Safety of Six Minute Walking Test in Hospitalized Post-percutaneous Coronary Intervention Patients: Analysis of Vital Signs, Borg Scale, and Angina Scale Responses

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ABSTRACT

Background: *Heart disease is one of the non-communicable diseases that cause the highest mortality. Its symptoms affect the patient's functional capacity and activities. The six-minute walking test can be done to assess a person's functional ability, response to therapy, and prognosis of chronic heart-lung conditions. The study aims to determine the safety of the six-minute walking test in inpatients after percutaneous coronary intervention by assessing the response of vital signs, Borg scale, and angina scale.* ***Methods:*** *This study was a one-group pre- and post-test design study with subjects of inpatients after percutaneous coronary intervention at the Integrated Cardiac Service in Cipto Mangunkusumo General Hospital Jakarta. Research subjects conducted a six-minute walking test twice with a five-minute break in between. Examination of vital signs, Borg scale, and angina scale before and after walking test. The number of subjects was 30 (27 male and 3 female) with the majority classified as a low-risk stratification.* ***Results:*** *The six-minute walking test was performed over two days or more in 56.7% of the subjects. The mean covered distance was 294.68 ± 57.02 meters. Vital signs of systolic and diastolic blood pressure, pulse rate, respiratory rate, and Borg rating of perceived exertion (RPE) scale increased during the test. They decreased to baseline after resting for five minutes with p-value <0.05 in the Wilcoxon Signed Rank test. Changes in saturation, dyspnea, and leg fatigue of the Borg scale, and angina scale were not statistically significant. All study subjects did not have major adverse events.* ***Conclusion****: The six-minute walking test is safe to do in inpatients after percutaneous coronary intervention with vital signs, Borg scale, and angina scale change accordingly to physiological response.*

Keywords: *Six-minute walking test, submaximal exercise test, coronary heart disease, percutaneous coronary intervention, phase one cardiac rehabilitation, functional capacity*

INTRODUCTION

Heart disease is one of the non-communicable diseases that causes high mortality. In 2017, the number of deaths from heart disease was 17.8 million worldwide, the third leading cause of mortality.[1] In Indonesia, the prevalence of heart disease reaches 1.5% of the population. The diagnosis of heart disease given by doctors can vary. Among them is coronary heart disease (CHD). Coronary heart disease in Indonesia has a prevalence of 1.5% of the population or around 1,017,290 people in 2018.[2] One of the treatments

for patients with CHD is to perform percutaneous coronary intervention (PCI).[3]

Patients with coronary heart disease have symptoms that have often complained of such as shortness of breath, fatigue, and edema, which can cause anxiety and depression due to chest pain. These symptoms have an impact on the patient's limited functional capacity and activities and reduce the quality of life. To assess a person's functional ability, response to therapy, and prognosis of chronic heart-lung conditions, several cardiorespiratory function tests can be used, one of which is the six-minute walking test which is a test that is simple, inexpensive, valid, and reliable so that the test it is widely used in patients with chronic heart and lung disease.[4]

The six-minute walking test allows the patient to rest when unexpected symptoms occur that can no longer be tolerated.[5] This allows the six-minute walking test to be a test that has been proven safe for cardiac patients according to several studies.[5-6] The six-minute walking test official guideline by ATS stated that it may be used for cardiac patients as it is used commonly in recent systematic reviews in patients with ischemic heart disease.[7-8]

Several studies have assessed the safety and cardiac response to the six-minute walking test in inpatients performed on days 3-5 post-PCI. However, we have not found studies regarding the safety and vital signs, Borg scale, and angina scale responses produced by the six-minute walking test conducted in the post-PCI inpatient population in Indonesia. The vital signs, Borg scale (consists of effort scale, shortness of breath scale, leg fatigue scale), and angina scale (chest pain scale) are used to evaluate the hemodynamic responses, safety, and exercise tolerances of the patient. Post-PCI inpatients still need attention regarding cardiovascular complications that can still occur.[9]

Therefore, it is important to ensure and evaluate the safety of the six-minute walking test by studying the response of vital signs, the Borg scale, and the angina scale during the six-minute walking test in post-percutaneous coronary intervention inpatients at Dr. Cipto Mangunkusumo Hospital.

