

## Original Research Article

# Six-minute walking test distance predicts readmission in hospitalized heart failure patient in integrated cardiac centre, Makassar, Indonesia

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## ABSTRACT

**Background:** Assessment of functional capacity prior to discharge can help identify patients at risk for readmissions in heart failure patients. This research aims to conduct a study in order to assess the distance traveled in the six-minute walk test (6-MWT) as a predictor of readmission rates in patients with congestive heart failure.

**Methods:** This type of research is a quantitative correlational study with a prospective cohort study experimental design. Data were collected when the patient was treated at the Integrated Cardiac Center of Wahidin Sudirohusodo Hospital with a diagnosis of heart failure. The research was conducted from June 2019 to December 2019 after obtaining clearance from the institutional ethical committee. 6-MWT measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6-MWD. To see the correlation between the components of 6-MWT the readmission using one-way anova. To determine the cut-off point, sensitivity and specificity of each component of the 6-MWT to rehospitalization using the receiver operating characteristic (ROC) curve. Statistical analysis was carried out using SPSS and SAP programs.

**Results:** Out of the 93 samples, the 6-MWD has a significant  $p < 0.001$  for the readmission incidence  $\leq 30$  days, meaning that the higher the 6-MWT value, it correlates with the decrease in the number of readmission incidents. In the ROC curve analysis for the 6-MWD parameter, it was found that the 6-MWD had a good predictability of readmission events in  $\leq 30$  days ( $C=0.781$ ,  $p < 0.001$ ).

**Conclusions:** 6-MWD can be used to predict readmissions in  $\leq 30$  days in heart failure patients. The lower the 6-MWD with a cut off of 183 meters, the higher the risk of readmission in  $\leq 30$  days of heart failure patients. By knowing the cut off value, 6-MWD can be used as a reference to create a comprehensive treatment flow for heart failure patients to prevent increased readmission rates. In the end, it can reduce the burden of treatment costs on heart failure patients.

**Keywords:** Heart failure, Readmission, Six-minute walking test

## INTRODUCTION

Cardiovascular disease (CVD), including heart failure (HF), is a major health problem with high mortality and morbidity rates, with the burden continues shifting from developed countries to developing countries, including Indonesia.<sup>1</sup> HF is a group of clinical symptoms characterized by specific symptoms such as shortness of

breath, fatigue, and ankle swelling, and accompanied by signs of increased jugular venous pressure and pulmonary crackles as a result of structural and/or functional heart defects.<sup>2</sup> Based on the Indonesian basic health research in 2013, congestive HF causing around 9.7% of all heart diseases death in Indonesia, with the highest prevalence in East Nusa Tenggara (0.8%), Central Sulawesi (0.7%), followed by South Sulawesi and Papua (0.5%).<sup>3</sup>

Even though HF management has evolved over recent years with improvements in medical therapies, among Medicare patients hospitalized for HF from 2008 to 2010, 67.4% experienced a readmission with the daily risk of readmission was highest on day 3 after discharge.<sup>4</sup> Kilgore et al reported that out of 63,678 patients from July 2005 to December 2011, who experienced congestive HF, a 30-day readmission rate was 22.3%, and the funds spent on HF due to readmissions per patient were USD 14,631, while for HF patients treated for other diseases USD 15,924.<sup>5</sup> These high rates can be prevented by proper identification of patients at high risk for readmissions. Readmissions could be prevented so as to reduce hospitalization costs.<sup>6</sup>

Assessment of functional capacity prior to discharge can help identify patients at risk for readmissions. Assessing functional capacity is a key step in the field of cardiac rehabilitation, which contributes to reducing cardiovascular events and re-hospitalization of patients with heart failure. Cardiac training tests are known as the "standard method" for assessing functional capacity. Previous researches show the values of the six-minute walk test (6-MWT) have high prognostic value in predicting cardiac morbidity and mortality in patients with CHF.<sup>7</sup>

The 6-MWT is a simple, objective, cost-effective, and well-tolerated test for the assessment of the daily physical capacity of patients with HF. 6-MWT can be performed in a clinic with fast and efficient time management and evaluates the responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism.<sup>8,9</sup> A study conducted by Wegrzynowska-Teodorczyk et al found that a shorter 6-MWT distance was found in patients with a higher grade NYHA, older patients, and patients with impaired renal function.<sup>10</sup> This research aims to conduct a study in order to assess the distance traveled in 6-MWT as a predictor of readmission rates in patients with congestive heart failure.

## METHODS

This type of research is a quantitative correlational study with a prospective cohort study experimental design. Data were collected when the patient was treated at the Integrated Cardiac Center of Wahidin Sudirohusodo Hospital with a diagnosis of heart failure. Then observations were made with the primary end point being the time and number of times the next hospitalization. The research was conducted from June 2019 to December 2019 after obtaining clearance from the Institutional Ethical Committee.

Sample collection was conducted with a purposive sampling method.

## Inclusion criteria

Patients diagnosed with samples that were included were all hospitalized heart failure patients with an ejection fraction below 40%, aged above 18 years-old, were hemodynamically stable, had no cognitive nor anatomical deficits which may affect walking abilities, and lastly were willing to be included in this study, followed up, and have given consent to all procedures and examinations.

