Promoting Phase II Cardiac Rehabilitation for Patients with Acute Myocardial Infarction — Post-COVID-19 Pandemic Experience from One Medical Center

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Abstract

Background: Patients with acute myocardial infarction often exhibit functional decline and exercise intolerance after discharge. Cardiac rehabilitation (CR) could benefit these patients by improving their aerobic capacity and reducing their recurrence and mortality rates. However, the participation rate in CR is quite low, especially since the COVID-19 pandemic. In this retrospective cohort study, we aimed to (1) identify strategies to promote CR participation, (2) improve the referral rate for CR through our physical medicine and rehabilitation outpatient department, and (3) assess the efficacy of CR training in our hospital.

Method: Patients admitted with acute myocardial infarction from June 2018 to December 2022 were recruited for this single medical center, retrospective, cohort study. We collected data including basic characteristics, referral rates, the parameters from exercise tests and data on training efficacy.

Results: In total, 642 patients were enrolled. By 2021, the referral rate had dropped to 34.2%, however, with quality improvement projects, the referral rate recovered to 44.8% in 2022. Only 15 (9.7%) patients participated in CR that year. Significant improvements in aerobic capacity were found (4.4 MET to 5.4 MET, $p < 0.05$) in patients who completed at least 12 sessions of CR.

Conclusions: Our study indicated that through multidisciplinary team collaboration, participation in CR could be promoted. The patients experienced improvements in aerobic capacity after CR training for 6 weeks. We recommend that team members educate patients about the importance of outpatient cardiac rehabilitation programs.

Keywords: acute myocardial infarction, cardiac rehabilitation, cardiopulmonary

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Introduction

Patients diagnosed with acute myocardial infarction (AMI) tend to exhibit severe inactivity. This can lead to the sequelae of severe weakness, effort intolerance, fear of activity, depression, anxiety, unemployment, intolerance and functional decline.[1,2] According to the guidelines of the American College of Cardiology (ACC) and the American Heart Association (AHA), a cardiac rehabilitation (CR) program is recommended for patients after myocardial infarction and should be considered as a part of the treatment plan.[3-5] The benefits of CR include improvements in exercise tolerance, quality of life and functional status. Furthermore, CR plays an important role in reducing the risks of re-hospitalization, myocardial infarction recurrence and cardiovascular-related mortality.[6,7] However, researchers have frequently reported low participation rates in CR programs for patients with acute myocardial infarction.[2,8,9]

In the implementation of CR, the relevant professionals face barriers at several levels, including lack of patient awareness, poor insurance support, transportation challenges, low enrollment and lack of facilities.[10] The participation rates in Europe and the United States are about 20-30%. The Million Hearts Cardiac Rehabilitation Collaborative has suggested a road map and strategies to increase participation in cardiac rehabilitation to at least 70% nationally by 2022.[8] In Taiwan, patients can gain access to cardiac rehabilitation services covered by National Health Insurance. The first step is for the patients to be referred to the physical medicine and rehabilitation (PMR) department where they complete a cardiopulmonary exercise test (CPET). After the CPET, phase II cardiac rehabilitation training begins under the supervision of physical therapists. To promote participation in phase II cardiac rehabilitation, it is crucial that patients be referred to an outpatient PMR department, where doctors can give the patients suggestions about their activity levels and home training programs. Such exercise tests can help patients understand their fitness levels after discharge and determine what activity levels will be appropriate for them. The results of an exercise test can also provide information on the possibility of returning to work.[11,12]

During the COVID-19 pandemic, participation in CR entailed some challenges. Center-based cardiac rehabilitation programs were shut down to minimize infection risks, and the focus shifted to home-based cardiac rehabilitation under telemonitoring and telecoaching.[13,14] At our hospital, where our multidisciplinary team has provided CR services since 2012, the team members noted an obvious drop in the referral rate during the pandemic. Responding to this drop, this study aimed to (1) find strategies to promote CR participation, (2) improve the referral rate to our outpatient PMR department, and (3) assess the efficacy of training for the patients.

