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Research Article

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Prognostic factors related to angina frequency and health-related quality of life during the recovery period in patients with acute myocardial infarction: A follow-up study

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Abstract

Background and Objective: *Angina frequency (AF) and health-related quality of life (HRQoL) are important outcomes of acute myocardial infarction (AMI) survivors. The aim of this study was to identify the specific characteristics related to the changes of AF and HRQoL among AMI patients after treatment.*

Methods: *We performed a prospective cohort study of 102 AMI patients in Taiwan. Data were collected at baseline and 1 month (T2), 3 months (T3), and 6 months (T4) after treatment. AF was assessed using the Seattle Angina Questionnaire (SAQ). The HRQoL was evaluated with the 12-Item Short-Form Health Survey (SF-12). The generalized estimating equation (GEE) model explored the prognostic factors related to the changes in AF and HRQoL.*

Results: *Patients who received PCI had a reduction of the changes in AF compared with those in non-PCI group from baseline to T2 (B: -15.70, $p < 0.05$), T3 (B: -21.50, $p < 0.05$) and T4 (B: -22.91, $p < 0.05$). Occlusive vessels negatively associated with the changes in physical HRQoL from baseline to T3 (B: -11.44, $p < 0.001$) and T4 (B: -11.53, $p < 0.05$). Patients who had longer hospital stay (B: 0.86, $p < 0.001$) and jobs (B: 5.88, $p < 0.05$) showed better physical HRQoL from baseline to T3. Patients who were older (B: -4.56, $p < 0.05$) and unemployment (B: -6.86, $p < 0.05$) reported worse mental HRQoL.*

Conclusion: *Higher risk AMI patients such as PCI therapy, older age, and occlusive vessels would take care carefully for promoting HRQoL and AF.*

Keywords: Acute Myocardial Infarction (AMI); Generalized Estimating Equation (GEE); Angina Frequency (AF); Health-Related Quality of Life (HRQoL)

Abbreviations

AMI: Acute Myocardial Infarction;
BMI: Body Mass Index;
CHD: Coronary Heart Disease;
HRQoL: Health-Related Quality of Life;
LVEF: Left Ventricular Ejection Friction;
MCS: Mental Component Score;
NSTEMI: Non-St-Elevation MI;
PCS: Physical Component Score;
PCI: Percutaneous Coronary Intervention;
PTCA: Percutaneous Transluminal Coronary Angioplasty;
STEMI: ST-Elevation MI;
SE: Standart Error

Introduction

Acute myocardial infarction (AMI) is one of the major leading causes of mortality and morbidity worldwide [1]. Although AMI has high mortality, the prognosis of patients and the survival rate has improved in recent years [1, 2]. Patients affected by complications exhibit a risk of deterioration in health-related quality of life (HRQoL). Among patients with post-AMI, angina was also a common symptom after treatment. Several studies indicate that approximately 30-40% of patients experience angina after treatment [3-5]. The persistence and recurrence of angina remains an important issue after successful percutaneous coronary intervention (PCI) therapy [6]. On the other hand, patient characteristics associated with angina. For example, Chang et al. found that patients' clinical characteristics, such as Post-PCI electrocardiogram (ECG), cardiac troponins (cTns) elevation and number of stent placement, were correlated with occurrence of post PCI chest pain [5]. Persistent smokers had a 1.5-fold increased risk of angina at 1 year compared with never smokers (95% CI=1.1-1.9, $p < 0.01$) [4]. However, little is known about the association between patients' clinical characteristics and angina in a dynamic situation. It would be helpful to identify patients with specific characteristics for improvement of angina management.

Moreover, the American Heart Association noted that a patient's HRQoL is an important index among patients with cardiovascular disease [7]. Previous studies have found that HRQoL may predict poor prognosis and increase the mortality rate in myocardial infarction patients [8, 9]. Given the variety of CHDs, targets selected by research institutes to track HRQoL changes including not only patients undergoing invasive treatment, such as cardiac surgery or coronary artery interventions, but also others who not undergoing such invasive treatment. Therefore, the conclusions of these studies are inconsistent.

