Artikel Penelitian

Description of Thoracic Expansion and Mobility Capacity in Covid-19 Patient in Isolation Ward

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Abstract

Introduction. *COVID-19 patient not only experienced respiratory manifestation, but they also generate generalized muscle weakness. This manifestation results in deterioration of physical capacity.*
Methods. *This cross-sectional study identified the characters of COVID-19 patient based on their age, gender, severity of disease and whether they have comorbidities or not. This study also described the functional capacity using a modified 30-Second Sit-to-Stand Test (m30STS) and chest expansion measured at three levels (axillary, nipple, and xiphisternum).*
Result. *M30STS was one of reliable measure that used for physical or functional capacity. Chest wall expansion determines lung volume and functional capacity as well. Eighty-five subjects in isolation ward were enrolled. This study shows there is reduction of functional capacity in COVID-19 patients. Majority of subjects tend to reached lower number of repetitions in m30STS or about 10.37 times in average.*
Clonclusion. *The thoracic expansion was reduced below normal range in all subjects.*

Keyword: *Covid-19, Physical Capacity, Chest Expansion*

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Gambaran Ekspansi Toraks Dan Kemampuan Mobilisasi Pada Pasien Covid-19 Di Ruang Isolasi

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Abstrak

***Pendahuluan**. Pasien COVID-19 tidak hanya mengalami masalah pernapasan, tetapi juga dapat merasakan kelemahan otot. Gejala ini dapat mengakibatkan penurunan kapasitas fisik pada pasien.*
***Metode**. Penelitian dilakukan dengan desain potong lintang untuk mengidentifikasi karakteristik pasien COVID-19 berdasarkan usia, jenis kelamin, derajat keparahan, dan adanya komorbid. Penelitian ini juga memberikan gambaran kapasitas fungsional dengan menggunakan Uji Duduk Berdiri 30 detik yang dimodifikasi (m30STS) dan pengukuran pengembangan dinding dada yang diukur pada tiga tingkat pemeriksaan (aksiler, nipple, dan xiphisternum).*
***Hasil**. M30STS merupakan salah satu pengukuran yang dapat dipercaya untuk menilai kapasitas fungsional. Selain menggambarkan volume paru, pengembangan rongga dada juga dapat menilai kapasitas fungsional. Sebanyak 85 subjek di ruang isolasi dilibatkan, asil penelitian ini menunjukkan memang ada penurunan kapasitas fungsional pada pasien COVID-19. Rerata jumlah repetisi pada 30STS adalah 10,37 kali atau di bawah nilai normal.*
***Kesimpulan**. Pengembangan rongga dada juga didapatkan menurun pada semua subjek.*

***Kata Kunci:** Covid-19, Kapasitas Fisik, Pengembangan Rongga Dada*

Introduction

The clinical manifestations of coronavirus infection vary from asymptomatic carriage to atypical pneumonia, respiratory failure, and acute respiratory distress syndrome (ARDS). Covid-19 patient adhere to pulmonary damage in physiological and radiological. The radiological changes in Covid pneumonia do not appear to resolve completely in all patients. In some, inflammation matures to form residual pulmonary fibrosis.[1] As the most affected organ by corona virus, the lung shows pathologies form including diffuse alveolar epithelium destruction, capillary damage/bleeding, hyaline membrane formation, alveolar septal fibrous proliferation, and pulmonary consolidation. Previous studies have demonstrated impaired lung function was common in recovered patients with coronavirus pneumonia and it could last for months or years.[2] Pulmonary fibrosis not only revealed in computed tomography, but able to seen in functional impairment. It is possible that covid survivors experience persistent physiological impairment and radiological abnormalities. In previous study, it was found that radiological abnormalities were correlated with lung function test parameters for six months. This finding conclude that imaging abnormalities were physiologically relevant and related to parenchymal lung disease.[1]

Beside the respiratory manifestation, Covid-19 patient experienced generalized muscle weakness, as the result from the course of an ICU admission which is labelled "Intensive Care Unit Acquired Weakness" (ICUAW).[3] Skeletal muscles and other cells in the muscles like satellite cells, leukocytes, fibroblasts, and endothelial cells express

ACE-2. The skeletal muscles are susceptible to direct muscle invasion by coronavirus. Other possible mechanisms suggested deposition of immune complex in muscles, release of myotoxic cytokines, and adsorption of viral protein on muscle membranes leading to expression of viral antigens on myocyte surface. Whether the exact mechanisms for myositis which is responsible for myalgia related to covid-19 infection are remain unknown.[4]

