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Referral and participation in cardiac rehabilitation of patients following acute coronary syndrome; lessons learned

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ABSTRACT

Purpose: Cardiac rehabilitation (CR) after hospitalization for acute coronary syndrome (ACS) has shown to reduce mortality, readmissions, and improve quality of life. CR is recommended by international guidelines but previous studies have shown low participation rates. Systematic CR referral might improve CR participation.

Methods: The present study evaluates CR referral and CR participation of patients hospitalized for ACS in 2017 and treated according to local protocol, which includes systematic CR referral. Participation rate was divided into a group that finished the CR program and drop outs. In addition, factors associated with CR referral and participation rate were evaluated.

Results: A total of 469 patients eligible for CR were included in the study, of which 377 (80%) were referred for CR and 353 (75%) participated in CR. Ninety percent of participants completed the CR program. Factors independently associated with CR referral included age (50–60 year vs. > 70 year: odds ratio [OR] 4.7, 95% confidence interval [CI] 1.98–11.2), diagnosis (ST-elevation myocardial infarction vs. unstable angina: OR 17.7, CI 7.59–41.7), previous cardiovascular disease (OR 0.4, CI 0.19–0.73) and left ventricular dysfunction vs. normal function (OR 2.2, CI 1.11–4.52). A larger distance to the CR center was associated with lower CR participation (<5km vs. > 20 km: OR 3.1, CI 1.20–7.72).

Conclusions: Systematic CR referral in ACS patients results in high CR referral (80%) and participation (75%) rates. CR adherence might be further improved by increasing CR referral, especially in older patients and patients with NSTEMI or unstable angina.

1. Introduction

Cardiac rehabilitation (CR) comprises a multidisciplinary intervention programme involving exercise training, modification of risk factors, education and psychological support [1]. Research has shown that CR reduces mortality and hospital readmission, and improves exercise capacity and quality of life in patients with ischemic heart disease [2–5]. CR is recommended by the ESC guidelines for patients with a ST-elevation myocardial infarction (STEMI), a non ST-elevation myocardial infarction (NSTEMI) or unstable angina pectoris (Class I, Level of evidence A) [6]. Despite these recommendations, CR referral services are still underused with, in the Netherlands, currently only a third of eligible patients with acute coronary artery disease participating [7,8].

The reasons for this low CR participation rate are diverse and relate to various factors including patient characteristics such as age and gender, socio-economic status (SES) and logistic factors, such as traveling distance to the CR center [8–11]. Furthermore, low participation rate may be related to a lack of referral to CR or by patient refusal to participate in CR. Determining the reasons for non-attendance has been the goal of many studies in order to optimize CR participation [8,12,13]. One of the proposed strategies to improve CR adherence is systematic CR referral after hospitalization [14]. An ischemic heart treatment protocol should include

Abbreviations: ACS, Acute coronary syndrome; CI, Confidence interval; CR, Cardiac rehabilitation; CVA, Cerebrovascular accident; DBC, Diagnosis treatment combination (Diagnose behandel combinatie); EPD, Electronic patient dossier; LV, Left ventricular; NSTEMI, Non ST-elevation myocardial infarction; OR, Odds ratio; SES, Socio-economic status; STEMI, ST-elevation myocardial infarction; TIA, Transient ischemic attack.

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referral to a CR center as this may result in a higher CR referral and participation rate.

The current study evaluates CR referral and participation rate in patients hospitalized for an ACS at the Leiden University Medical Center. Furthermore, the present study aims to identify patient characteristics that are predictive of CR referral, participation, and dropout.

2. Methods

Patient selection was based on DBC (*diagnosis treatment combination*) code for STEMI, NSTEMI and unstable angina pectoris in 2017, derived from the electronic patient dossier (EPD-Vision, Leiden, The Netherlands). Inclusion criteria included age > 18 years, patient admittance to the coronary care unit at the Leiden University Medical Center for treatment of an ACS, agreement to be treated according to local protocol and outpatient follow up at our center [15]. Patients were excluded when deceased during hospitalization, when digitally stated that CR participation was considered not feasible, or CR participation at the time of the ACS or within the year prior to the ACS. Patient data were retrospectively collected from hospital records, which included received letters from the referred CR centers. Based on this information, 'CR referral' was defined as being referred for CR within 12 months after admission for ACS, 'CR participation' was defined as having started the CR program. In addition, in order to evaluate patient dropout during the CR program, 'CR completion' was defined as having successfully completed the CR program. The institutional ethical committee waived the need for patient written informed consent for this retrospective analysis.

