ORIGINAL RESEARCH

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Slow Gait Speed and Cardiac Rehabilitation Participation in Older Adults After Acute Myocardial Infarction

Kelsey Flint, MD; Kevin Kennedy, MS; Suzanne V. Arnold, MD, MHA; John A. Dodson, MD, MPH; Sharon Cresci, MD; Karen P. Alexander, MD

***Background*—**Lack of participation in cardiac rehabilitation (CR) and slow gait speed have both been associated with poor long-term outcomes in older adults after acute myocardial infarction (AMI). Whether the effect of CR participation on outcomes after AMI differs by gait speed is unknown.

***Methods and Results*—**We examined the association between gait speed and CR participation at 1 month after discharge after AMI, and death and disability at 1 year, in 329 patients aged ≥65 years enrolled in the TRIUMPH (Translational Research Investigating Underlying Disparities in Recovery From Acute Myocardial Infarction: Patients' Health Status) registry. Among these patients, 177 (53.7%) had slow gait speed (<0.8 m/s) and 109 (33.1%) participated in CR. Patients with slow gait speed were less likely to participate in CR compared with patients with normal gait speed (27.1% versus 40.1%; *P*=0.012). In unadjusted analysis, CR participants with normal gait speed had the lowest rate of death or disability at 1 year (9.3%), compared with those with slow gait speed and no CR participation (43.2%). After adjustment for cardiovascular risk factors and cognitive impairment, both slow gait speed (odds ratio, 2.30; 95% confidence interval, 1.30–4.06) and non-CR participation (odds ratio, 2.34; 95 confidence interval, 1.22–4.48) were independently associated with death or disability at 1 year. The effect of CR on the primary outcome did not differ by gait speed (*P*=0.70).

***Conclusions*—**CR participation is associated with reduced risk for death or disability after AMI. The beneficial effect of CR participation does not differ by gait speed, suggesting that slow gait speed alone should not preclude referral to CR for older adults after AMI. **(*J Am Heart Assoc*. 2018;7:e008296. DOI: 10.1161/JAHA.117.008296.)**

Key Words: acute myocardial infarction • cardiac rehabilitation • frailty • function • gait speed

Slow gait speed, along with other frailty measures, has been associated with all-cause mortality, adverse surgical outcomes, and incident disability and cardiovascular disease.[1–7] Although gait speed may change over time,[8,9] the most effective treatment for improving the outcomes of patients with slow gait speed and cardiovascular disease is less clear. Exercise is the most studied intervention[10,11] but remains underused because of lack of widespread screening and logistical challenges in designing exercise programs specific to older frail patients. Cardiac rehabilitation (CR) combines exercise and lifestyle interventions, and it is a guideline-recommended therapy after acute myocardial infarction (AMI).[12] Therefore, CR is an attractive potential way to improve outcomes of older patients with AMI and slow gait speed. Data suggest that older patients are less likely to be referred to CR,[13,14] but it is not known how slow gait speed affects referral to, or participation in, CR. In addition, it is unknown whether patients with slow gait speed who participate derive similar (or perhaps greater) benefit from CR as patients with normal gait speed do.

We aimed to describe the demographic, clinical, and social characteristics of patients with AMI with slow gait speed who

From the Division of Cardiology, University of Colorado, Aurora, CO (K.F.); Colorado Cardiovascular Outcomes Research, Aurora, CO (K.F.); Saint Luke's Mid America Heart Institute, Saint Luke's Health System, Kansas City, MO (K.K., S.V.A.); University of Missouri–Kansas City, Kansas City, MO (S.V.A.); Leon H. Charney Division of Cardiology, Department of Medicine (J.A.D.), and Division of Healthcare Delivery Science, Department of Population Health (J.A.D.), New York University School of Medicine, New York, NY; Cardiovascular Division, Washington University in St Louis, MO (S.C.); and Division of Cardiology, Duke Clinical Research Institute, Duke University Medical Center, Durham, NC (K.P.A.).

Accompanying Table S1 and Figures S1, S2 are available at http://jaha.ahajournals.org/content/7/5/e008296/DC1/embed/inline-supplementary-material-1.pdf

Correspondence to: Kelsey Flint, MD, 12631 E 17th Ave, B130, Aurora, CO 80045. E-mail: kelsey.flint@ucdenver.edu

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Clinical Perspective

What Is New?

- Slow gait speed (a marker of frailty) did not modify the benefit that older patients derived from cardiac rehabilitation after acute myocardial infarction.

What Are the Clinical Implications?