The recovery of HRQoL might require different amounts of time. For example, Xue et al. found that physical symptoms and mental health improved 2 months after treatment, and the process of recovery in physical function could require one year [9]. Furthermore, some studies found that HRQoL of AMI patients showed good improvement from 1 month to two years [10-12]. These studies showed that HRQoL changes with time, and recovery could extend up to the long-term post-AMI recovery period, and patient characteristics, such as age, gender, smoking, location of AMI, length of stay in hospital, and job status, were associated with HRQoL [4, 12-21]. Nevertheless, these studies used patient characteristics as covariates and mostly compared the differences between two time-points. Evidence regarding the effects of patients' characteristics on patient-reported HRQoL would be needed.

Regarding mental health, AMI is often followed by poor mental health status [22]. One retrospective observational study indicated that mental stress was associated with AMI [23]. Nielsen et al. further indicated that low mental health status after MI was a strong predictor of new cardiovascular events or death [22]. Previous studies reported that patient characteristics were associated with mental health among AMI patients. Vazquez-Oliva et al. found that the older patients had higher population case-fatalities than younger ones, and population case-fatality increased with age [24]. Stendardo et al. noted that a lower value of Hospital Anxiety and Depression Scale (HADS) depression score had positive effects on job status, and another longitudinal study also found that patients with job status changes were more likely to experience depression [25, 26]. Moreover, individual characteristics, such as age, gender, smoking status, job status and types of treatment, were also associated with poor mental health [27, 28]. However, most studies focused on the comparison or the evaluation of risk between two time-points. The deterioration of mental health could potentially be avoided by investing the effects of patient characteristics on changes in mental health during post-AMI recovery.

The objectives of this study are: (1) to explore the association between patients' characteristics and the changes in angina frequency (AF) and HRQoL in 6 months after treatment; (2) to examine the interaction effects of prognostic factors on changes in AF and HRQoL during the different periods of prognosis.

Methods

Design

The study was conducted as a prospective cohort study with convenience sampling to explore the prognostic factors for changes in HRQoL and AF in AMI patients. Acute myocardial infarction was defined and as recommended in current guidelines and the diagnosis was conducted by cardiologists in the hospitals [29]. AMI patients were recruited from the two major hospitals in eastern Taiwan from 2014 to 2016. The study inclusion criteria included patients who were (1) newly diagnosed with AMI; (2) age 18 years or older; (3) and able to communicate with healthcare professionals. To control confounding for comorbidity, patients with the following conditions would be excluded: (1) Type II myocardial infarction; (2) mechanical complications, such as papillary muscle rupture, left ventricular aneurysm or acute mitral insufficiency; and (3) cancer, psychiatric or neurological related disorders. Patients were given a detailed description of the study, and written consent was obtained after they agreed to participate in this study. The case history was obtained by patients' medical records. Data were collected when patients received treatment (baseline, T1), one month after treatment (T2), three months after treatment (T3) and six months after treatment (T4). A total of 102 patients completed the baseline survey. In total, 23 patients were lost to follow up or rejected participation in this study, and 3 patients died during the study period.

All procedures performed in this study was approved by the Research Ethics Committee of Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation (Approval No: IRB103-13-B) and the Institutional Review Board/Ethics Committee of Mennonite Christian Hospital (Approval No: 14-04-007). All signed consents form patients were obtained in the current study at baseline visit.