Materials and Methods

This retrospective cohort study from a single medical center was conducted during the COVID-19 pandemic in Taiwan (June 2021). Patient inclusion criteria included: (1) age 20 years or older, (2) admitted with a diagnosis of acute myocardial infarction (ICD-10-CM code: I21); including both ST-segment elevated myocardial infarction (STEMI) and non-ST-segment elevated myocardial infarction (NSTEMI), from January 1st, 2018 to December 31st, 2022, and (3) possible recipient of percutaneous coronary intervention (PCI) or coronary artery bypass surgery (CABG) during hospitalization. Patients were excluded if they (1) had died upon admission, (2) were discharged against the advice of the attending physician after admission, or (3) refused treatment. We collected the basic characteristics of patients at Wan-Fang Hospital, drawn from a list provided by the case manager. These data were extracted from the electronic chart system and recorded in the case checklist. The study was approved by the TMU Joint Institutional Review Board. (N202410093)

This study simultaneously served as a quality improvement project. The strategies we implemented to improve the referral rate for CR are listed as follows. First, a physical therapist and the case manager provided education about cardiac rehabilitation to the patients during their hospitalization. Second, we reinforced the concepts of cardiac rehabilitation among the team members and enhanced communication between the AMI team members from the cardiovascular department and the PMR department. Third, we pre-scheduled appointments with the outpatient PMR department before discharge. To reduce commuting time, we arranged the outpatient appointments with the cardiology and PMR departments in the same time slot. Fourth, we provided online training courses so that more PMR physicians could handle the CR program. These arrangements provided schedules that were more user-friendly for the patients. We defined the referral rate in our study as the percentage of patients who visited the outpatient PMR department after discharge.

During hospitalization (including intensive care unit and general ward), a physical therapist conducted education on concepts of cardiac rehabilitation through 1-to-1 interaction using a brochure to explain in detail the activity regimen and home programs after discharge. The mode of the home program was mainly walking on level ground 4-7 times per week for 30 minutes each time, beginning from 10 minutes and gradually working up to the full 30 minutes. The intensity, based on the Rate of Perceived Exertion (RPE) scale, ranged from 12 to 16.

Upon enrollment in Phase II cardiac rehabilitation, patients completed the CPET.[11,12] This test helped the physician and physical therapists to identify risks and provide appropriate training programs. The primary physiological parameters were maximal oxygen consumption (ml/min/kg or metabolic equivalent of task (MET)). One MET equals a whole-body resting oxygen consumption of 3.5 ml/kg per minute. Other parameters included heart rate, blood pressure, RPE and respiratory exchange ratio (RER).[15]

Phase II cardiac rehabilitation was provided in the PMR department of our hospital. The center-based training programs were conducted in two 30-minute sessions per week over at least 12 sessions. The training programs were focused on aerobic training with a stationary bicycle, and the training intensity was calculated with 40% to 80% oxygen consumption reserves from the results of the CPET. To ensure safety, the patient's heart rate, blood pressure, EKG and rate of perceived exertion were monitored during the training.[16,17] The outcome measures included referral rate and changes in maximal oxygen consumption after CR.

Statistical analysis

Categorical variables were summarized and are presented as frequencies and percentages. Continuous variables are expressed as means ± standard deviation. The difference between maximal oxygen consumption before and after cardiac rehabilitation was determined by paired samples t-test or Wilcoxon signed-rank test. The significance level was set at $p < 0.05$. All statistical analyses were performed using SPSS 19 statistical software (IBM, USA).

Results

A total of 642 patients were enrolled in the study. The mean age was 64.0 ± 13.2 years old and males constituted 77.3% of the subjects (n = 496). The patients' basic characteristics and comorbidities are presented in Table 1.