- Slow gait speed alone should not preclude referral to cardiac rehabilitation in older adults who experience acute myocardial infarction.

did and did not participate in CR to understand potential barriers to participation. Furthermore, we sought to assess whether CR participation affected the association of slow gait speed with 1-year mortality and disability among patients aged ≥65 years after hospitalization for AMI.

Methods

Participants and Baseline Patient Characteristics

Participants were identified from the TRIUMPH (Translational Research Investigating Underlying Disparities in Recovery From Acute Myocardial Infarction: Patients' Health Status) registry. The design and rationale of the TRIUMPH registry was previously described.[15] Briefly, the TRIUMPH registry was a 24-site US study that prospectively enrolled patients admitted with an AMI from April 11, 2005 to December 31, 2008. Eligible patients had elevated cardiac biomarkers and additional clinical evidence supporting the diagnosis of an AMI (eg, prolonged ischemic signs/symptoms or electrocardiographic ST changes) during the initial 24 hours of admission. Baseline data were obtained via chart abstraction and a detailed clinical interview by trained researchers. Follow-up occurred at 1, 6, and 12 months after AMI with a structured interview. Participants could opt for an additional in-person assessment at 1 and 6 months that included laboratory data, biometric and hemodynamic assessments, and, for patients aged ≥65 years, gait speed assessments. This current analysis is limited to patients aged ≥65 years who completed the 1-month in-home assessment and had both gait speed and CR participation status data available (Figure S1). Those without in-home visits were similar in age, sex, and race, but had lower educational attainment and had more activities of daily living (ADL) impairment at baseline, as previously described.[2] Participants provided written informed consent for in-hospital and follow-up assessments, and the institutional review board at each participating site approved the protocols. The data, analytic methods, and study materials will not be made available to other researchers for purposes of reproducing the results.

Gait Speed, Cognitive Impairment, and CR Participation Status

Slow gait speed was defined as an average gait speed <0.8 m/s on 3 trials of the 5-meter walk test.[1,2] Cognitive impairment was measured using the Telephone Interview for Cognitive Status (TICS-m), a 13-item questionnaire that provides a global assessment of cognitive function.[16] The TICS-m measures cognitive impairment in 4 domains: (1) orientation; (2) registration, recent memory, and delayed recall; (3) attention/calculation; and (4) semantic memory, comprehension, and repetition (language). The TICS-m is associated with other cognitive impairment measures and does not have a ceiling effect.[17] The TICS-m is scored from 0 to 39, with scores <19 indicating moderate to severe cognitive impairment. CR participation at 1 month was assessed by asking "Were you encouraged to participate in a CR program at the time you left the hospital after your heart attack or heart problem?" and "Did you participate in the program?" Participants who answered "yes" to both questions were counted as having participated in CR.

One-Year Outcomes: Death and Disability

The primary outcome was death or new disability 1 year after AMI. Death was assessed via follow-up interview and the Social Security Master Death File. New disability was defined as a decrease in ≥1 ADLs between the 1- and 12-month interviews. ADLs were assessed by the EuroQol 5-Dimensions questionnaire.[18] Participants are asked to identify whether they have "no problem," have "some problems," or are unable to perform functions in the following categories: (1) mobility (walking about), (2) self-care (washing or dressing), and (3) usual activities (work, study, housework, and family or leisure activities). Disability at 1 year was defined as a decrease in ability to perform at least 1 ADL. For example, a patient who rated mobility at baseline as having no problem but at 12 months as having some problems met the outcome of disability.

Statistical Analysis

Demographic and clinical characteristics and unadjusted 1-year outcomes were compared between patients who did and did not participate in CR, using *t* tests for continuous variables and χ^2 test or Fisher's exact test for categorical variables. Categorical variables are shown as percentages, and continuous variables are shown as means with SDs. Logistic regression was used to assess the association between gait speed, CR participation status, and 1-year death or disability. There were a limited number of events; therefore, we constructed a parsimonious multivariable logistic regression

model. We used a hierarchical model to account for clustering by site. Variables included the GRACE (Global Registry of Cardiac Events) score[19] to account for traditional cardiovascular risk factors, TICS-m score <19 for cognitive impairment, gait speed status, CR participation status, and the interaction between gait speed and CR participation.

Participants missing CR participation data (n=9), gait speed (n=89), TICS-m (n=3), or change in ADLs from 1 to 12 months (n=38) were excluded (Figure S1). Mortality status and GRACE score were collected on all participants.

All analyses were performed using SAS, version 9.4.