Demographic and Clinical Data Collection

Data on age, sex, education level, job status, marital status, living status, and living status were obtained from the survey questionnaire at the first interview (the second day after treatement). We used medical records to collect data, such as length of stay in the hospital, smoking status, and alcohol consumption. Body mass index (BMI) was classified as follows: normal weight (18.5–23.9%), overweight (24–26.9%), and obese (≥27%). Other medical record data included AMI-specific information, such as types of AMI (STEMI/NSTEMI [ST-elevation MI/non-ST-elevation MI]), Killip classification, AMI times, creatine-phosphate-kinase (CPK), and type of reperfusion therapy, which was classified as percutaneous coronary intervention (PCI), non-PCI, including percutaneous transluminal coronary angioplasty (PTCA) or none. Patients who had only one occlusive vessel in the left anterior descending coronary artery (LAD), left circumflex coronary artery (LCX) or right coronary artery (RCA) were included in group one (only one occlusive vessel), and the others were referred to group two (above two occlusive vessels). The severity of chest pain at AMI onset was evaluated using intracranial pressure (ICP) scores.

Angina Frequency Assessment

Angina frequency in patients was assessed using the Seattle Angina Questionnaire (SAQ). The SAQ is a commonly used instrument for assessing symptoms affecting daily life among patients with coronary artery disease [30]. It is a 19-item questionnaire measuring five dimensions of coronary artery disease: physical limitation (PL), angina stability (AS), angina frequency (AF), treatment satisfaction and disease perception [30]. In the AF subscale, each item uses a five-point Likert scale from 1 (less than once in one week) to 5 (more than 4 times a day). The score has a transformed range from 0 to 100, with higher scores indicating more angina-symptoms. The Chinese version of SAQ exhibits acceptable reliability (the test-retest reliability of the Chinese SAQ was 0.95) and validity [31, 32].

Measurement of Health-related Quality of Life

The 12-Item Short-Form Health Survey (SF-12) is a short-form 12-item scale derived from the 36-Item Short-Form Health Survey (SF-36) that is used to evaluate the HRQoL of patients. This scale consists of eight subscales and two dimensions, namely, the physical component scores (PCS) and mental component scores (MCS), to access HRQoL from the patients' perspective. The PCS included physical functioning (PF), role functioning (RF), body pain (BP) and general health (GH). The MCS included vitality (VT), social functioning (SF), role emotional (RF) and mental health (MH) [33]. The PF is a three-level response continuum from 0 (not limited at all) to 2 (limited a lot). The PF and RF were scored with yes-no questions from 0 (yes) to 1 (no). The BP, GH, VT, SF, and GH were scored with a five-point Likert scale from 1 (most of the time) to 5 (none of the time). The score has a transformed range from 0 to 100, with higher scores representing better HRQoL. The PCS and MCS had satisfactory reliability (test-retest of 0.89 for PCS and 0.76 for MCS) and validity [4, 33].

Statistical Analyses

Descriptive statistics were presented as counts, percentages, mean and standard deviation (SD). The difference between the continuous variables was analyzed via ANOVA. Correlations analysis was conducted using different variable types. The factors entering in the generalized estimating equation (GEE) models were examined with correlation analysis. Pearson correlations were used to examine consecutive variables. The correlation between two consecutive variables was analyzed with Spearman correlations, and the categorical and continuous variables were tested with point bi-serial correlations. Only those significant characteristics associated with AF, PCS and MCS in the correlations analyses were included in the GEE models. The association between prognostic factors and the changes in AF and HRQoL were examined with GEE. Moreover, the interactions between the patients' characteristics and HRQoL in relation to changes over time were also examined. Estimated parameter (B), robust SE and 95% confidence intervals were also estimated by GEE models. P-values (two-sided test) ≤ 0.05 were considered statistically significant. All statistical analyses were performed using SPSS 18 software (SPSS Inc., Chicago, IL, USA).