Patient characteristics included age, gender, previous cardiovascular disease (prior myocardial infarction, coronary artery bypass grafting or percutaneous coronary intervention [PCI]), diabetes mellitus, hypertension, dyslipidaemia, smoking (current, previous, never), family history of cardiovascular disease, peripheral artery disease, pervious transient ischemic attack [TIA]/cerebrovascular accident [CVA], disease presentation (STEMI, NSTEMI, unstable angina pectoris), left ventricular (LV) ejection fraction derived by echocardiography within 3 months after the event, distance to CR center, time between hospital discharge and start of CR, and SES. Distance to CR center was based on patient's postal code and postal code of the referred CR center. Patient's SES was based on a 4-category classification system, developed by the Netherlands Institute for Social Research, which accounts for the average income in the corresponding city district, the percentage of people with a low income, the percentage of people with low-level education and the percentage of people without a paid job, based on postal code [16].

2.1. Statistical analysis

Continuous variables are reported as mean ± SD and categorical variables are presented as frequencies and percentages. Differences in patient characteristics between patients with and without CR referral, CR participation and CR completion were evaluated by Student's *t*-test or Chi-square test. The correlation between patient characteristics and CR referral, CR participation and CR completion was assessed by univariate and multivariate logistic regression. Variables that reached statistical significance in univariate analysis entered the multivariate stage. Regression analysis results are reported as odds ratios (OR) and 95% confidence intervals (CI). All statistical analyses were performed with SPSS software version 25 (SPSS Inc., Chicago, IL, USA). All tests were two-sided, with a $P < 0.05$ considered statistically significant.

3. Result

Based on DBC code, 1045 patients were eligible for inclusion. A total of 576 patients met the following exclusion criteria: admission for ACS at another hospital (and only PCI at our center) in 219 patients, transfer to another hospital for treatment and outpatient follow up in 218 patients, outpatient follow up at another hospital in 65 patients, and 51 patients were excluded as they died during hospitalization. Three patients were excluded as the physician had determined them unable to participate in CR which was due to orthopedic problems in 2 patients and for extensive comorbidity in 1 patient. Furthermore, 20 patients were excluded as they were currently participating in CR or had been participating within the year prior to the ACS. Therefore, a total of 469 patients (mean age 63 ± 12 years, 73% male) were included in the analyses. (Fig. 1) Baseline characteristics of these patients are shown in Table 1.

Out of 469 patients, 377 patients (80% of all eligible patients) were actually referred for CR. Of these patients, 353 (75% of total) participated in CR, of which 90% (319 patients) completed their rehabilitation program. Twenty-four patients (6% of total) referred for CR did not start the CR program. In conclusion, 319 patients (68% of all patients eligible) finished the CR program (Fig. 1).

Patient referral was higher in patients who were younger, had a more favorable coronary artery disease risk profile (based on known cardiovascular risk factors) and were more often diagnosed with STEMI or NSTEMI as compared to unstable angina. Also, patients with a reduced LV function were more frequently referred for CR as compared to a normal LV function (Table 1). Multivariate analyses demonstrate that age, diagnosis, distance to the CR center, previous cardiovascular disease and LV function were independently associated with CR referral rate (Table 2). Patients below the age of 70 had a 3.5–4.7 times higher referral rate than patients above the age of 70. CR referral in NSTEMI was 2.8 times higher than patients diagnosed with unstable angina, and referral in STEMI was even 17.7 times higher as compared to unstable angina (OR 2.8, CI 1.32–6.02, P = 0.007 and OR 17.7, CI 7.59–41.7,