Results

Among 4340 patients with AMI enrolled in the TRIUMPH registry, 1314 were aged ≥65 years and survived 1 month after discharge. Of patients who were eligible for in-home assessment, 329 (25%) participated and had both CR and gait speed data available. Approximately half (n=177; 53.7%) of these patients had slow gait speed, and 220 (66.7%) did not participate in CR. Of the patients who did not participate in CR, most (n=127; 58%) were never encouraged to participate. Of the 202 patients who were encouraged to participate in CR, 109 (54%) did not.

Demographic and clinical differences by gait speed and CR participation status

Compared with patients with normal gait speed, patients with slow gait speed were less likely to be encouraged to participate in CR (55.7% versus 68.9%; *P*=0.014) and were less likely to actually participate in CR (27.1% versus 40.1%; *P*=0.012). Among patients with slow gait speed, those who did not participate in CR were more likely to be older, women, nonwhite, and unmarried; have lower education and socioeconomic status; and have more cardiac and noncardiac comorbidities than those who did. Among patients with normal gait speed, there were fewer demographic and clinical differences between those who did and who did not participate in CR, although non-CR participators were more likely to be nonwhite, have lower education, and have more cognitive impairment (Table 1 and Table S1).

One-Year Outcomes by Gait Speed and CR Participation Status

Among the 329 patients, 19 (5.8%) died and 66 (24.2%) had a loss of ≥1 ADLs at 1 year after AMI. In unadjusted analyses, both slow gait speed and lack of CR participation were associated with higher rates of death or disability (Table 2). Gait speed as a continuous variable also demonstrated a dose-response relationship in risk for poor outcomes. For every 0.1-m/s decrease in gait speed, the odds of experiencing death or disability in the 1 year after MI increased by 11% (adjusted odds ratio, 1.11; 95% confidence interval, 1.03–1.19). In hierarchical multivariable analysis, there was no clustering effect by site (*P*=0.22), and the association between slow gait speed, CR participation, and outcomes persisted. CR nonparticipation and slow gait speed were both independently associated with death or disability (odds ratio, 2.27 [95% confidence interval, 1.17–4.40]; and odds ratio, 2.27 [95% confidence interval, 1.27–4.05], respectively; Table 3 and Figure S2). However, the interaction between gait speed and CR participation was not significant (*P*=0.70).

Discussion

In this observational analysis, patients with slow gait speed were less likely to be encouraged to participate in CR after AMI, and when referred, were less likely to participate. Both slow gait speed and CR nonparticipation were independently associated with greater odds of 1-year death or disability. Furthermore, the interaction analysis suggested that CR participation was similarly associated with 1-year outcomes, in both gait speed groups.

Although slow gait speed has been shown in several studies to be associated with increased risk of poor outcomes,[1–3,5] interventions designed to treat frailty (which can be measured by gait speed) and, thus, mitigate the poor outcomes associated with it, have had mixed results.[10,11] Exercise is the most promising intervention in frail older adults,[10,11] thereby making CR arguably even more important to frail (versus nonfrail) patients after AMI. However, we found that patients with slow gait speed are much less likely to be encouraged to participate in CR, and if encouraged, are less likely to actually participate than those with normal gait speed. Although CR is underused in eligible patients of all age groups, older age is associated with lower referral rate and lower participation in CR.[20–22] Despite these challenges, older adults still can have a significant benefit from CR, both in terms of survival and maintenance of independence.[13,23] We found that patients with slow gait speed who did not participate in CR had a greater burden of comorbidities than those who did participate, and they more likely experienced economic, cognitive, and social barriers to CR participation. These data suggest that novel design and implementation of CR programs accessible to all older adults, particularly those with slow gait speed, is imperative.

The first barrier to CR participation is encouragement and referral. Although frail older adults may derive benefit from CR, our data show that they are less likely to be referred. One of the strongest predictors of whether an eligible patient will participate in CR is physician endorsement of the program[24,25]; therefore, standardized referral to CR after