Results

Baseline Patient Characteristics

A total of 102 patients' demographic and clinical characteristics at baseline were displayed in Table 1. Most of the participants were men (74.8%). In total, 83.3% had a high school education or less, 61.8% were over 60 years old (mean = 62.75; SD = 11.71), 53.9% had a full-time job, 77.5% were married, 81.4% lived with family, 61.8% were nonsmokers and 64.7% had no alcohol intake. Of the participants, 52.0% were NSTEMI patients, 59.9% experienced a one-vessel infarction of AMI, 59.9% experienced minor AMI severity (Killip I-II), 85.3% received PCI therapy, and 41.1% were obese. The mean scores of PCS at four-time points were 42.17 (SD = 10.19), 42.33 (SD = 10.64), 41.64 (SD = 10.32), and 40.68 (SD = 11.26), respectively, during the study period. The mean scores of MCS at four-time points were 47.16 (SD = 9.82), 46.35 (SD = 8.77), 45.89 (SD = 8.42), and 45.61 (SD = 9.08), respectively, during the study period. The means scores of both PCS and MCS improved by time but there were no statistical significance between time-points. The mean scores of AF at four-time points were 79.80 (SD = 18.67), 92.61 (SD = 13.01), 93.61 (SD = 11.98), and 91.49 (SD = 14.62), respectively, during the study period. AF increased from baseline to T3 but it slight decreased from T3 to T4. There were significant difference between time-points ($F = 17.06$, $p < 0.001$, T1 vs. T2, T1 vs. T3, T1 vs. T4). The mean scores of ICP were 7.37 (SD = 2.49) at baseline. The average occlusive vessels was 1.9 (SD = 0.85, range: 1-3) at baseline. The mean onset of AMI was 1.2 (SD = 0.55, range: 1-4) and 83.3% (n = 85) were new diagnosis of AMI. The average length of hospital stay was 6.06 days (SD = 4.72, range: 1-26). The average CPK was 1009.83 (SD = 1290.62 (U/L)) which was in the reasonable range among patients with AMI. Participants were evaluated at four time points: during hospitalization after AMI (T1; n = 102), 1 month (T2; n = 79), 3 months (T3; n = 76) and 6 months (T4; n =76). During follow-up, three (2.9%) died, and 23 (22.5%) were lost to follow-up or refused to continue in the study (**Table 1**).

Table 1: Demographic and clinical characteristics of patients at baseline.

	N (102)	Percentage (%)
Gender		
Male	80	78.4
Age (ref: 18-59)		
≥60	73	61.8
Education (ref: College or above)		
High school or below	85	83.3
Job status (ref: None)		
Yes	55	53.9
Marital status (ref: Non-married)		
Married	79	77.5
Living alone (ref: Yes)		
No	83	81.4
Smoking (ref: Yes)		
No	63	61.8
Alcohol (ref: Yes)		
No	66	64.7

AMI type		
STEMI	49	48.0
NSTEMI	53	52.0
Occlusive vessels		
One	61	59.9
Above two	41	40.1
Killip classification		
Minor (I-II)	61	59.9
Advanced (III-IV)	41	40.1
Reperfusion therapy		
PCI	87	85.3
PTCA and none	14	14.7
BMI		
Normal weight (18.5–23.9%)	27	26.5
Overweight (24–26.9%)	33	32.4
Obesity (≥27%)	62	41.1
	Mean	SD
SF-12		
PCS		
T1	42.17	10.19
T2	42.33	10.64
T3	41.64	10.32
T4	40.68	11.26
MCS		
T1	47.16	9.82
T2	46.35	8.77
T3	45.89	8.42
T4	45.61	9.08
AF[a]	88.66	16.18
T1	79.80	18.67
T2	92.61	13.02
T3	93.61	11.98
T4	91.49	14.62
AMI times	1.21	0.55
CPK (U/L)	1009.83	1290.62
Length of hospital stay (days)	6.06	4.72
ICP Score	7.37	2.49

AMI, acute myocardial infarction; BMI,body mass index; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty; CPK, creatine-phosphate-kinase. [a]The differences between four time-points were statistical significance ($p < 0.05$).

Correlation between Factors

The AF significantly correlated with education level (r =0.26), job status (r = -0.23), living alone (r = -0.28,), occlusive vessels (r = -0.23), Killip classification (r = -0.21), CPK (r = 0.30), length of hospital stay (r = -0.31), ICP scores (r = -0.23) and AMI times (r = -0.21).