## Exclusion criteria

Exclusion criteria were decompensated heart failure patients, patients who have undergone interventional procedures with the aim of correcting structural cardiac disorders such as cardiac resynchronization therapy (CRT), coronary artery bypass graft (CABG), and heart valve replacement, as well as patients were not willing to be included in this study or followed up.

6-MWT measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6-MWD. All patients then underwent the six-minute walk test 1 day before discharged. Patients' data including clinical history, laboratory work-up, and echocardiography results were obtained from patient medical records and hospital computer systems. Patients were then followed-up for 3 months by telephone and were routinely checked on the hospital's inpatient registration computer system. Readmission or re-hospitalization under the same diagnosis within 30 days, 60 days and 90 days following prior hospitalization was recorded.

To determine the basic characteristics of numerical variables, the mean±standard deviation is used. To see the correlation between the components of 6-MWT the readmission using one-way anova. To determine the cut-off point, sensitivity and specificity of each component of the 6-MWT to rehospitalization using the receiver operating characteristic (ROC) curve. Statistical analysis was carried out using SPSS and SAP programs.

## RESULTS

This research was conducted at the Department of Cardiology and Vascular Medicine at the Integrated Heart Center (PJT) Makassar from June 2019 to December 2019 with a total sample of 93 patients with heart failure who were included in the inclusion criteria who were treated at the Hospital's Integrated Heart Center. Dr. Wahidin Sudirohusodo Makassar (Table 1).

Out of the 93 samples, the majority of the samples in this study were male (n=57; 61.3%). In terms of age, it was found that the mean age of the sample was 56.1 years, with the youngest 27 years old and the oldest 82 years old. The average body weight in this study was 57.4 kg with the lowest body weight 34 kg and the highest 75 kg.

While the average height is 159 meters with the lowest 145 meters and the highest 179 meters (Table 2).

**Table 1: Demographic characteristics, 6-MWT parameters and patient readmission observations (categorical variables).**

Variable		N	Percentage (%)
<b>Gender</b>	Male	57	61.3
	Female	36	38.7
<b>6-MWD (m)</b>	<200	33	35.5
	200-300	42	45.2
	>300	18	19.4
<b>METs</b>	<5	64	68.8
	5-7	26	28.0
	>7	3	3.2
<b>Readmission ≤30 days</b>	Yes	33	35.5
	No	60	64.5
<b>Readmission 31-60 days</b>	Yes	32	34.4
	No	61	65.6
<b>Readmission &gt;60 days</b>	Yes	25	26.9
	No	68	73.1
<b>Reasons for readmission</b>	<b>Fluid overload</b>		
	Readmission ≤ 30 days	28	30.1
	Readmission 31-60 days	3	3.2
	Readmission > 60 days	1	1.1
	<b>Poor compliance with therapy</b>		
	Readmission ≤ 30 days	17	18.3
	Readmission 31-60 days	6	6.5
	Readmission > 60 days	10	10.8
	<b>Infection/ due to other comorbidities</b>		
	Readmission ≤ 30 days	8	8.6
	Readmission 31-60 days	8	8.6
	Readmission > 60 days	9	9.7

Each sample in this study underwent a 6-MWT examination. In the measurement results, the 6-MWT distance is divided into three <200m, 200-300m and >300m. The average distance is 6MWT which is 228.3 meters and the highest is at 200-300 distance of 42 (45.2%).

Patient readmission data were divided into 3 categories, namely readmissions ≤30, 31 to 60 and >60 days. The

highest number of patients with readmissions was in the ≤30-day category, namely 33 (35.5%).

**Table 2: Demographic characteristics and 6-MWT parameters (numerical variables).**

	Minimum	Maximum	Mean	SD
<b>Age</b>	27	81	56.11	10.135
<b>Body weight</b>	34	78	57.41	9.056
<b>Body height</b>	145	178	159.48	6.087
<b>Ejection fraction</b>	15.60	39.92	28.44	8.324
<b>VO2max</b>	2.94	35.15	13.75	6.068

6-MWD were analyzed the mean comparison of the three groups of patient readmissions in ≤30 days, 31-60 days and 60 days (Table 3). The comparison method used is the one-way anova method. The requirements for the one-way anova test are: 1) data normality test, 2) homogeneity tests, 3) anova test and 4) Post Hoc/Tukey test. From the normality test, only readmissions ≤30 days were normally distributed. While the homogeneity of the three readmission groups met the requirements, but in the ANOVA test only one readmission group met the requirements for the Post Hoc test, namely the ≤30-day readmission group.

The test results with the one-way anova method found that of the three parameters only one group had a significant impact on the readmission, namely readmission within ≤30 days, while the readmission within 31-60 days and >0 days did not show a significant comparison with the readmission incidence.

The 6-MWD has a significant  $p < 0.001$  for the readmission incidence ≤30 days, meaning that the higher the 6MWT value, it correlates with the decrease in the number of readmission incidents. This implies that the value of the 6MWT distance can be used as a predictor of the decrease in the number of readmissions in ≤30 days.

