnostic tool for respiratory diseases. The people who live around the volcanic eruption may have a respiratory problems, both acute and chronic conditions. The aim of this study is to evaluate whether spirometry can be used as a diagnostic tool in the context of disaster in particular volcanic eruption. Data was obtained from medical examination in community services of Semeru volcanic eruption affected community in Pronojiwo, Oro Oro Ombo, Lumajang in last January 2022. Spirometry was performed for the patient who had a respiratory problems. Data was analyzed descriptively to assess lung function test using spirometry and its benefit in the people affected by volcanic eruption. Among the subjects, 77.27% had abnormal findings from the spirometry result. The mean of %VC, % FVC and % FEV1/FVC were 71.49%; 74.58%; 74.39% respectively. The result of spirometry revealed normal, restriction, and obstruction with suggestive restriction 18.18%; 22.73%; 31.82%; 22.73% respectively. The evaluation of spirometry parameters showed that 54.55% was appropriate for clinical diagnosis made by a physician. Our data show that most subjects had an abnormal results from spirometry. Spirometry may be a diagnostic tool can be used in natural disasters, particularly volcanic eruption for assessing respiratory symptoms.

KEYWORDS

Community; Diagnostic; Spirometry, Volcanic Eruption

INTRODUCTION

Pulmonary function tests are an important tool to assess and evaluate patients with respiratory pathology. They provide important data on the large and small airways and lung parenchyma [1]. Spirometry is the most widely used measure of lung function as a diagnostic tool and an effective procedure for evaluating obstructive from other lung abnormalities [2]. Obstructive lung disease, including asthma [3], bronchiectasis [4], chronic bronchitis, emphysema, or COPD[5]. Restrictive lung diseases are defined by the restrictive pattern of spirometry and may result from abnormalities in the pleural, alveolar, interstitial, neuromuscular and thoracic cages [6].

Indonesia is well known as a volcanic country, with more than 30% of total volcanoes in the world located in Indonesia [7] and approximately 130 active volcanoes spread among the Indonesian archipelago [8]. Volcanic ash can affect respiratory health with both acute and chronic impacts [9]. This study was conducted to evaluate lung function by spirometry in the people affected by Semeru volcanic eruption in December 2021.

MATERIALS AND METHODS

This research employs a descriptive method. The data was obtained from medical examination in the people affected by the Semeru volcanic eruption in Pronojiwo, Oro Oro Ombo, Lumajang in last January 2022 (approximately one month after the eruption). The study population was people who attended healthcare services with respiratory problems. The inclusion criteria were subjects with respiratory problems, both acute and chronic symptoms, and living near the Semeru volcanic eruption. The data was obtained from one visit examination study and has not been continued as a

follow-up study. The physicians and spirometry operators were Pulmonologists and Respiratory Medicine Residents.

Demographics and clinical data were obtained, including sex, age, body weight, body height, the distance of living place from the eruption center, occupations, history of smoking, gas or smoke exposure, clinical symptoms, comorbidities, and vital signs. The Likert scale was used for assessing the obedience of masks used in daily activities within the 1-10 range (1 is disobedient and 10 is very obedient).

Spirometry was performed on both SVC and FVC maneuvers. Spirometry results were divided into four categories, including normal if there were no abnormalities of both obstruction and restriction, obstruction if FEV1/FVC <5th percentile of predicted, restriction if there was a reduced VC when FEV1/VC was normal or increase, and obstruction and suggestive restriction (mixed defect) if there was a decrease FEV1/FVC < 5th percentile predicted and reduced of VC [10]. We are preferable use the largest VC whether obtained from slow vital capacity (SVC) or forced vital capacity (FVC) because the FVC is usually reduced more than SVC in airflow obstruction [10]. Interpreting Lower Limit Normal (LLN) in the spirometry result is problematic. We used the normal predicted spirometry measurement calculated by spirometry machine according to race, sex, age, and body height of subjects. In the context of community services, it was difficult to get the criteria of reproducibility/ repeatability or usable. So the criteria of acceptability were used for all the subject spirometry.