Table 1. Baseline Characteristics by CR Participation Status

Characteristics	Total (N=329)	CR (n=109)	No CR (n=220)	*P* Value
Slow gait speed (<0.8 m/s)	177 (53.6)	48 (44.0)	129 (58.6)	0.012
Gait speed, mean±SD, m/s	0.8±0.5	0.9±0.4	0.7±0.5	0.019
Age, mean±SD, y	73.7±6.2	73.2±5.9	73.9±6.3	0.321
Female sex	137 (41.6)	37 (33.9)	100 (45.5)	0.046
Race				<0.001
White	257 (78.1)	100 (91.7)	157 (71.4)	
Black	61 (18.5)	6 (5.5)	55 (25)	
Other	11 (3.3)	11 (3.3)	3 (2.8)	
High school education	254 (77.4)	98 (89.9)	156 (71.2)	<0.001
Married	189 (57.4)	69 (63.3)	120 (54.5)	0.13
Medical costs a burden	106 (32.6)	23 (21.1)	83 (38.4)	0.016
Atrial fibrillation	21 (6.4)	8 (7.3)	13 (5.9)	0.617
Heart failure	30 (9.1)	5 (4.6)	25 (11.4)	0.044
Hypertension	247 (75.1)	79 (72.5)	268 (76.4)	0.443
Diabetes mellitus	101 (30.7)	25 (22.9)	76 (34.5)	0.031
Chronic lung disease	31 (9.4)	2 (1.8)	29 (13.2)	<0.0014
Chronic kidney disease	26 (7.9)	4 (3.7)	22 (10.0)	0.045
Peripheral vascular disease	24 (7.3)	6 (5.5)	18 (8.2)	0.379
Depression	13 (4.0)	1 (0.9)	12 (5.5)	0.067
Smoker	156 (47.4)	52 (47.7)	104 (47.3)	0.940
Cognitive impairment	59 (18.1)	10 (9.3)	49 (22.4)	0.008
GRACE score, mean±SD	126.3±22.3	122.1±20.8	128.3±22.7	0.017
STEMI	128 (38.9)	56 (51.4)	73 (37.7)	0.001
AMI treatment				0.010
CABG	31 (9.4)	15 (13.8)	16 (7.3)	
PCI	217 (66.0)	77 (70.6)	140 (63.6)	
Medical therapy only	81 (24.6)	17 (15.6)	64 (29.1)	

Data are given as number (percentage) unless otherwise indicated. AMI indicates acute myocardial infarction; CABG, coronary artery bypass grafting; CR, cardiac rehabilitation; GRACE, Global Registry of Cardiac Events; PCI, percutaneous coronary intervention; and STEMI, ST-segment–elevation myocardial infarction.

AMI, regardless of age, frailty, or socioeconomic status, is an important first step. CR services must be able to handle increased referrals. Therefore, expanding traditional CR programs may be facilitated by recent policy change by allowing well-qualified advanced practice providers to supervise CR. This may also improve access to CR, particularly for

Table 2. One-Year Post-AMI Outcomes Stratified by 1-Month Gait Speed and CR Participation After AMI

	Slow Gait Speed		Normal Gait Speed		
Outcomes	CR (n=48)	No CR (n=129)	CR (n=61)	No CR (n=91)	*P* Value
Mortality or loss of ≥1 ADL	10 (24.4)	51 (43.2)	5 (9.3)	19 (24.4)	<0.001
Mortality	1 (2.1)	12 (9.3)	2 (3.3)	4 (4.4)	0.232
Loss of ≥1 ADL*	9 (22.0)	39 (36.8)	3 (5.8)	15 (20.3)	<0.001

Data are given as number (percentage). *P* values are comparing differences among the 4 groups. ADL indicates activities of daily living; AMI, acute myocardial infarction; and CR, cardiac rehabilitation.

*Patients who died are not included in the denominator.

Table 3. Unadjusted and Adjusted ORs for the Variables Included in the Hierarchical Multivariable Model

Variable	Unadjusted OR (95% CI)	*P* Value	Adjusted OR (95% CI)*	*P* Value
Slow gait speed	2.68 (1.53–4.69)	<0.001	2.27 (1.27–4.05)	0.006
No CR participation	2.79 (1.47–5.31)	0.002	2.27 (1.17–4.40)	0.015
GRACE score	1.25 (1.11–1.41)	<0.001	1.20 (1.06–1.36)	0.005
Cognitive impairment	1.20 (0.62–2.32)	0.59	0.94 (0.47–1.87)	0.86
Interaction between gait speed and CR participation	…	…	…	0.70

CI indicates confidence interval; CR, cardiac rehabilitation; GRACE, Global Registry of Cardiac Events; and OR, odds ratio.
*Hierarchical model accounting for clustering by site.

older adults who live in rural areas.[26] Furthermore, novel strategies, such as home-based CR, could be used to circumvent the transportation and cost-related barriers to participation. Although long-term outcome and safety data are lacking, home-based CR programs in general achieve similar outcomes to center-based programs,[27] with small studies also showing benefit among older adults.[13,28] Future work should also focus on the design of a structured exercise intervention that is feasible and safe for patients with slow gait speed who cannot participate in a traditional CR program (eg, Tai chi[29,30] or encouraged walking with accelerometer feedback[31]).