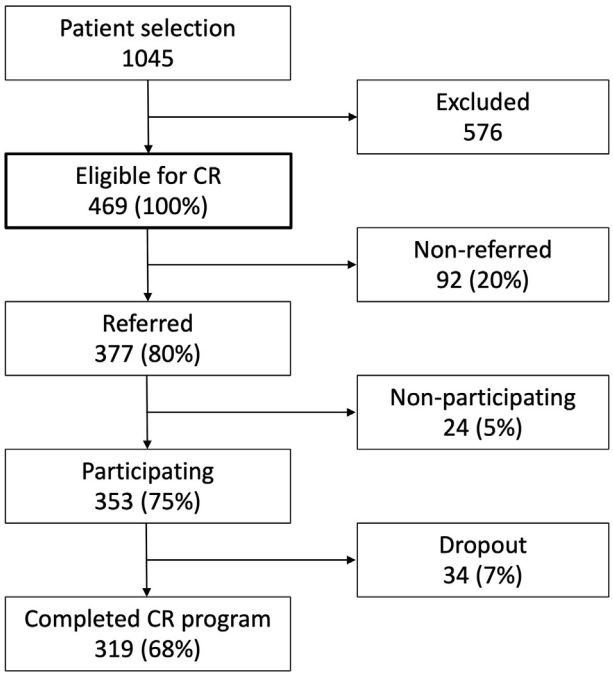

Fig. 1. Flow of patient selection and number of patients (and percentage of total patient population eligible for CR) referred for CR, participating in CR, and that completed the CR.

Table 1
Patient characteristics of the total study population, and according to CR referral, CR participation and completion of the CR program.

	All patients	CR referral			CR participation			Completion of CR program		
		Yes	No	P Value	Yes	No	P Value	Yes	No	P Value
Number of patients	469	377	92		353	22		318	34	
Male	341 (73%)	279 (74%)	62 (67%)	0.202	259 (74%)	18 (82%)	0.382	232 (73%)	26 (77%)	0.660
Age, years	63.3 (11.8)	61.5 (10.9)	70.8 (12.2)	<0.001	61.1 (10.7)	66.8 (12.7)	0.017	61.4 (10.7)	58.7 (11.9)	0.165
Age, categories										
< 50 years	56 (12%)	51 (14%)	5 (5%)	0.001	49 (14%)	2 (9%)	0.209	41 (13%)	8 (24%)	0.348
50–60 years	121 (26%)	111 (29%)	10 (11%)		106 (30%)	5 (23%)		96 (30%)	8 (24%)	
60–70 years	141 (30%)	116 (31%)	25 (27%)		110 (31%)	5 (23%)		99 (31%)	11 (32%)	
> 70 years	151 (32%)	99 (26%)	52 (57%)		88 (25%)	10 (46%)		82 (26%)	7 (21%)	
Comorbidities										
Previous cardiovascular disease	109 (23%)	63 (17%)	46 (50%)	<0.001	56 (16%)	7 (32%)	0.052	49 (15%)	7 (21%)	0.433
Hypertension	228 (49%)	172 (46%)	56 (61%)	0.009	159 (45%)	13 (59%)	0.199	145 (46%)	13 (38%)	0.412
Dyslipidemia	158 (34%)	116 (31%)	42 (46%)	0.007	111 (31%)	5 (23%)	0.391	100 (31%)	9 (27%)	0.551
Diabetes mellitus	83 (18%)	61 (16%)	22 (24%)	0.073	55 (16%)	5 (23%)	0.375	49 (15%)	6 (18%)	0.733
Familiar cardiovascular disease	216 (46%)	179 (48%)	37 (40%)	0.203	169 (48%)	9 (41%)	0.518	158 (50%)	11 (33%)	0.074
Periferal artery disease	40 (9%)	25 (7%)	15 (16%)	0.003	24 (7%)	1 (5%)	0.681	21 (7%)	3 (9%)	0.625
Previous TIA/CVA	26 (6%)	20 (5%)	6 (7%)	0.647	18 (5%)	2 (10%)	0.419	18 (6%)	0 (0%)	0.154
Smoking, categories										
Nonsmoker	156 (33%)	121 (32%)	35 (38%)	0.350	116 (33%)	4 (18%)	0.112	103 (32%)	11 (32%)	0.07
Current smoker	130 (28%)	103 (27%)	27 (29%)		92 (26%)	10 (46%)		78 (25%)	14 (41%)	
Previous smoker	183 (39%)	153 (41%)	30 (33%)		145 (41%)	8 (36%)		137 (43%)	9 (27%)	
SES	0.47 (0.73)	0.50 (0.72)	0.35 (0.78)	0.082	0.51 (0.73)	0.39 (0.59)	0.455	0.52 (0.73)	0.35 (0.81)	0.184
SES, categories										
Low SES	106 (22%)	79 (21%)	27 (29%)	0.220	72 (20%)	7 (32%)	0.442	62 (20%)	10 (29%)	0.300
Moderate SES	247 (53%)	202 (54%)	45 (49%)		191 (54%)	10 (45%)		172 (54%)	18 (53%)	
High SES	116 (25%)	96 (25%	20 (22%)		90 (26%)	5 (23%)		84 (26%)	6 (18%)	
Diagnosis, categories										
Unstable angina	76 (16%)	29 (8%)	47 (51%)	<0.001	28 (8%)	1 (5%)	0.769	27 (9%)	1 (3%)	0.512
STEMI	261 (56%)	247 (66%)	14 (15%)		231 (65%)	14 (64%)		208 (65%)	23 (68%)	
NSTEMI	132 (28%)	101 (27%)	31 (34%)		94 (27%)	7 (31%)		83 (26%)	10 (29%)	
LVEF, categories										
Normal	210 (45%)	154 (41%)	56 (61%)	0.001	141 (40%)	12 (54%)	0.326	123 (39%)	17 (50%)	0.381
Mildly reduced	210 (45%)	184 (49%)	26 (28%)		176 (50%)	7 (32%)		160 (50%)	16 (47%)	
Moderately reduced	39 (8%)	33 (9%)	6 (7%)		30 (8%)	3 (14%)		29 (9%)	1 (3%)	
Severely reduced	10 (2%)	6 (1%)	4 (4%)		6 (2%)	0 (0%)		6 (2%)	0 (0%)	
Start CR after hospital discharge, days								32 (32)	28 (20)	0.466
Start CR after hospital discharge										
< 3 weeks								134 (42%)	17 (50%)	0.194
3–6 weeks								113 (36%)	14 (41%)	
> 6 weeks								70 (22%)	3 (9%)	
Distance to CR center, km	10.8 (7.5)	11.0 (7.6)	9.7 (7.1)	0.128	10.7 (7.5)	15.0 (9.2)	0.011	10.8 (7.5)	10.6 (7.5)	0.873
Distance to CR center										
0–5 km	131 (28%)	100 (27%)	31 (34%)	0.082	96 (27%)	4 (18%)	0.011	87 (27%)	9 (26%)	0.699
5–10 km	139 (30%)	114 (30%)	25 (27%)		109 (31%)	5 (23%)		95 (30%)	13 (38%)	
10–20 km	134 (29%)	104 (28%)	30 (33%)		98 (28%)	4 (18%)		91 (29%)	7 (21%)	
> 20 km	65 (14%)	59 (16%)	6 (6%)		50 (14%)	9 (41%)		45 (14%)	5 (15%)	