The PCS significantly correlated with education level (r = 0.26), job status (r = -0.23), living alone (r = -0.28), occlusive vessels (r = -0.23), Killip classification (r = -0.21), CPK (r = 0.30), length of hospital stay (r = -0.31), ICP scores (r = -0.23) and AMI times (r = -0.21). Job status (r = -0.23), marital status (r = 0.24), living alone (r = -0.25), BMI (r = -0.23), occlusive vessels (r = -0.30), Killip classification (r = -0.28), CPK (r = 0.33), length of hospital stay (r = -0.25), ICP scores (r =-0.27) and AMI times (r = -0.28) were significantly associated with MCS.

Predictors of AF

The main effects showed that patients with more occlusive vessels reported greater AF scores (B = 11.96, $p = 0.001$). The results of the interaction analysis revealed that patients who underwent PCI experienced less angina onset from baseline to T2 (B = -15.7, $p = 0.03$), T3 (B = -21.5, $p = 0.01$) and T4 (B = -22.91, $p = 0.01$) (**Table 2**).

Table 2: Predictors of angina frequency (AF) as estimated by generalized estimating equations (GEE).

	B	SE	95% CI		Wald χ^2	p
Intercept	82.73	6.17	70.64	94.83	179.72	< 0.01
Gender (ref: female)	2.34	4.70	-6.88	11.56	0.25	0.62
Age (ref: 18-59)	-3.49	4.03	-11.39	4.40	0.75	0.39
Smoking (ref: no)	-4.24	4.40	-12.87	4.39	0.93	0.34
Occlusive Vessels (ref: one)	-2.46	3.79	-9.89	4.98	0.42	0.52
Reperfusion therapy (ref: non-PCI)	0.66	6.87	-12.80	14.12	0.01	0.92
Occlusive vessels	11.96	3.64	4.82	19.09	10.78	0.001
Interaction[a]						
T2 * PCI (ref: non-PCI)	-15.70	7.03	-29.49	-1.92	4.98	0.03
T3 * PCI (ref: non-PCI)	-21.50	8.37	-37.90	-5.09	6.59	0.01
T4 * PCI (ref: non-PCI)	-22.91	8.46	-39.49	-6.32	7.33	0.01

B, coefficient estimated by GEE; SE, standard error; CI, confidence interval; [a]: the interaction term was only present the significant terms.

Predictors of PCS of HRQoL

GEE results showed that the longer length of hospital stay had negative effects on PCS (B = -1.04, $p < 0.001$), and statistically significant differences were noted among other predictors. The interaction analysis results indicated that patients with more than two occlusive vessels had worse PCS than those who had only one occlusive vessel from baseline to T3 (B = -11.44, $p = 0.001$) and T4 (B = -11.53, $p = 0.03$). Patients with longer length of hospital stay (B = 0.86, $p < 0.001$) and employed patients (B = 5.88, $p = 0.01$) has improved PCS from baseline to T3 (**Table 3**).

Table 3: Predictors of PCS of HRQoL as estimated by generalized estimating equations (GEE).

	B	SE	95% CI		Wald χ^2	*p*
Intercept	48.24	4.98	38.48	57.99	93.92	< 0.001
Gender (ref: female)	5.78	3.01	-0.12	11.67	3.69	0.05
Age (ref: 18-59)	-4.22	2.48	-9.07	0.64	2.90	0.09
Education (ref: College or above)	-4.49	2.94	-10.25	1.27	2.34	0.13
Job status (ref: None)	-1.81	2.67	-7.04	3.42	0.46	0.50
Living alone (ref: Yes)	2.10	3.04	-3.86	8.07	0.48	0.49
Occlusive Vessels (ref: one)	7.92	4.43	-0.77	16.61	3.19	0.07
Killip classification (ref: minor)	1.68	2.44	-3.09	6.46	0.48	0.49
Occlusive vessels	-3.13	2.70	-8.43	2.17	1.34	0.25
CPK	0.001	0.0009	-0.001	0.003	0.86	0.35
Length of stay in hospital	-1.04	0.22	-1.46	-0.61	22.92	< 0.001
ICP Score	-3.81	2.82	-9.33	1.72	1.82	0.18
Interaction[a]						
T3 * Occlusive Vessels (ref: one)	-11.44	3.44	-18.18	-4.70	11.05	0.001
T4 * Occlusive Vessels (ref: one)	-11.53	5.46	-22.23	-0.83	4.46	0.03
T3 * Length of stay in hospital	0.86	0.24	0.39	1.34	12.84	<0.001
T3 * Job status (ref: None)	5.88	2.31	1.36	10.40	6.49	0.01