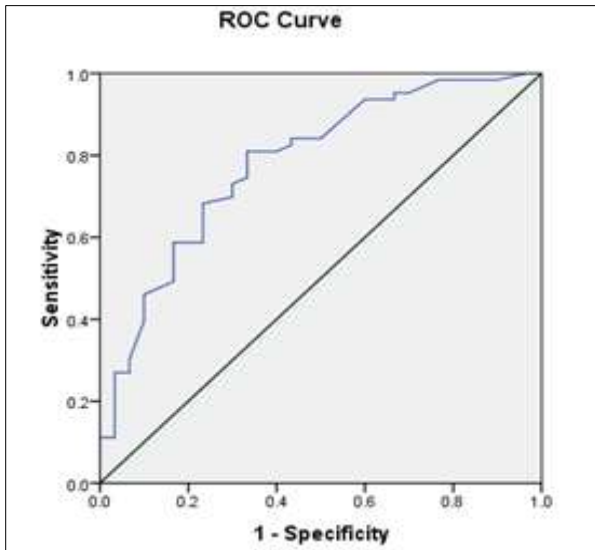
By using the ROC curve, analysis tests can be performed on the variable 6-MWD for the readmission incidence in ≤30 days. The analysis was performed using a 95% confidence interval. In the ROC Curve analysis for the 6MWD parameter, it was found that the 6-MWD had a good predictability of readmission events in ≤30 days. ( $C=0.781, p < 0.001$ ) (Figure 1).

This implies that the 6MWD is a parameter that has moderate sensitivity and specificity in predicting the incidence of readmission in ≤30 days. The cut off value for the 6MWD in predicting readmissions in ≤30 days is 183 meters.

**Table 3: Comparison between 6-MWT parameters with hospital readmission.**

Variable	Readmission	Homogeneity Sig>0.05	ANOVA Sig.<0.05	Post Hoc
6MWD	≤30 days	0.749	<0.001	<0.001
	31-60 days	0.433	0.22*	NS*
	>60 days	0.543	0.63*	NS*

\*NS=not significant



**Figure 1: ROC curve for 6-MWD on patient readmission incidence ≤30 days.**

## DISCUSSION

The results of the study between the 6-MWD to the ≤30 days readmission obtained good sensitivity (AUC=0.78,  $p<0.001$ ) with a cut-off value of 183 meters. This result implies that 6-MWT is a parameter that has sufficiently optimal sensitivity and specificity in predicting the incidence of readmission in ≤30 days.

The 6-MWT distance is highly correlated with readmission in heart failure patients with correlation coefficients reported in the range from  $r=0.42$  to  $r=0.52$ .<sup>11</sup> In patients whose 6-MWD was ≤300 m ( $n=21$ ), the mortality rate was 57.1% versus 5% in those who walked >300 m ( $p<0.001$ ), and readmissions were 57.1%, respectively. % versus 22.5% ( $p=0.02$ ). Cox multivariate regression analysis showed that a distance of 6-MWT ≤300 meters (adjusted HR=16.75, 95% CI=3.42-81.94,  $p<0.001$ ), experienced readmissions of less than 30 days.<sup>12</sup> 6-MWD at discharge was significantly shorter in patients who were readmitted than in patients who were not readmitted ( $p<0.001$ ) and was a significant predictor of readmission ( $p<0.001$ ). The chance ratio for readmission was 198 meters ( $p<0.001$ ) with a sensitivity of 0.75 and a specificity of 0.77. 6-MWD was measured at the time the heart failure patient was discharged. The results of this study can be an independent predictor for readmissions to the hospital within 30 days.<sup>13</sup> Data from 4,566 patients aged 40 years were included in the analysis. Among them, 446 (9.8%) had a 30-day

readmission showing sensitivity (AUC of 0.710; 95% confidence interval, 0.685-0.735).<sup>14</sup> The results of the research conducted also found the same thing, there was a strong correlation between 6-MWT and a 30-day readmission. Sixty-one patients (52% female, mean age  $46.9\pm14.1$  years, 6-MWT distance  $336.3\pm65$  meters) had  $27.6\pm12.8$  days readmission, twenty one patients (45 , 3%) readmissions, with patients who readmissions having a shorter 6-MWD ( $p=0.007$ ) and more likely to die than those who were not readmitted (RR=1.72, 95% CI= 1.13-2.62,  $p=0.003$ ).<sup>15</sup> A 30-day readmission occurred in 14 (19.7%) patients whose mean 6-MWD was  $230\pm123$  meters. 6-MWD was able to predict 30-day readmissions in this study with sensitivity (AUC=0.84,  $p<0.001$ ).<sup>16</sup>

## CONCLUSION

6-MWD can be used to predict readmissions in ≤30 days in heart failure patients. The lower the 6-MWD with a cut off of 183 meters, the higher the risk of readmission in ≤30 days of heart failure patients. By knowing the cut off value, 6-MWD can be used as a reference to create a comprehensive treatment flow for heart failure patients to prevent increased readmission rates. In the end, it can reduce the burden of treatment costs on heart failure patients.

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