Continuous data are presented as mean (standard deviation); Categorical data are presented as numbers (%).
CR, Cardiac rehabilitation; TIA/CVA, Transient ischemic attack/cerebrovasculair accident; SES, Socio-economic status; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; LVEF, Left ventricular ejection fraction.

P=<0.001, respectively). Furthermore, patient referral after NSTEMI was also less frequent as compared to STEMI (OR 0.2, CI 0.08–0.33, P= <0.001). Patients with previous cardiovascular disease were less likely to be referred for CR (OR 0.4, CI 0.19–0.73, P = 0.004), and a mildly reduced LV function resulted in a 2.2 times higher referral rate as compared to a normal LV function (OR 2.2, CI 1.11–4.52, P = 0.025). There was no significant difference in CR referral between men and women (P = 0.202) (Table 2).

CR participation was higher in younger patients (P = 0.017) and in patients living closer to the CR center (P = 0.011) (Table 1). There was an independent association between CR participation and the distance from patients' home to the CR center (OR 0.2, CI 0.07–0.79, P = 0.02). Whereas patient referral was higher in patients that lived further away (>20 km) from the CR center, CR participation was significantly lower in these patients when compared to patients living <5 km from the CR center (OR 4.0, CI 1.26–13.0, P = 0.02 and OR 0.2, CI 0.07–0.79, P = 0.02, respectively). Of note, other variables, such as SES or gender did not show to significantly influence patient participation.

Analysis of CR completion did not reveal a significant association with any of the patient parameters.

4. Discussion

The main finding of the present study is that 80% of ACS patients eligible for CR are actually referred for CR, and that 75% of eligible patients participated in the CR program. Furthermore, older patients, patients with unstable angina or NSTEMI, previous cardiovascular disease and absence of LV dysfunction after ACS, are referred less frequently compared to patients with STEMI. In addition, a larger distance to the CR center is associated with a lower CR participation rate.