Figure 1 presents the referral rates since 2018. Due to the COVID-19 pandemic, all outpatient CR operations were discontinued from May to August 2021. The referral rate dropped to 34.1% in 2021 (28.6% from January to June). The quality improvement project was initiated in October 2021, whereupon the referral rate increased to 41.8% from July to December, 2021. Finally, the

Table 1. Basic characteristics of the participants

Variables	Total subjects (n=642)	Subjects recruited from 2018 to 2021 (n=488)	Subjects recruited in 2022 (n=154)
Age, year		63.57 ± 12.61	65.22 ± 15.07
Gender, n (%)			
Male		378 (77.5%)	118 (76.6%)
Female		110 (22.5%)	28 (18.2%)
BMI		26.15 ± 13.51	25.37 ± 4.31
Type of AMI, n (%)			
STEMI		230 (47.1%)	65 (42.2%)
NSTEMI		258 (52.9%)	89 (57.8%)
Multiple vessel disease, n (%)		372 (76.23%)	119 (77.27%)
Comorbidities, n (%)			
Hypertension		310 (63.5%)	80 (52.6%)
Hyperlipidemia		299 (61.3%)	79 (52.0%)
DM		267 (54.7%)	69 (45.4)
CKD		62 (12.7%)	27 (11.6%)
Stroke		34 (7%)	14 (9.1%)
Gout		26 (5.3%)	12 (7.9%)
Smoking, n (%)		256 (52.5%)	82 (53.9%)
LVEF (%)		57 ± 15	54 ± 18
Medications n (%)			
DAPT		465 (95.2%)	141 (91.6%)
ß-blocker		422 (86.5%)	129 (83.8%)
ACEI/ARB		395 (80.9%)	121 (78.6%)
Statin		477 (97.7%)	153 (99.4%)

Abbreviations:
STEMI: ST segment elevated myocardial infarction
NSTEMI: non-ST segment elevated myocardial infarction
CKD: chronic kidney disease
DAPT: dual anti-platelet therapy
ACEI/ARB: angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker

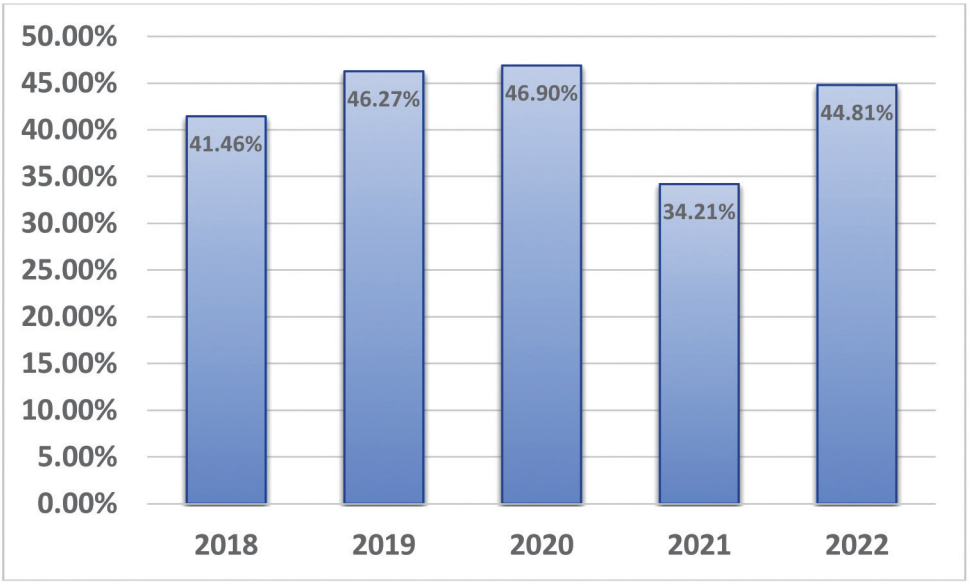

Figure 1. Referral rates for Phase II cardiac rehabilitation.

referral rate recovered to 44.8% in 2022.