METHODS

Study Design and Setting

The study was a one-group pre-and post-test design study conducted on inpatients at the Integrated Heart Service Centre (IHSC) Dr. Cipto Mangunkusumo Hospital, Jakarta.

Study Population

This study analyzed primary data on patients undergoing treatment at the Integrated Heart Service Centre (IHSC) Dr. Cipto Mangunkusumo Hospital, Jakarta with a diagnosis of coronary heart disease (CHD) and Percutaneous Coronary Intervention (PCI) conducted between November 2021 and February 2022 were considered for this study. The inclusion criteria were all adult patients (> 18 years old) admitted to the hospital, diagnosed with CHD underwent PCI, and hospitalized in Dr. Cipto Mangunkusumo Hospital between November 2021 and February 2022, clinically and hemodynamically stable, undergoing phase 1 cardiac rehabilitation. Exclusion criteria were unable to understand instructions (MoCA INA < 26), neuromusculoskeletal disorders interfering with the ability to walk (intermittent claudication, paralysis, pain, etc), exercise intolerance, on continuous oxygen therapy, presence of arrhythmia, active infection, hearing loss, visual disturbances (visual acuity <20/40), depression, balance disorder (Timed Up and Go test >12 seconds), frailty (Fried-Frailty Scale >2), and high fear of fall. Subjects who terminated the six-minute walking test due to angina and dyspnea which could not be tolerated, extremities cramps, headache and dizziness, pallor, diaphoresis, cyanosis, nausea, and vomiting.

Data Collection

Data for this study were collected using consecutive sampling methods acquired from the IHSC at Dr. Cipto Mangunkusumo Hospital. Case definitions were based on clinical diagnosis which was based on clinical symptoms, electrocardiogram, echocardiography, and elevated cardiac enzymes. Subjects were then screened through anamnesis and physical examination and samples were selected according to the inclusion and exclusion criteria until the numbers of samples were met. The six-minute walking test was done when the patient was

clinically and hemodynamically stable. The vital signs, Borg scale, and Angina Scale were assessed before the test. The six-minute walking test was conducted based on official ATS guidelines on technical aspects, required equipment, patient preparation, and measurement protocol.[7] The practice test was done 2 times with the second test was conducted after 5 minutes resting when the vital signs and Borg scale had already gone back to baseline.

Data Analysis

Identified data were analyzed with IBM SPSS for Windows version 20. Descriptive analysis will be carried out to assess the basic characteristics of the research subjects and clinical response, as well as the distance traveled for the 6-minute walking test (6MWT). Each variable was analyzed to determine the distribution and percentage. Furthermore, categorical data were presented in the table, and numerical data in mean (+SD) or median (IQR) depending on the data distribution. The normality of the data was measured by the Shapiro-Wilk test. The distribution was normal if $p > 0.05$. The analysis was carried out to find out the significant differences in objective conditions in response to the 6-minute walking test. Data before and after the six-minute walking test will be analyzed using a paired T-test if the data distribution is normal or a Wilcoxon test if the data distribution is not normal. The significance limit is $p < 0.05$.

Ethical Approval

This study was approved by the institutional review board of the Faculty of Medicine Universitas Indonesia with the number KET-215/UN2.F1/ETIK/PPM.00.02/2021. The informed consent was taken after the patients had been given the information about the phase 1 cardiac rehabilitation, the purpose, and adverse events of the six-minute walking test.

RESULTS

The sample of the study was 30 subjects after one subject was excluded from 31 participants due to neuromusculoskeletal disorder.