CR has shown to reduce cardiovascular mortality and hospitalization for repeat cardiovascular events, and also improve exercise capacity and quality of life in patients with coronary heart disease [2,17–21]. Therefore, CR is recommended by the ESC guidelines for patients after ACS [1]. Nevertheless, previous studies of CR

Table 2
Predictors of referral for cardiac rehabilitation.

	Univariate analysis		Multivariate analysis	
	OR	**95% CI**	**OR**	**95% CI**
Male	1.3	(0.84–2.26)		
Age, categories				
< 50 years	5.3	(2.02–14.2)	4.0	(1.22–13.4)
50–60 years	5.8	(2.81–12.1)	4.7	(1.98–11.2)
60–70 years	2.4	(1.41–4.21)	3.5	(1.69–7.09)
> 70 years	ref			
Comorbidities				
Previous cardiovascular disease	0.2	(0.12–0.33)	0.4	(0.19–0.73)
Hypertension	0.5	(0.34–0.86)	0.7	(0.41–1.38)
Dyslipidemia	0.5	(0.33–0.84)	1.3	(0.66–2.38)
Diabetes mellitus	0.6	(0.35–1.05)		
Familiar cardiovascular disease	1.3	(0.85–2.15)		
Peripheral artery disease	0.4	(0.18–7.20)	0.7	(0.26–1.74)
Previous TIA/CVA	0.8	(0.31–2.06)		
Smoking, categories				
Nonsmoker	ref			
Current smoker	1.1	(0.63–1.95)		
Previous smoker	1.5	(0.86–2.54)		
SES, categories				
Low SES	0.6	(0.32–1.17)		
Moderate SES	0.9	(0.52–1.67)		
High SES	ref			
Diagnosis, categories				
Unstable angina	0.2	(0.10–0.35)	0.2	(0.08–0.33)
STEMI	5.4	(2.77–10.6)	2.8	(1.32–6.02)
NSTEMI	ref			
LVEF, categories				
Normal	ref		ref	
Mildly reduced	2.6	(1.54–4.29)	2.2	(1.11–4.52)
Moderately reduced	2.0	(0.80–5.03)	1.4	(0.44–4.52)
Severely reduced	0.5	(0.15–2.01)	0.8	(0.16–3.62)
Distance to CR center, categories				
0–5 km	ref		ref	
5–10 km	1.4	(0.78–2.55)	2.1	(0.97–4.45)
10–20 km	1.1	(0.61–1.90)	1.2	(0.58–2.44)
> 20 km	3.1	(1.20–7.74)	4.0	(1.26–13.0)

OR, Odds ratio; CI, Confidence interval; ref, Reference; TIA/CVA, Transient ischemic attack/cerebrovasculair accident; SES, Socio-economic status; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; LVEF, Left ventricular ejection fraction; CR, Cardiac rehabilitation.

participation in The Netherlands as well as in other countries in Europe, have shown CR participation rates as low as 30–40% of eligible patients [7,8,22,23]. In comparison to these studies, the present study demonstrates a high CR participation rate of 75% of ACS patients following treatment and outpatient follow up at our center. In STEMI patients participation rate was even 89%.

The high participation rate is predominantly explained by the referral rate of 80% which is related to systematic clinical care track used for all ACS patients. This previously described MISSION! protocol contains a pre-hospital, in-hospital and outpatient clinical framework for decision-making and treatment [24], and includes systematic CR referral. This protocol ensures that all patients admitted with an ACS diagnosis are automatically referred to the CR center at the time of hospital discharge, unless specifically stated by the physician that CR is not indicated. In line with this hypothesis, a study from Gravely-Witte et al. demonstrated that automated referral strategies within the hospital setting leads to increased CR referral rates [14,25]. In addition, as compared to previous studies demonstrating a patient dropout around 20–25%, the relatively low dropout rate of 10% in the current study attributes to the high CR completion rate [8,13,22]. The reason for this low drop out is unknown, but might be related to the wide range in options for patient tailored rehabilitation programs that are facilitated by the cardiac rehabilitation centre.