Previous study provides that Covid-19 patients have significantly reduced functional capacity similar to patients with other respiratory dysfunctions. This will have an effect on their activities of daily living and their participation in society and thus quality of life. The feature of Covid-19 infection is ventilation perfusion mismatch. This causes reduced oxygen diffusion which in turn results in breathlessness and exercise intolerance that has an impact on their physical activities of daily living. Daily activity and simple task such as sit to stand is more likely become difficult as oxygen diffusion to the muscles is reduced.[5]

Modified 30-Second Sit-to-Stand Test (m30STS) is commonly used for assessing individual's lower extremities muscle strength also physical performance. This test is easy to perform and unexpensive. Subjects were instructed to sit on the chair with 45cm height, back straight, feet approximately shoulder-width apart, and placed on the floor with one foot in front of the other to help maintain balance when standing.[6] Then they were instructed to get up to standing position until hip and knee are fully extended and back to sitting position. They were permitted to use their upper extremities and armrests. The examiner encouraged the subjects to perform this maneuver as fast as possible for 30 seconds. The number of completed STS repetitions was recorded.[7]

ICUAW may affect respiratory muscles as well. Reducing of respiratory muscle function affected normal breathing.[3] The measurement of thoracic expansion can be used to determine the respiratory function. Thorax expansion measurement was done by using the midline.[8] In the present study, chest expansion was taken on three levels: axilla level, nipple level and xiphisternum level. Measurements were made at the peak of inspiration and maximum expiration. Increasing the expansion of the thorax cage will affect respiratory control, coughing ability, and lung vital capacity. The subjects were instructed to breathe out as much as they can and then asked to take a deep breath as much as they can.[9] The vital lung capacity is the maximum volume of air released by the lungs after maximum inspiration. Measurement of vital lung capacity can give important information about the strength of respiratory muscles. Previous studies were also provided that there was a correlation between the vital lung capacity with the mobility of the thorax. If the thorax expansion decreases, the vital lung capacity will also reduce, and so will the contrary.[8]

Methods

This study was using cross sectional study design. The aim is to describe the functional capacity measured by m30STS and thoracic expansion in covid patient in isolation ward. This study took place on isolation ward on December 2020 to March 2021.

Among 85 subjects were included in this study with inclusion and exclusion criteria. The inclusion criteria were patient with COVID-19 in isolation ward in Universitas Indonesia Hospital, age above 18 years old, which were alert and cooperative, capable to walked independently without assisted-walking device and were willing to take part in this study. The exclusion criteria were patient with neurological disorder, side-weakness in lower extremity, had psychiatric and cognitive impairment.

The subjects' characteristics including gender, age, comorbid and degree of Covid-19 severity. The age was categorized as young adult (<40 years); productive adult (40–60 years); and elderly (>60 years). The degree of severity was described as moderate, severe, and critically ill based on their oxygen saturation (SpO2). A saturation between 90–94% on room air was described as moderate disease, and SpO2 below 90% on room air was categorized as severe disease. While the critical disease that was mentioned in this study referred to subjects with oxygen impairment or respiratory failure who had been moved from intensive care unit. Assessment was done in isolation ward days after patient has medically improved.[10]

Data analysis was conducted by using SPSS version 26.0. The significant level was set at $p < 0.05$ for all statistical procedures. Univariate analysis was performed to evaluate the distribution of subjects descriptively regarding age, gender, comorbid, degree of Covid-19 severity, m30STS results and thoracic expansion measured in three levels (axillary, nipple, xiphisternum).

Results

Characteristics of Patients

Table 1. Demographic Description of Covid-19 Patients in Isolation Ward

Variable	N	%	Mean±SD
Gender			
Male	44	51.76	
Female	41	48.24	
Age			
< 40 years	28	32.94	
40–60 years	45	52.94	47.18±1.477
>60 years	12	14.12	
Comorbid			
(+)	63	74.12	
None	22	25.88	
Covid-19 Severity			
Moderate	59	69.41	
Severe	21	24.71	
Critical	5	5.88	

Clinical Outcome

The characteristics of Covid-19 patients in isolation ward mentioned in Table 1 were gender, age, comorbid and degree of severity. Based on gender, majority subject in isolation ward was male (51.76%). Age was categorized into three groups consist young adult (below 40 years), productive adult in range of 41–60 years old, and elderly in 60 years old and above. It was shown that productive age more likely involved in this study consist of 45 subjects (52.94%) followed by young adult group in number of 28 subjects (32.94%). From the Table 1, it also mentioned that 63 subjects (74.12%) have comorbid and 22 subjects (25.88%) didn't have any comorbid. Based on the degree of severity, it was shown that moderate covid was high in number consist 59 subjects out of 85 (69.41%), followed by severe degree with 21 subjects included (24.71%).