The characteristics of the patients are shown in **Table 1**. The subjects were 27 men and 3 women, most of the subjects (53.3%) were under 60 years old (non-elderly), and most (63.3%) had their first Percutaneous Coronary Intervention (PCI). The majority of subjects had a low-risk stratification with an ejection fraction above 55% (60%). The six-minute walking test was performed in less than 2 days, even within 24 hours post-PCI in 13 subjects (43.3%), and within 2 days or more post-PCI in 17 subjects

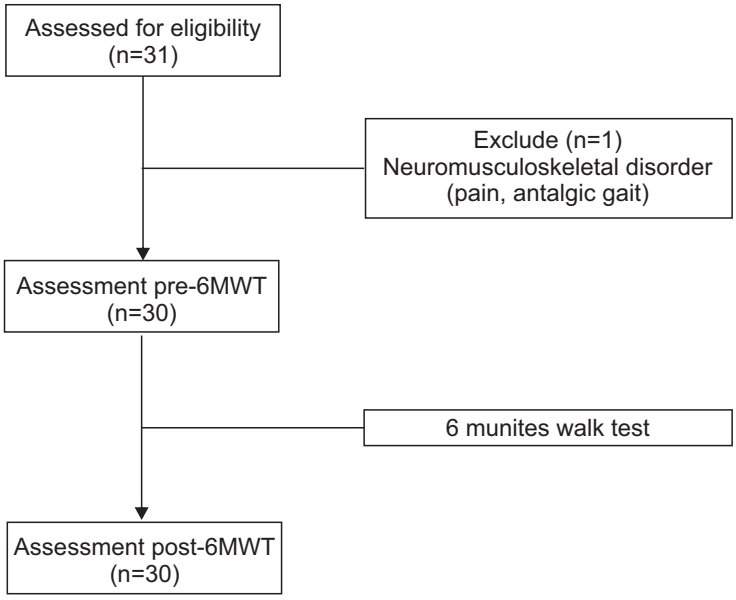

Figure 1. Subjects' recruitment flowchart

Table 1. Characteristics of the patients

Characteristics	All Subject N (%)
Gender	
Male	27 (90.0)
Female	3 (10.0)
Age	
≥ 60 years old (elderly)	14 (46.7)
< 60 years old (non-elderly)	16 (53.3)
Body Mass Index	
Normoweight	12 (40.0)
Overweight	5 (16.7)
Obese	13 (43.3)
Risk Factors	
Hypertension	23 (76.7)
Type 2 Diabetes Mellitus	17 (56.7)
Dyslipidemia	6 (20.0)
Ejection Fraction	
>50%	18 (60.0)
40%-49%	5 (15.7)
<40%	7 (23.3)
Six-minute walking test	
Performed <2 days post PCI	13 (43.3)
Performed ≥2 days post PCI	17 (56.7)

(56.7%). The mean age of research subjects was 56 ± 11 years. Data on height and weight, BMI, LVEF of patients, and time of 6MWT were presented as the median (min-max) because the data was not normally distributed which had been tested for data normality using the Shapiro-Wilk test, respectively 166cm (148 – 178cm), 67kg (45 - 107kg), 24.025kg/cm2 (20.5 - 30 kg/cm2), 55.9% (11.3 - 69%), 2 days (1-9 days). Subjects also had a low HADS score with a median (min-max) of 1 point (0-5). All subjects completed the six-minute walking test and were included in the analysis. The mean distance traveled by the subjects on the first test was 289.97 meters and the mean distance traveled on the second test run was 299.40 meters. The overall test run mean was 294.68 ± 57.02 meters. During the test, blood pressure, pulse rate, respiratory rate, and Borg scale showed a physiological pattern, increasing during the test and decreasing to baseline after 5 minutes of rest (**Table 2** and **Table 3**).