Physicians made the clinical diagnosis based on anamnesis and physical examination. The data of clinical diagnosis was not supported by radiology and laboratory examination. We compared the result of spirometry with clinical diagnosis by a physician and defined *criteria* of spirometry suitability as a diagnostic tool, including appropriate, not appropriate, and not applicable (n/a). Appropriate means spirometry result is appropriate with minimal one of clinical diagnosis. Not appropriate means spirometry result is not appropriate with clinical diagnosis. Not applicable (n/a) means the clinical diagnosis is not associated with spirometry as a diagnostic tool; there is no clinical diagnosis data, or spirometry results cannot be concluded because of a lack of data. Data were analyzed descriptively, and the data was calculated by Microsoft Excel.

RESULTS AND DISCUSSION

Subjects consisted of 22 people with respiratory symptoms and living near the Semeru mountain eruption. Subject characteristics and clinical parameters can be seen in Table 1. Most of the subjects were female (68.18%). The average age was 41.48 years old. The average body height and weight were 57.79 kg and 150.36 cm, respectively. The average distance for distance house from the mount eruption was 4.77 km. Our data showed that 7 (31.82%) subjects were exposed to gas or smoke while working, including firewood, burned trash, pesticide, and household smoke waste. The subjects were quite obedient (scale of 6.48) to mask use in daily activities by evaluating the subjective Likert scale (scale 1 is disobedient and scale 10 is obedient). Most subjects had a cough (72.73%), and 11 (50%) subjects complained about shortness of breath.

Spirometry parameters and clinical diagnosis can be seen in Table 2. Our data showed that among of the subjects, 17 (72.27%) had abnormalities for spirometry results including restriction, obstruction and obstruction with suggestive restriction 22.73%; 31.82%; 22.73% respectively. The mean of %VC, %FVC and FEV1/FVC were 71.49%; 74.58%, and 74.39% respectively. The most common diagnoses in the context of respiratory disease made by physicians were COPD and asthma. Obstructive pattern (with or without restrictive) from spirometry results was found in 10 (45.45%) subjects, and restrictive pattern (with or without obstruction) was found in 8 (36.36%) subjects. The suitability of spirometry as a diagnostic tool according to clinical diagnosis by physicians can be seen in figure 1. Spirometry results were appropriate at 54.55% with the clinical diagnosis, and 18.18% were not appropriate with clinical diagnosis, including normal findings in the diagnosis of pneumonia and post tuberculosis obstructive airway disease (Post TB-OAD) and restrictive pattern in one case of asthma.

A volcanic eruption can affect acute and long-term respiratory health. The acute and chronic health effects of volcanic ash depend on particle size, mineralogical composition, and the Physico-chemical particles of the surfaces of the ash [9]. Our data showed that 72.73% of patients had a cough, and 50% had shortness of breath which is 59.09% of clinical diagnoses revealed obstructive lung diseases like asthma and COPD (with or without other clinical diagnoses). This finding is supported

by the spirometry result, in which 54.55% had an obstruction pattern (obstruction only and obstruction with suggestive restriction). In our opinion, this finding can be interpreted as worsening of clinical symptoms of the subjects because of the eruption impact. The acute effects of volcanic ash on respiratory health have been well described. A review stated that acute respiratory symptoms suggesting asthma and bronchitis and exacerbations of pre-existing lung disease are common after inhalation of eruption ash [11]. The one that can impact respiratory health is the Vog exposure. Vog is a cloudy air mixture of sulfur dioxide (SO_2), water vapor, carbon dioxide, sulfate particles and volcanic ash [12]. Vog exposure may lead to respiratory problems following a volcanic eruption in people with a history of pre-existing conditions, including obstructive airway disease (asthma, bronchitis, bronchiectasis, Chronic Obstructive Pulmonary Disease (COPD)), cardiovascular disease, infants and elderly, and pregnancy. [12]. People with asthma and COPD may develop bronchoconstriction that causes clinical symptoms such as shortness of breath, wheezing, and cough [12]. A cross sectional study conducted by Shimizu et al stated that in the ash that fall over 100 g/m^2 area can affect asthma clinical condition such as exacerbations, decrease Peak Expiratory Flow (PEF) and increase asthma treatments [13] Interestingly another study stated that the peak of acute respiratory symptoms did not coincide with the eruptions and the higher emissions of SO_2 were not associated with higher incidence of acute respiratory symptoms [14].