Table 2 showed us the number of repetitions achieved on m30STS. There were 54 subjects (63.53%) reached the sit to stand test below 12 times for 30 seconds and only 31 subjects (36.47%) could achieve more.

The thoracic expansion was measured in three levels which were axillary, nipples and xiphisternum levels. The average of thoracic expansion in this study for each level were 2.57cm; 2.78cm; and 2.88cm.

Table 2. 30-second Sit-to-stand Test Results and Thoracic Expansion in Three Level Measurement of Covid-19 Patients in Isolation Ward

Variable	N	%	Mean±SD
30-Second Sit-to-Stand Test			
< 12 times	54	63.53	10.37±0.431
≥ 12 times	31	36.47	
Thoracic Expansion			
Axillary			2.57 + 0.057
Nipple			2.78 + 0.084
Xiphisternum			2.88 + 0.087

The m30STS scores in table 3 showed that the number of repetitions in female subjects were 10.37 times in average and 10.61 times for the male group. This table also showed that productive age (41–60 years old) groups showed highest number of 30STS (10.73 + 3.75 times) results in any other age groups. In the other hand, subject in elderly group (> 60 years old) reached only 9.17 repetitions in this test.

The subject who doesn't have any comorbid reached 10.63 times repetition in 30 seconds and the group with comorbid reached 10.37 times repetition. Based on the degree of severity, the m30STS results were 10.66 times in patient with moderate disease; 9 times in severe disease; and 12.8 times in critical disease.

The thoracic expansion's mean for each group on table 3 were about 2.3–3 cm at all three levels. In axillary levels, subjects with no comorbid has the highest value of chest expansion (2.70 ± 0.43cm) and the lowest value was accomplished by critical groups. The higher value was showed in male; productive adult (41–60 years); and moderate Covid-19 disease groups at nipple levels. The xiphisternum level reached the highest value than any other level of measurement, which reached 3.04 cm.

Discussion

The higher incident Covid-19 in male were explained in the present study. There was a greater number of men than women in the 99 cases of 2019 Covid infection similar

Table 3. Mean 30-second sit-to-stand Results and Chest Wall Expansion Based on Characteristic (Gender, Age, Severity, Comorbid)

Variable	30-Second Sit-to-Stand Test	Thoracic Expansion		
		Axillary	Nipple	Xiphisternum
		Mean ± SD		
Gender				
Male	10.61 ± 3.93	2.57 ± 0.54	2.86 ± 0.75	2.86 ± 0.71
Female	10.37 ± 3.97	2.56 ± 0.50	2.76 ± 0.81	2.91 ± 0.91
Age				
< 40 years	10.32 ± 4.22	2.57 ±0.60	2.71 ± 0.89	2.71 ± 0.76
41–60 years	10.73 ± 3.75	2.54 ± 0.49	2.82 ± 0.75	2.96 ± 0.83
> 60 years	9.17 ± 3.76	2.67 ± 0.49	2.78 ± 0.77	3.04 ± 0.81
Comorbid				
No	10.63 ± 3.67	2.70 ± 0.43	2.86 ± 0.82	3.02 ± 0.91
Yes	10.37 ± 3.97	2.52 ± 0.55	2.76 ± 0.76	2.84 ± 0.77
Covid-19 Severity				
Moderate	10.66 ± 4.15	2.62 ± 0.51	2.84 ± 0.80	2.94 ± 0.90
Severe	9.00 ± 3.16	2.48 ± 0.51	2.76 ± 0.70	2.83 ± 0.48
Critical	12.8 ± 3.70	2.30 ± 0.67	2.20 ± 0.57	2.50 ± 0.70

to MERS-CoV and SARS-CoV infection. The reduced susceptibility of female to viral infections can be explained by the role of X-chromosome and sex hormones as a protective mechanism to produce innate and adaptive immunity.[11]

Differences in contact patterns among individuals of different ages, affect the expected number of cases in each age group.[12] The high case numbers of adults were linked to rebounding mobility and elevated transmission risk due to their necessity to go to workplace in this pandemic era.[12,13] This is why the productive age group (41–60 years old) were higher in number than any other groups.