Table 2. Differences in Vital Signs, Borg Scale, and Angina Scale Before and After the Six-Minute Walking test

	Before 6MWT Median (*min-max*)	Post 6MWT Median (*min-max*)	Differences Median (*min-max*)	p-value
Systolic	127.5(100-153)	132.5 (107-161)	6.5 ((-3)-24)	<0.001[a]
Diastolic	81.5 (55-97)	86 (60-97)	3 ((-9)-12)	0.008[a]
Heart Rate	77.5 (60-100)	91 (68-115)	14 (3-28)	<0.001[a]
Respiratory Rate	18 (15-19)	20 (18-26)	4 (2-8)	<0.001[a]
SaO_2	99 (97-100)	99 (95-100)	0 ((-2)-2)	1[a]
Effort	9 (6-11)	12 (9-13)	3 (0-6)	<0.001[a]
Dyspnea	0 (0-0)	0 (0-2)	0 (0-2)	0.038[a]
Leg fatigue	0 (0-3)	0 (0-4)	0 (0-4)	0.001[a]
Angina scale	0 (0-1)	0 (0-1)	0 ((-1)-0)	0.317[a]

[a] Wilcoxon Signed Rank

Table 3. Differences in Vital Signs, Borg Scale, and Angina Scale Before and After the Six-Minute Walking test and 5 Minutes of Recovery

	Post 6MWT Median (*min-max*)	5 Minutes Recovery Median (*min-max*)	Differences Median (*min-max*)	p-value
Systolic	132.5 (107-161)	125 (97-156)	7.5 ((-3)-24)	<0.001[a]
Diastolic	86 (60-97)	80 (52-96)	2.5((-4)-18)	0.001[a]
Heart Rate	91 (68-115)	79.5 (62-105)	12.5 (2-36)	<0.001[a]
Respiratory Rate	20 (18-26)	18 (14-22)	2.5 (1-8)	<0.001[a]
SaO_2	99 (95-100)	99 (91-102)	0 ((-3)-4)	0.776[a]
Effort	12 (9-13)	9 (6-12)	2 (1-6)	<0.001[a]
Dyspnea	0 (0-2)	0 (0-1)	0 (0-2)	0.063[a]
Leg fatigue	0 (0-4)	0 (0-2)	0 (0-3)	0.007[a]
Angina scale	0 (0-1)	0 (0-1)	0 (0-0)	1[a]

[a] Wilcoxon Signed Rank

DISCUSSION

All subjects completed two six-minute test runs with a mean distance of 289.97 meters in the first test run and a mean distance of 299.4 meters in the second test run. The overall test run mean was 294.68 ± 57.02 meters (an increase in test run distance of 3.14%). On a repeat of the six-minute walking test conducted in the cardiac rehabilitation outpatient population where the distance traveled for the second walking test was an increase of 3% - 5% from the first walking test.[5,10] The mean mileage in this study is 50% of the expected mean distance. This may be due to the fear of getting tired of the subject and many not walking as fast as usual. Many subjects who did the six-minute walking test less than 2 days after the intervention still felt discomfort in the puncture area, especially in subjects who underwent catheterization via the femoral artery. Nevertheless, no postintervention complications were found in the subjects.[4]

The research subjects had a change in systolic blood pressure before and after the six-minute walking test of 6.5 ((-3)-24) mmHg with an initial median (min-max) systolic blood pressure value of 127.5 (100-153) mmHg which increased after the walking test six minutes to 132.5 (107-161) mmHg. The increase that occurred was statistically significant with a p-value <0.001. After resting for 5 minutes, systolic blood pressure experienced a statistically significant recovery of 7.5 ((-3)-24) mmHg until it reached the baseline value. The results of this study are similar to data from previous studies where there was an increase in systolic blood pressure of 10-14 mmHg during the walking test and returned to baseline after rest.[4,5] In this study, there was no change in systolic blood pressure that exceeded 200mmHg or decreased ≥10mmHg with symptoms, so it can be said to be safe.