In 2022, we recruited 154 patients with AMI. Sixty-nine patients (44.8%) returned to the outpatient PMR department. Thirty-five patients (22.7%) completed CPET with 5.7 ± 1.5 MET in aerobic capacity (non-CR: 20 patients; complete CR: 9 patients; incomplete CR: 6 patients). The aerobic capacity of the patients not undergoing CR was 6.14 ± 1.60 MET (21.13 ± 5.60 ml/kg/min). Only 15 patients (9.7%) participated in at least 1 session of CR, while 9 patients (5.8%) completed at least 12 sessions and the post-training test. The 6 patients who partially completed CR attended an average of 3.67 ± 1.37 sessions and had a baseline aerobic capacity of 4.19 ± 0.69 MET (15.59 ± 2.63 ml/kg/min). Unfortunately, follow-up CPET data was not available for non-CR and incomplete CR patients.

The CPET parameters for the patients who completed CR are listed in Table 2. Their baseline average maximal oxygen consumption was 15.5 ± 3.7 ml/min/kg. The average maximal oxygen consumption after training was 18.9 ± 3.8 ml/min/kg. The improvement in aerobic capacity was significant, with $p = 0.001$. In terms of MET, their aerobic capacity increased from 4.4 ± 1.1 MET to 5.4 ± 1.1 MET ($p = 0.001$), an improvement of 22.5% (Figure 2). Supplementary Table 1 shows the baseline left ventricular ejection fraction (LVEF) for non-CR, incomplete CR and complete CR patients.

Discussion

Our study demonstrated that our quality improvement project contributed to the recovery of the referral rate to CR programs to reach 44.8% in 2022. Patients who received aerobic exercise training showed significant improvements in maximal oxygen consumption.

In our hospital, referral is driven by the attending physician (personal referral) during hospitalization, rather than by an automated referral system. If the physician pre-schedules an appointment in the outpatient PMR department at discharge, the patients have the opportunity to receive Phase II cardiac rehabilitation. Automatic referral means that CR referral is based on electronic medical records for all eligible patients, whereby this referral should be accompanied by a strong endorsement by physicians. The Million Hearts Initiative proposes the use of CR referral

Table 2. Physiological parameters on CPET for those who completed at least 12 sessions (n=9)

Parameters	Before CR	After CR	p value
Total sessions		22.00 ± 11.82	
Load peak (watts)	86.89 ± 34.26	108.89 ± 30.93	0.002*
Load at VT (watts)	46.11 ± 18.90	56.67 ± 21.03	0.084
Peak VO2 (ml/min)	1148.22 ± 256.20	1383.00 ± 334.83	0.001*
Peak VO2 (ml/min/kg)	15.51 ± 3.74	18.90 ± 3.82	0.001*
MET	4.41 ± 1.07	5.40 ± 1.00	0.001*
RER	1.12 ± 0.04	1.18 ± 0.11	0.091
Resting HR	70.78 ± 8.35	67.67 ± 8.87	0.362
Peak HR	118.67 ± 17.97	125.78 ± 16.33	0.217
Resting SBP	108.38 ± 9.20	115.00 ± 13.35	0.064
Peak SBP	144.88 ± 20.26	155.11 ± 16.14	0.119
RPE	16.44 ± 1.13	14.89 ± 2.37	0.043*

* $p < 0.05$ after CR
Abbreviations:
CR: cardiac rehabilitation
VT: ventilatory threshold
VO2: oxygen consumption
MET: metabolic equivalent of task
RER: respiratory exchange ratio
HR: heart rate
SBP: systolic blood pressure
RPE: rate of perceived exertion

as a quality-of-care indicator to improve the referral rate.[8,10] Simultaneously, patients should be educated about cardiac rehabilitation by team members, especially the case manager, physical therapists, and the nurse in charge.[18]