B, coefficient estimated by GEE; SE, standard error; CI, confidence interval; [a]: the interaction term was only present the significant terms.

Predictors of MCS of HRQoL

The main effects showed that patients with jobs reported better MCS (B = 10.04, $p < 0.001$) than those who were unemployed. Patients with advanced Killip classification had better MCS (B = 4.39, $p = 0.03$). Increased AMI numbers were associated with decreased MCS (B = -8.55, $p < 0.001$). The results of the interaction analysis indicated that patients with more AMI had improved MCS from baseline to T3 (B = 6.72, $p = 0.02$). Older patients reported worse MCS than younger patients from baseline to T3 (B = -4.56, $p = 0.03$) and T4 (B = -7.64, $p = 0.01$). Employed patients (B = -6.86, $p = 0.02$) had worse MCS than patients without a job from baseline to T3 (**Table 4**).

Table 4: Predictors of MCS of HRQoL as estimated by generalized estimating equations (GEE).

	B	SE	95% CI		Wald χ^2	*p*
Intercept	64.12	4.96	54.40	73.84	167.20	< 0.001
Gender (ref: female)	-0.77	2.44	-5.55	4.00	0.10	0.75
Age (ref: 18-59)	0.67	2.39	-4.01	5.35	0.08	0.78
Job status (ref: None)	10.04	2.82	4.52	15.56	12.72	< 0.001
Marital status (ref: Non-married)	-11.24	3.20	-17.51	-4.97	12.35	< 0.001
Living alone (ref: Yes)	0.80	3.06	-5.19	6.79	0.07	0.79
BMI (ref: Normal weight)						
Overweight	-0.64	2.78	-6.09	4.82	0.05	0.82
Obese	0.56	3.14	-5.59	6.72	0.03	0.86
Occlusive Vessels (ref: one)	-4.04	5.26	-14.36	6.27	0.59	0.44
Killip classification (ref: minor)	4.39	2.07	0.34	8.44	4.51	0.03
CPK	0.00	0.00	0.00	0.00	0.09	0.76
Length of stay in hospital	-0.05	0.20	-0.45	0.35	0.07	0.79
ICP Score	-0.97	0.49	-1.93	-0.01	3.96	0.05
AMI times	-8.55	2.11	-12.68	-4.42	16.50	< 0.001
Interaction[a]						
T3 * AMI times	6.72	2.79	1.25	12.19	5.80	0.02
T3 * Age (ref: 18-59)	-4.56	2.08	-8.65	-0.47	4.79	0.03
T4 * Age (ref: 18-59)	-7.64	2.93	-13.38	-1.89	6.79	0.01
T3 * Job status (ref: None)	-6.86	2.83	-12.40	-1.32	5.88	0.02

B, coefficient estimated by GEE; SE, standard error; CI, confidence interval; [a]: the interaction term was only present the significant terms.

Discussion

In this study of AMI patients using four repeated measurements of HRQoL over a 6-month period, the predictors of AF, PCS and MCS were identified. The effects of predictors were noted in different time periods. However, the main effects of GEE presented the effect of prognostic factors on outcome variable averaged across the levels of prognostic factors, regardless of time. Hence, we mainly discussed the interaction term in the GEE analysis.