Our study showed that the results of spirometry approximately one month after eruption, including normal, restriction, obstruction, and obstruction with suggestive restriction, were 18.18%; 22.73%; 31.82%; 22.73%, respectively. This finding revealed that most subjects with respiratory symptoms decline in lung function approximately one month after the eruption. This finding may suggest the possibility of a decrease in lung function because of acute exposure to volcanic eruption particles. Our finding is supported by the study from Ramos et al., which stated that significant low forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1) during the major exposure period improved seven months later [15]. In our opinion, the decline of the subject's lung function can be caused by an acute decline of the lung function because of eruption particle exposure or subjects already have a pre-existing condition or worsening of the lung function in the context of subjects have a pre-existing condition. It is unclear yet because we do not know the baseline of the subject's lung function, and this study did not evaluate the subject's lung function after acute exposure.

CONCLUSIONS AND SUGGESTION

Most of subjects with respiratory symptoms have an abnormal finding from spirometry results. Most of the spirometry results is appropriate with clinical diagnostic had been made by physician. This finding suggest that spirometry has a benefit as a diagnostic tool in the context of natural disasters, particularly in volcanic eruptions. However, further studies are still needed with large number of subjects and post-evaluation spirometry examination after acute volcanic eruption exposure.

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Table 1. Subject characteristics and clinical parameters

Characteristic dan Clinical Parameter	**Value (n=22)**
Sex	
- Male	7 (31,82%)
- Female	15 (68,18%)
Age (year)	41,48 (11-67)
Body weight (kg)	57,79 (36,1-96)
Body height (cm)	150,36 (140-170)
The distance of living place from eruption (km)	4,77 (0,1-50)
Occupation	
- Teacher	3 (13,64%)
- Housewife	4 (18,18%)
- Farmer	7 (31,82%)
- Carpenter	1 (4,55%)
- Cook	1 (4,55%)
- Volunteer	1 (4,55%)
- Student	1 (4,55%)
- Trader	1 (4,55%)
- n/a	3 (13,64%)
History of smoking	
- Active smoker	6 (27,27%)
- Passive smoker	7 (31,82%)
- Non-smoker	9 (40,91%)
Gas/smoke exposure while working	7 (31,82%)
Mask use obedience in daily activities (likert 1-10)	6,48 (4-10)
Clinical symptoms	
- Shortness of breath	11 (50%)
- Chest pain	4 (18,18%)
- Cough	16 (72,73%)
- Fever	1 (4,55%)
- Sore throat	1 (4,55%)
- Nasal congestion	2 (9,10%)
- Headache	4 (18,18%)
Comorbidities	
- Hypertension	4 (18,18%)
- Diabetes	1 (4,55%)
- Tuberculosis	2 (9,10%)
- Asma	2 (9,10%)
Vital signs	
- Pulse rate (times/minutes)	90,95 (69-118)
- Respiratory rate (times/minutes)	20,45 (20-29)
- Oxygen saturation (%)	96,59 (94-98)
Spirometry parameters	
- VC (mL)	1971,82 (860-2990)

- %VC	71,49 (32,80-111,9)
- FVC (mL)	2067 (930-3360)
- %FVC	74,58 (48-104,3)
- FEV1/FVC (%)	74,39 (38,82-100)
Spirometry conclusion	
- Normal	4 (18,18%)
- Restriction	5 (22,73%)
- Obstruction	7 (31,82%)
- Obstruction with suggestive restriction	5 (22,73%)
- n/a	1 (4,55%)

Values are presented as number (%) or mean (lowest-highest). Abbreviation : Vital Capacity (VC) ; Forced Vital Capacity (FVC); Forced Expiratory Volume in 1 second (FEV1