According to a report published in 2020, the rate of participation in CR of patients with AMI treated with PCI increased from 21% in 2007 to 33% in 2017.[19] In Taiwan, the participation rate in outpatient CR tends to be lower (ranging from 7% to 15%).[18] In our study, the participation rate was only 9.7%. Key points in the promotion of CR participation are patient education and self-awareness, potentially following a family-centered empowerment model.[20] Team members should increase patient motivation and suggest appropriate training programs, whereby personal issues and demands should also be taken into consideration.[14] Scheduling a staff member to introduce CR may help with coordinating the referral process. In our hospital, physical therapists implemented a progressive physical activity regimen during hospitalization.[16] This regimen potentially instilled in the patients the concept of appropriate physical activity and initiated the physiotherapist-patient interaction. A previous qualitative study found that interaction with physical therapists in the acute phase was an important driving factor for patients to attend CR programs after discharge.[21] Another strategy to promote CR participation is to reduce the time interval from discharge to the first CR

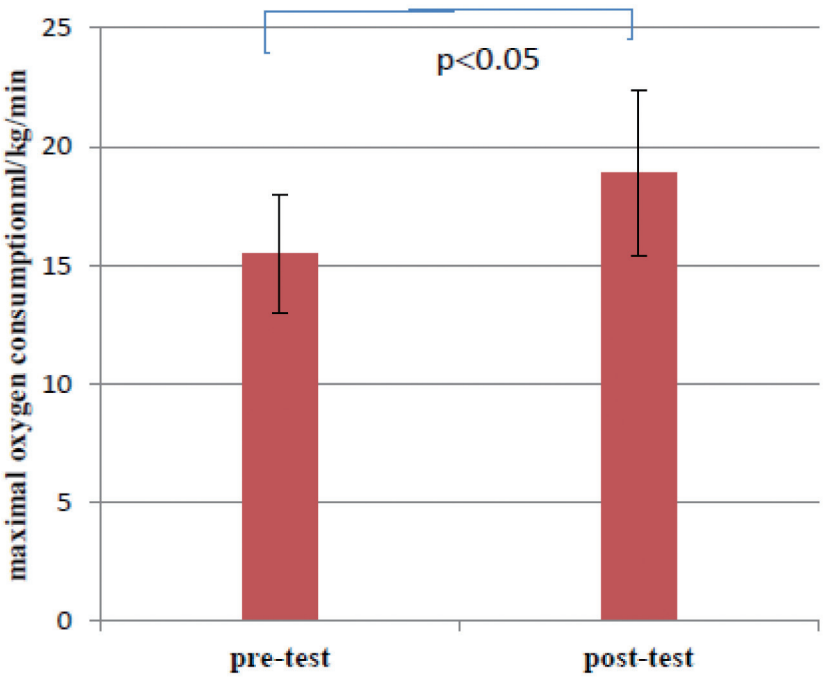

Figure 2. Efficacy of training for those who participated in at least 12 sessions.

Supplementary Table 1. Baseline LVEF values of all participants (n=154)

CR status	No. n (%)	LVEF (%)
No CR	139 (90.3)	57 ± 13
Incomplete CR	6 (3.9)	52 ± 11
Complete CR	9 (5.8)	51 ± 23

appointment, which may also help to increase the participation rate.

A road map from the Million Hearts Cardiac Rehabilitation program outlined the framework of CR.[8] The first step is cardiac rehabilitation referral. The second step is cardiac rehabilitation enrollment. The final step is cardiac rehabilitation adherence. In the USA, the future goal is to promote CR participation from 20% to 70%, however, since our participation is lower (nearly 10% in 2022), we still have a long way to go. While increasing referral rates is a crucial first step, future efforts should prioritize enhancing enrollment and adherence. Patients can only fully realize the benefits of CR by completing the entire program, not just by being referred. We hope to conduct future studies on enrollment and participation after increasing referral rates.