These findings confirmed our assumption that patient characteristics are related to changes in AF and HRQoL over time in AMI patients.

Our results showed that the patient characteristics did not affect AF changes except for the type of treatment. Patients who received PCI therapy had less AF than those who received non-PCI. This result was consistent with previous studies [3-5]. One possible explanation was the physiologic benefits of PCI. AMI is an acute life-threatening disease, and greater than 90% of patients received PCI or other life-saving interventions. PCI prevents further cardiac damage and preserves cardiac function after a heart attack. In addition, the ischemic threshold is increased in patients who receive PCI via improved myocardial oxygen supply; hence, patients reported less angina. On the other hand, patients might seek medical care for angina. Although angina has inevitable symptoms, angina could be alleviated by medication use, such as β-blockers, ranolazine, nitrates, calcium channel blockers, and non-β-blocker antiangina medication [3, 34]. This medical intervention might contribute to the reduction in AF over time, and this notion is also supported by our results (B=-15.70 at T2, B=-21.50 at T3, B=-22.91 at T4). Our observations suggest that the effects of PCI on AF are reduced over time. Clinical professionals might pay more attention to patients in early stages and to specific clinical characteristics of patients, such as abnormal ECG changes, cTns elevation, and the number of stents placed, which are risk factors for post-PCI chest pain [5]. The effects of medical intervention and other clinical factors should be further explored for angina in future studies.

We also found that patients with AMI in only one occlusive vessel reported better PCS than those who had more than one occlusive vessel. This finding might be explained by the fact that LAD, LCX and RCA are the main three coronaries that supply blood to the heart and the main three coronary arteries that cause AMI [4, 35]. One recent study noted that AMI in the LAD, LCX or RCA was an independent predictor of major adverse clinical events [17]. Similarly, the greater number of occlusive coronary arteries AMI patients had, the greater the severity of MI. Increased severity of MI had longer negative effects on HRQoL [36]. Patients with insufficient blood supply had worse physical function; hence, they reported a worse PCS during the post-AMI recovery period.

On the other hand, patients with a job reported a better PCS from baseline to 3 months after treatment. This might because patients with jobs had better physical health. Mirmohammadi et al. indicated that the decision to return to work was dependent on the patient's evaluation [21]. If patients experienced sufficient recovery after treatment, they would be qualified to return to work. Additionally, Brink et al. also noted that low physical health after myocardial infarction had negative effects on the ability to return to work [20]. Therefore, patients with a job had better PCS than those without a job. The distribution of job status was similar (53.9% with job), and the effects of selection bias might limited. Moreover, patients with a job were subject to extra physical therapy to improve cardiovascular conditioning and prevent thromboembolic events [3]; hence, they showed higher PCS.

Moreover, the length of hospital stay had a positive association with PCS from baseline to 3 months. Previous studies noted that the length of hospitalization was 3 days, which was shorter than our results (mean = 6.06, SD=4.72) [18, 19]. This finding might be attributed to the fact that these studies included patients with different medical conditions. For example, the length of hospital stay was short when patients experienced an uncomplicated myocardial infarction. One randomized trial conducted by Melgerg et al. revealed a similar readmission rate in the early vs. standard discharge group among patients with uncomplicated primary percutaneous coronary intervention (PPCI); however, the high-risk group had a longer length of hospital stay [19]. Patients might not understand the postoperative care, and non-adherence to medical advice produced poor healthcare after treatment. Poor healthcare could have caused postoperative complications, and these patients likely required readmission. Additionally, the cost of treatment was primarily covered by the National Health Insurance in Taiwan. Hence, physicians might extend the length of hospitalization for better prognosis, and patients showed a better PCS. Nerveless, the appropriate use of medical resources is a significant issue between cost effectiveness and health care outcomes. Our study suggested that the modifiable length of hospitalization among individuals at different levels of risk represents a solution to this issue.