Table 2. Spirometry parameters and clinical diagnosis

Subjek	**VC pred (mL)**	**VC (mL)**	**VC (%)**	**FVC (mL)**	**FVC (%)**	**FEV1/ FVC (%)**	**FEV1/ FVC pred (%)**	**Conclusion**	**Clinical diagnosis**
1	2620	860	32,80	1280	48	100	89,22	Restriction	n/a
2	2100	2350	111,90	1660	79	86,14	85,07	Normal	Pneumonia
3	2270	2000	88,10	2000	88,10	82	86,18	Normal	Pneumonia
4	2490	1470	59	1600	64,30	53,75	86,81	Obstruction, suggestive restriction	Asthma
5	2700	1340	49,60	1630	60,40	82,82	89,40	Obstruction, suggestive restriction	Asthma
6	3110	1700	54,70	3270	69,80	100		Restriction	HT
7	2900	1810	62,40	2740	94,50	63,14	86,25	Obstruction	HT
8	4050	1900	46,90	2720	67,20	n/a		n/a	n/a
9	2900	2440	84,10	1570	54,10	52,87		Obstruction	COPD
10	2200	2030	92,30	1130	51,80	88,60	81,73	Normal	Post TB-OAD
11	4550	2030	44,60	3040	66,80	76,97		Restriction	Asthma
12	2160	2990	138	3360	155	71,43	80,58	Obstruction	COPD + HT
13	2810	2370	84,30	930	33,10	47,30	80,25	Obstruction	COPD + HT
14	2440	2250	92,20	2160	88,50	87,96	90,30	Normal	Asthma
15	3200	2190	68,40	2470	77,20	74,49	85,81	Obstruction, suggestive restriction	HF + HT
16	2750	1970	71,60	1920	69,8	88	87,68	Restriction	URTI + HT
17	2570	2550	99,20	2680	104,30	81,72	87,56	Obstruction	n/a
18	3340	2230	66,80	2530	75,70	80,24	86,35	Obstruction, suggestive restriction	Asthma
19	2270	1690	74,40	1520	67	38,82	86,16	Obstruction, suggestive restriction	COPD
20	2230	990	44,40	1590	71,30	95,60	84,74	Restriction	COPD + HT + HF
21	2780	2240	80,60	1670	60,10	70,06	87,90	Obstruction	Asthma
22	2130	1980	93	2020	94,80	65,84	85,29	Obstruction	COPD

Abbreviation : Vital Capacity (VC) ; Forced Vital Capacity (FVC); Forced Expiratory Volume in 1 second (FEV1); Hypertension (HT); Heart Failure (HF); Upper Respiratory Tract Infection (URTI); Chronic Obstructive Pulmonary Disease (COPD)

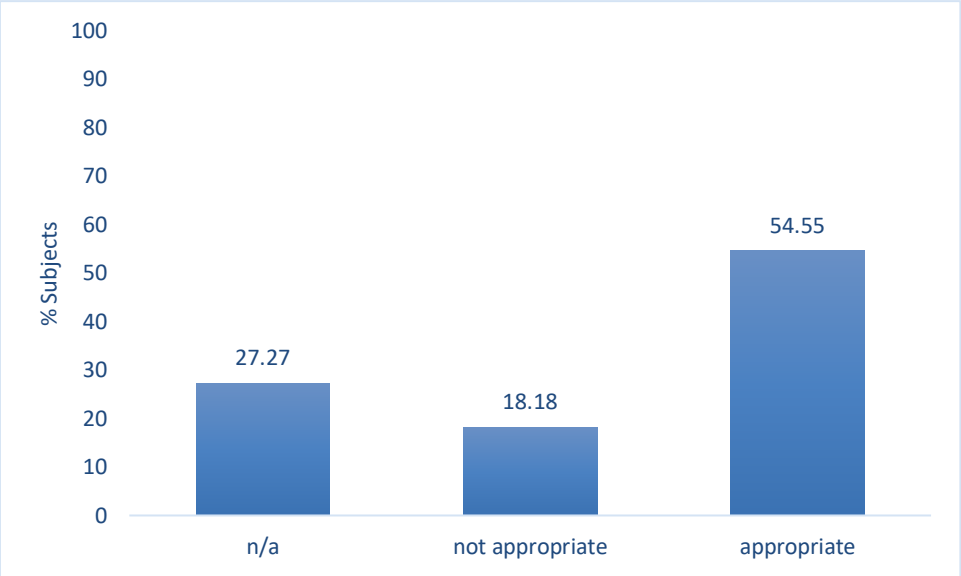

Figure 1. Suitability spirometry as a diagnostic tool according to clinical diagnosis. The result of spirometry appropriate 54,55% and 18,18% not appropriate with clinical diagnosis made by physician.