Through the promotion of the Disease-Specific Care Certification, cardiac rehabilitation should be incorporated into the care plans not only for patients with acute myocardial infarction but also for patients with coronary artery disease, heart failure, coronary artery bypass graft, and other cardiovascular conditions. All team members should consistently share their experiences and participate in mutual learning to enhance the implementation of cardiac rehabilitation.[22] In

our study, the case manager played an important role in coordinating and organizing CR for eligible patients. A study on CR-related quality improvement activities and motivational programs was conducted at the Mayo Clinic from 2009 to 2012. In that study, for every 6 sessions of training that patients and staff completed, they could receive rewards such as parking passes, T-shirts, or water bottles. The results revealed that the CR delivery rate was increased by this approach.[23]

Pre-training evaluation with a CPET is important too. The cardiopulmonary fitness levels of the patients were found to be related to their prognoses. Nichols et al. conducted a study to build up a cardiometabolic profile for patients with coronary artery disease, and a maximal cardiopulmonary exercise test was included in the profile after discharge from hospital. The patients were categorized as having low, moderate, or high cardiorespiratory fitness (CRF). The results showed that the five-year mortality risk (CALIBER risk score) was higher in the low CRF group (14.9%) than in the high CRF group (3.7%).[24] In our study, 35 patients (22.7%) underwent CPET, and their average aerobic capacity was 5.69 ± 1.49 MET, possibly indicating moderate CRF (male/female: 5-7/4-6 MET) according to the categories used in the study by Nichols. The CPET could serve as an indicator of prognosis.

After at least 12 sessions (6 weeks) of training, 9 patients in our study (2022) showed significant improvements in aerobic capacity (increasing from 4.4 ± 1.07 MET to 5.4 ± 1.11 MET, $p = 0.001$), or an average improvement of 22.45%. One previous study analyzed the database used for the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH).[25] Patients diagnosed with coronary artery disease were referred for CR and then participated in 12-week comprehensive training programs. The average improvement in the low fitness group (baseline level < 5 MET) was 1.41 MET. The results also indicated that each increase of 1 MET was associated with a significant 30% reduction in mortality risk. It follows that team members should explain the benefits of CR participation to patients in order to increase their motivation to attend such programs.

In our study, the COVID-19 pandemic contributed to a reduction in access to CR programs. During the pandemic, our outpatient training program was temporarily suspended from May to August 2021. Although services were later resumed, various factors, including infection control measures, protective equipment, and patient willingness impacted CR participation. Our team noticed a decline in referral rates even after reopening the CR service. In response, we implemented strategies in October 2021 to prevent further decline in referral rates as the pandemic subsided. We believe that the improvement in CR referral rates can be attributed to a combination of our strategies and to the end of the pandemic. In the digital era, diverse choices exist for cardiac rehabilitation, such as home-based training with mobile-technology support or hybrid models.[26,27] For patients who are unable to attend traditional center-based training, these choices could overcome the barriers contributing to low utilization of CR.

Limitations

This study has some limitations. First, since the data were collected from electronic medical charts, we were unable to obtain the patients' reasons for non- referral or absence from the CPET. Such information could shed further light on the barriers to CR. Second, this was a single retrospective study reflecting the experience at one hospital, so the findings have limited generalizability. Third, the small sample size of the patients who completed the full 12 weeks of CR might be another limitation. Fourth, cardiac echocardiography was not routinely or periodically conducted for patients with acute myocardial infarction at our institution. If we had obtained echocardiograms before and after the

completion of cardiac rehabilitation, we could have more accurately assessed the impact of CR on LVEF.

Conclusions

Cardiac rehabilitation is necessary for patients with acute myocardial infarction. In the current study, our multidisciplinary team implemented a quality improvement project to increase the referral rate after the COVID-19 pandemic. The training was obviously effective for the patients. We strongly advise clinical practitioners to instill the concepts of CR and promote CR participation in such patients. Future quality improvement projects may develop an automatic referral system and investigate the CR referral and participation rates.

Abbreviations

CR: cardiac rehabilitation
COVID-19: coronavirus disease 2019
AMI: acute myocardial infarction
CPET: cardiopulmonary exercise test
STEMI: ST segment elevated myocardial infarction
NSTEMI: non-ST segment elevated myocardial infarction
PCI: percutaneous coronary intervention
CABG: coronary artery bypass grafting

Conflict of Interest Declaration

All authors declare no conflict of interest.

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