Our study also found that age had negative effects on MCS 3 and 6 months after treatment. This finding might be attributed to the fact that older patients perceived more fear of dying than younger patients. Larsen and his colleagues indicated that depressive symptoms were associated with death (HR = 1.13, 95% CI = 1.05-1.21) [37]. A positive association was also noted between age and population case-fatality [24]. The higher mortality increased the fear of death and caused mental stress; hence, older patients reported worse MCS. Although the effects of age on the medical prognosis were inevitable, healthcare professionals could provide mental health consultations to patients and their families to improve the MCS.

We also found the AMI episodes had positive effects on the MCS from baseline to 3 months. This finding might be explained by sensory adaptation. Sensory adaptation indicated that an individual's susceptibility changes with the number of times they are exposed to a stimulus. Typically, under the continuous action of stimulation, the sensitivity of humans can be improved [38]. AMI is a severe life event for patients that might result in mental health problems. The impact of AMI might result in the improvement of patient sensitivity. Moreover, patients also received information on AMI and coping strategies to reduce the mental burden after the occurrence of AMI. Consequently, the impact of AMI after the first AMI was reduced, and these patients showed a better MCS. As mentioned above, healthcare professionals should also provide an appropriate coping strategy to alleviate the negative effects of post-AMI on mental health.

Furthermore, we also found that patients with jobs experienced a reduction in MCS from baseline to 3 months. This result was in line with previous studies [25, 39]. According to the results of Stendardo et al., 92.7% patients returned to work after one year [25], and a return to work might represent recovery from AMI. However, patients might worry that their work performance is not the same as that prior to AMI. Work performance is related to performance appraisal, and lower work performance potentially reduces income. Additionally, males are typically the main income provider in Taiwan, and patients perceived more finical stress, which was support by our data (78.4% of patients were male in this study). These conditions enhance the mental burden of patients; thus, they reported a lower MCS. Healthcare professionals and patients' families should provide psychological support to reduce worrying among patients to improve MCS.

Limitations

There were some limitations of this study. First, replication with a larger number of baseline participants and a longer observation period of AMI patients is needed. The loss to follow-up rate is an important issue in longitudinal study design, but GEE might minimize the effects of the loss to follow-up. Instead of deleting the missing data of subjects, GEE can analyze the other complete time-point data from subjects. However, our sample size (n = 102) was consistent with the minimal numbers estimated for a G*power of 60 under these conditions: Effect size f = 0.25, $\alpha = 0.05$, power = 0.90, and number of measurements=4 [4]. Furthermore, there were no statistical difference between lost to follow up and participants in age (t = 0.49, $p = 0.63$) or gender ($\chi^2 = 1.20$, $p = 0.39$). The effects of the loss to follow-up might be minimal. Second, researchers collected data from patients using a self-report questionnaire, which would cause a recall bias. However, the symptoms were direct responses of patients, and these symptoms persisted over time. Patients reported their symptoms based on their recall of symptoms; hence, causal inference in this study might not be affected. Third, we collected our data using convenience sampling in one medical center and one regional hospital in eastern Taiwan; hence, we would not performed the sensitivity analysis to examine the difference between participants and non-participants. Besides, convenience sampling might limit the generalizability of our findings to other populations. Further studies also should recruit more representative samples to examine the risk factors for HRQoL in long-term observations. It would be clearer to explore the specific factors affecting the changes in HRQoL with larger and more representative samples.

Conclusions

In previous studies on HRQoL, traditional repeated measures were applied to examine the mean trend of HRQoL and predictors, and we extend the results of previous studies by considering dynamic changes. Our findings could be used to identify a high-risk group that requires advanced health care in different periods of post-AMI recovery. Demographic and clinical characteristics, such as age and job status, AMI location, length of hospital stay, the AMI events and the treatment type showed different effects on change in HRQoL. Our results add evidence to the belief that each prognostic factor affected AF and HRQoL in different periods instead of the entire prognosis. These finding might also increase patients' family and clinicians' awareness of the changes in healthcare needs based on these characteristics for improving AF or HRQoL.

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