This study also revealed than more than half subjects in isolation ward have comorbid. It was similar to current study mentioning about of half of patients infected by Covid-19 had chronic underlying disease, mainly cardiovascular and cerebrovascular diseases and diabetes.[11] Significant pathways and genes were identified associated with comorbidities and underlying disease presenting susceptibility and/or severity to covid infection.[14]

A significant portion of young Covid-19 patient in previous study experienced serious disease outcomes, demonstrating the risk of severe disease among members of marginalized communities and people living with comorbid such as obesity, asthma, cardiovascular disease, or diabetes. The race and ethnicity, economic status, and environmental factors also considered to be contributing to higher prevalence of severe conditions of Covid-19. The social determinants of health such as stress, low socioeconomic status, access to health care, and trust issues to healthcare providers communities may also increase the incidence of poor outcomes in some populations.[15]

We reported that Covid-19 patients in the isolation ward in the Universitas Indonesia Hospital were more likely decreased their functional and mobility capacity. It explained by the number of repetitions achieved on m30STS. Majority of subjects (63.53%) reached the sit to stand test below 12 times for 30 seconds. It is reported that m30STS test correlates with leg press strength (r=0.71–0.78) in elderly population. Current study reported low physical functioning and impaired performance of activity daily living in Covid-19 patients who survived hospitalisation. This finding resembles findings in patients with COPD, who have a low physical functioning and poor performance.[16] A similar study was done in Italy in Covid-19 patients, which performed a mean number of 14 ± 6 sit to stand

repetitions which was below percentile 2.5 for almost 75% of the population.[5]

The result of previous study in healthy young adult emphasized that m30STS evaluated individual's ability to rise from a chair; the muscle strength of trunk and lower extremities; and physical performance of the individual.[7] A below average number of stands for the patient's age group indicates a low mobility capacity because it produces a high risk of falls and reduction of lower limb muscle strength. The test measures anaerobic capacity and lower limb muscle strength. This measurement is clinically important for respiratory disease as muscle strength is related to aerobic capacity and improvements in muscle strength are related to functional and mobility capacity.[17]

The average of thoracic expansion in this study was mentioned as well. They were 2.74 cm in average, which is below the normal level (3 cm), and the comparison between chest circumference in maximal respiration with minimal inspiration was slightly different. The results described the reduction of lung capacity and respiratory function because of inadequate costae excursion.[18] Assessment of thoracic expansion is important to provide the patient's initial limitations and also useful in monitoring improvement during rehabilitation. Adedoyen, et al also reported a significant relationship between chest expansion and lung function among adults.[19]

The m30STS scores mentioned before showed that the number of repetitions in female subjects was lower than numbers that male could reach. Most of previous study mentioned that men are more physically active than woman. It explained the difference of physical activity level between male and female in the young adult age has an effect of STS performance.[20]

Previous study suggests the individual performance, such as age and BMI were particularly noteworthy and correlated with Sit-to-Stand Test results.[21] It was studied that mean of m30STS performed in 60–64 years old female was 12.3 times while in 80–84 years old was 9.3 times. It concluded that older the age, the less number of repetitions was produced.[21] The findings of present study indicate that in community-dwelling older people, STS performance is also influenced by multiple sensorimotor, balance, and psychological processes and represents a particular transfer skill.[22]

Based on comorbid groups, the subject who doesn't have any comorbid tend to reach higher number of 30STS than the one who has comorbid. Reference values in subjects with current disease also concerned to consider the impact of a disease on lower body muscular strength and endurance. For example, a primary care cohort of patients with chronic obstructive pulmonary disease showed that the median number of repetitions was less than 50% compared with members of the same sex and age of the general population.[23]

The highest number of m30STS was achieved by critical patient of Covid-19. It might be due to the time of examination, which was taken after the subjects had medically improved.

The degree of chest wall mobility depends on several determinants including elasticity of soft tissue structures surrounding the thorax, chest shape, and strength of the respiratory muscles. Decreased chest wall expansion could be a result of decreased inspiratory and expiratory muscle strength. Otherwise, the larger the thoracic expansion measurement, the greater the maximum inspiratory pressure, maximum expiratory pressure, FVC, FEV1, and inspiratory capacity.[24]

In the present study, chest expansion in male subjects at all three levels was significantly higher than female subjects. The lung volumes and capacities vary with the age, height, body surface area. Females tend to have lesser average height and the body surface area than the males. It also mentioned that in the younger age, chest expansion measured was higher compared to older age groups.[25]

There were some limitations of our study. It consisted a few numbers of subjects in one hospital, so it could not represent wider populations. More ever, since the assessment in the critically ill patients was taken in different hospitalization periods, it might be confounded with the other factors such as the improvement of clinical condition. The results of this study should be interpreted cautiously.

Conclusion

This study described the reduction of respiratory function and mobility capacity in Covid-19 patient in the isolation ward. The reduction of respiratory function was explained by the lower number of thoracic expansions measured at three levels. Meanwhile the decrease of mobility capacity was described by the m30STS achieved, which were below the normal and average levels.

Conflict of Interst

No potential conflict of interest was reported by the authors.

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None.

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