The study subjects had a change in diastolic blood pressure before and after the six-minute walking test of 3 ((-9)-12) mmHg with an initial median (min-max) diastolic blood pressure value of 81.5 (55-97) mmHg which increased after the walking test six minutes to 86 (60-97) mm Hg. The increase that occurred was statistically significant with a p-value of 0.008. After resting for 5 minutes, diastolic blood pressure experienced a statistically significant recovery of 2.5 ((-4)-18) mmHg until it reached the baseline value. The results of this study are similar to data from previous studies where there was an increase in diastolic blood pressure of 4.2mmHg during the walking test and a return to baseline after rest.[5] Based on the theory, diastolic blood pressure generally does not change during exercise.[11] Although this study showed a statistically significant increase in diastolic blood pressure on the six-minute walking test, there was no change in diastolic blood pressure that exceeded 120mmHg or an increase in diastolic ≥20mmHg so it can be said to be safe.

The study subjects had a change in pulse rate before and after the six-minute walking test of 14 (3-28) times per minute with an initial median (min-max) pulse rate of 77.5 (60-100) times per minute which increased after the six-walking test. Minutes to 91 (68-115) beats per minute. The increase that occurred was statistically significant with a p-value <0.001. After resting for 5 minutes, the pulse rate recovers statistically significant at 12.5 (2-36) beats per minute until it reaches the baseline value. The results of this study are similar to data from previous studies, namely an increase of 12.6 beats per minute.[5] Based on the theory, the pulse rate generally increases during the exercise test and returns to basics at rest. The mean pulse rate in this study reached 56.39% of the calculated maximum pulse rate, similar to previous studies which showed that the pulse rate after a six-minute walking test in patients with heart failure using beta-blockers was only 62.26% of the predicted pulse rate.[12] In this study, there was no decrease in pulse rate and recovery of the pulse rate that occurred was achieved within 5 minutes so it can be said to be safe.[13]

The study subjects had a change in the value of the respiratory rate before and after the six-minute walking test of 4 (2-8) times per minute with the median initial value (min-max) of the pulse rate of 18 (15-19) times per minute which increased after the six-minute walking test. Minutes to 20 (18-26) beats per minute. The increase that occurred was statistically significant with a p-value <0.001. After resting

for 5 minutes, the respiratory rate experienced a statistically significant recovery of 2.5 (1-8) breaths per minute until it reached the baseline value. The change in respiratory rate that occurred was lower than the change in respiratory rate in the previous six-minute walking test studies. This may be due to the slower walking speed and shorter distance travelled in research subjects compared to healthy subjects and the rapid change in respiratory rate that occurs in the first 60 seconds of recovery.[14] Changes in respiratory rate What happened in this study is still following the theory, where at light-moderate training loads the increase in respiratory rate is minimal and occurs gradually reaching a steady state in the 5th minute. At 5-6 minutes, the respiratory rate can be in the range of 20-30.[13] After the six-minute walking test, there was no decrease in the respiratory rate, and did not require oxygenation or medication, so it can be said to be safe.

The research subjects had a change in oxygen saturation values before and after the six-minute walking test of 0 ((-2)-2) % with an initial median (min-max) oxygen saturation value of 99 (97-100) % which became 99 (95- 100) % post-six-minute walking test. The changes that occurred were not statistically significant with a p-value of 1. In this study, there was no decrease in oxygen saturation ≥4% or oxygen saturation below 90% which describes good air exchange and perfusion in the subject.[13]

The research subjects had a change in the value of the Borg effort scale before and after the six-minute walking test by 3 (0-6) points with an initial median (min-max) effort value of 9 (6-11) points which increased after the six-minute walking test to 12 (9-13) points. The increase that occurred was statistically significant with a p-value <0.001. After resting for 5 minutes, effort experienced a statistically significant recovery of 2 (1-6) points until it reached the baseline value. The Borg effort scale is especially valuable when the pulse rate assessment is inaccurate as in the present study where subjects were taking beta-blockers. The median Borg scale response to effort in this study, 12 (9-13), indicates reaching the submaximal zone in subjects during the six-minute walking test.[15] The results of this study are similar to data from previous studies with increased Borg response. Effort during the six-minute walking test of 1.6.[5]