Despite the high referral rate, still 20% of patients eligible for CR were not referred. Reasons for this nonreferral could be unawareness of the CR indication by the doctor, unwillingness of the patient to participate in CR, or the inability of the patient to participate in CR not digitally stated in the hospital records (and therefore not excluded from analysis in this study). As data on the reason for nonreferral is absent due to the retrospective nature of the study, this remains unknown. However, as previous studies concluded that physician's perceived benefit and endorsement of cardiac rehabilitation is an important predictor of CR referral and attendance, increased physician awareness and education about the benefits of CR may improve CR participation [10,26–29].

A consistent finding in literature is that patients diagnosed with STEMI are more likely to be referred for CR as compared to patients with NSTEMI and, especially, unstable angina [7,8,10]. The lower referral might be related to the perception that CR could be of less benefit in these patients. A similar perception of less benefit could exist when no sign of permanent damage, such as absence of troponin release (in unstable angina) or LV dysfunction is present. This may also explain the lower referral rate in patients without LV dysfunction. Nevertheless, guidelines advice CR participation in STEMI, NSTEMI and unstable angina as beneficial effects have been found in all ACS patients [3].

Low participation rate was also associated with older age which might be related to a lower expected benefit from CR, higher rate of comorbidities that could inhibit CR participation, or limited options for transportation to the CR center [13]. However, various studies in older patients have concluded that CR also reduces all-cause and cardiovascular mortality in this patient population [2,30]. Therefore, it is important to emphasise the importance of CR referral and participation in this patient population.

The larger distance to the CR center has been shown to negatively affect CR participation in previous studies [31,32]. In the present study however we found that patients who lived further away from the CR center (>20 km) had a higher CR referral rate. Reasons for this higher referral rate are unknown, but could be related to the extra attention given to adhere to protocol for practical reasons as these patients also had a greater travel distance for visiting the hospital for outpatient follow up. However, in line with other studies, the present study demonstrates that patients living >20 km away from the CR center have a lower participation rate. Similar conclusions were drawn in the study by Borg et al. which concluded that a distance >16 km was associated with a lower participation rate [32].

In contrast to previous findings, no significant differences in CR referral, CR participation or CR completion were found within gender or social-economic status. Several studies concluded that women [8,33,34] and patients with lower social-economic status [8,12,33,35] were less likely to attend CR. The contrasting findings in the current study could be related to the non-discriminatory effect of systematic CR referral of all hospitalized ACS patients, as currently used in our treatment protocol.

Interestingly, apart from the distance to the CR center, there were no patient parameters that influenced CR participation, and none of the parameters influenced CR completion. However, as the patient drop out is relatively low (10%, 34 patients) this could have resulted in underpowering to detect a significant difference. Nevertheless, parameters such as older age, female gender, lower SES, or non-STEMI ACS, which have led to lower participation rate in several other studies [7,8,31], did not influence patient adherence to the CR program in the present study. In order to further improve participation to CR, implementation of a home-based CR program might be considered to overcome the obstacle of a large travel distance to the CR center as the reason for non-attendance [36].

4.1. Study limitations

This study has several limitations. Due to the retrospective design of the study we were not able to determine the reason for nonreferral for CR. Furthermore, several factors that have shown to influence CR participation in other studies, such as disease perception and patient beliefs and intention to participate in CR, were not available and could have influenced outcomes [37–39]. Similarly, since information on ownership of a car, possession of a driving license and options for means of transportation to the CR center is unavailable, and has shown to influence participation rate in previous trials, bias cannot be excluded [31,40]. Furthermore, since no information on socio-demographic characteristics was available, the patients' SES score was estimated by using the classification system developed by the Netherlands Institute for Social Research which is based on area of residence, which is only a proxy for SES. As a result, since most patients lived in the same region (84% of patients lived within 20 km from the hospital), this could have led to a smaller range in SES scores and underpowering to detect a difference.

5. Conclusions

In conclusion, the present study demonstrates that implementation of a systematic clinical care track including referral to a CR center results in a high referral rate of 80%, and a high participation rate of 75% of ACS patients hospitalized and treated according to protocol. This high referral rate may be achieved by adherence to this protocol as it includes systematic CR referral. CR adherence might be further improved by increasing patient referral, especially in older patients and patients with NSTEMI or unstable angina. This may be achieved by increasing physician and patient awareness about the benefits of CR. Furthermore, the introduction of a home-based CR program might overcome the obstacle of a large travel distance and thereby further improve CR participation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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