The research subjects had a change in the value of the Borg scale shortness of breath before and after the six-minute walking test of 0 (0-2) points with an initial median (min-max) shortness of breath value of 0 (0-0) points which became 0 (0-2) points after the six-minute walking test. The changes that occurred were statistically significant with a p-value of 0.038. After resting for 5 minutes, shortness of breath experienced a statistically significant recovery of 0 (0-2) points until it reached a baseline value. Based on a systematic review by Johnson MJ et al, the Minimum Clinically Important Difference (MCID) change in the Borg shortness of breath scale in heart failure patients is 1.[16] In this study, although 5 patients had changes in the Borg shortness of breath scale ≥1 and there is a statistically significant change in the Borg shortness of breath scale, the shortness of breath that occurs does not cause the cessation of the six-minute walking test, does not require oxygenation or medication and returns to basics after the six-minute walking test is finished so that the shortness of breath response that occurs can be said to be safe. The mechanism for the occurrence of shortness of breath in heart patients can occur due to several things such as increased congestion/distended blood vessels accompanied by increased ventilation requirements during training trials.[17]

Research subjects had a change in the value of the tired leg Borg scale before and after the six-minute walking test by 0 (0-4) points with an initial median (min-max) tired leg value of 0 (0-3) points which became 0 (0-4) points after the six-minute walking test. The changes that occurred were statistically significant with a p-value of 0.001. After resting for 5 minutes, tired legs experience a statistically significant recovery of 0 (0-3) points until they reach the baseline value. The study by Ferreira et al also showed an increase in the response of the tired leg Borg scale by 1.4 points.[5] Some possibilities for the occurrence of tired legs are that some patients have type 2 diabetes mellitus which causes reduced peripheral muscle glucose uptake

and peripheral vascular disorders.[18] In addition, some patients have a low ejection fraction, causing changes in muscle metabolism by increasing the capacity of glycolysis and reducing the oxidative capacity of muscles, as well as decreasing blood perfusion to the muscles.[17] Although statistically it was found that there was a significant change in the tired leg Borg scale, there were no subjects who stopped the six-minute walking test or required medication therefore so that the tired leg response that occurred could be said to be safe.

Research subjects had a change in angina scale values before and after the six-minute walking test of 0 ((-1)-0) points with an initial median (min-max) angina scale value of 0 (0-1) points which became 0 (0- 1) points after the six-minute walking test. The changes that occurred were not statistically significant with a p-value of 0.317. The absence of an anginal response in this study indicates good perfusion to the cardiac organs after PCI and no recurrent ischemic lesions.[15] This also indicates a response to the angina scale on the safe six-minute walking test.

Overall, the adverse events that occurred in this study were minor events that did not interrupt the six-minute walking test and did not require treatment. Subjective complaints assessed using the Borg scale disappeared immediately after the road test was completed. Complaints of chest pain assessed using the angina scale also had no clinical significance.

The limitation of this study is that other factors that may affect the six-minute walking test have not been taken into account, such as impaired lung function or other lung diseases and other factors that affect the adequacy of the six-minute walking test. The other limitation is the study does not have any control group as it is a pre-and post-study design. The advantage of this study compared to previous studies is the existence of sample uniformity where all study samples used beta-blockers. Additionally, the subject had entered the submaximal zone of the six-minute walking test. Regarding the COVID-19 pandemic, all examinations were also modified according to existing health protocols without affecting the research output.

CONCLUSION

In this study, it was found that 6MWT was safe to do in post-PCI patients, even in less than 2 days post-PCI with vital signs response, Borg scale, and angina scale which were within safe limits.

ACKNOWLEDGMENTS

We thank Dr. Cipto Mangunkusumo General Hospital and the Faculty of Medicine Universitas Indonesia, especially those in the Cardiovascular Division, Internal Medicine Department, Faculty of Medicine Universitas Indonesia-Cipto Mangunkusumo Hospital and Integrated Heart Service Centre (IHSC) Dr. Cipto Mangunkusumo Hospital, Jakarta.

CONFLICT OF INTEREST

There is no conflict of interest.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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