Limitations

The current study must be interpreted in the context of several limitations. First, the number of patients in the TRIUMPH registry with gait speed data was relatively small, limiting comparisons among subgroups. We excluded patients with missing data, which could skew our results if those data were not missing at random. Our small sample had a limited number of outcome events, which precluded us from adjusting for surrogates of socioeconomic status (race, income, and education). Previous data do suggest that TRIUMPH registry participants who participated in the home visit had higher socioeconomic status than those who did not.[2] Our small sample size and low number of outcome events may also explain our nonsignificant interaction term for gait speed and CR participation status, and limit insight into the potential mechanisms for CR improving outcomes in patients with slow gait speed. CR participation status was patient reported, which limited our ability to assess the intensity of CR participation. Disability was assessed with the EuroQol 5 Dimensions, which is not a standard ADL assessment tool and, therefore, does not inquire about all ADLs. In addition, we did not have an assessment of instrumental ADLs. As such, we may be underestimating the degree of disability in the cohort. Gait speed was assessed at 1 month after the AMI hospitalization; therefore, our results are only applicable to those who survive at least 1 month. In addition, it is unclear if CR participation that occurred before the 1-month follow-up affected gait speed. Finally, we also do not know the specific reasons for nonparticipation in CR, which could better inform our conclusions about barriers to CR.

Conclusions

In older adults hospitalized for AMI, slow gait speed, a marker of frailty, at 1 month was common and associated with lower CR participation. Both slow gait speed and lack of CR participation were associated with increased 1-year mortality and disability. The beneficial effect of CR participation did not differ by gait speed. Further research should focus on strategies to increase CR participation in these vulnerable patients, including the development of home-based and less intensive exercise therapies tailored to this population.

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Disclosures

Dodson serves as a consultant to Novartis Pharmaceuticals on a research project unrelated to the current study. The remaining authors have no disclosures.

References

1. Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, Brach J, Chandler J, Cawthon P, Connor EB, Nevitt M, Visser M, Kritchevsky S, Badinelli

S, Harris T, Newman AB, Cauley J, Ferrucci L, Guralnik J. Gait speed and survival in older adults. *JAMA*. 2011;305:50–58.

2. Dodson JA, Arnold SV, Gosch KL, Gill TM, Spertus JA, Krumholz HM, Rich MW, Chaudhry SI, Forman DE, Masoudi FA, Alexander KP. Slow gait speed and risk of mortality or hospital readmission after myocardial infarction in the translational research investigating underlying disparities in recovery from acute myocardial infarction: patients' health status registry. *J Am Geriatr Soc*. 2016;64:596–601.
3. Guralnik JM, Ferrucci L, Pieper CF, Leveille SG, Markides KS, Ostir GV, Studenski S, Berkman LF, Wallace RB. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. *J Gerontol A Biol Sci Med Sci*. 2000;55:M221–M231.
4. Afilalo J, Kim S, O'Brien S, Brennan JM, Edwards FH, Mack MJ, McClurken JB, Cleveland JC Jr, Smith PK, Shahian DM, Alexander KP. Gait speed and operative mortality in older adults following cardiac surgery. *JAMA Cardiol*. 2016;1:314–321.
5. Afilalo J, Eisenberg MJ, Morin JF, Bergman H, Monette J, Noiseux N, Perrault LP, Alexander KP, Langlois Y, Dendukuri N, Chamoun P, Kasparian G, Robichaud S, Gharacholou SM, Boivin JF. Gait speed as an incremental predictor of mortality and major morbidity in elderly patients undergoing cardiac surgery. *J Am Coll Cardiol*. 2010;56:1668–1676.
6. Chainani V, Shaharyar S, Dave K, Choksi V, Ravindranathan S, Hanno R, Jamal O, Abdo A, Abi Rafeh N. Objective measures of the frailty syndrome (hand grip strength and gait speed) and cardiovascular mortality: a systematic review. *Int J Cardiol*. 2016;215:487–493.
7. Sergi G, Veronese N, Fontana L, De Rui M, Bolzetta F, Zambon S, Corti MC, Baggio G, Toffanello ED, Crepaldi G, Perissinotto E, Manzato E. Pre-frailty and risk of cardiovascular disease in elderly men and women: the Pro.V.A. study. *J Am Coll Cardiol*. 2015;65:976–983.
8. Freiheit EA, Hogan DB, Patten SB, Wunsch H, Anderson T, Ghali WA, Knudtson M, Maxwell CJ. Frailty trajectories after treatment for coronary artery disease in older patients. *Circ Cardiovasc Qual Outcomes*. 2016;9:230–238.
9. Hardy SE, Perera S, Roumani YF, Chandler JM, Studenski SA. Improvement in usual gait speed predicts better survival in older adults. *J Am Geriatr Soc*. 2007;55:1727–1734.
10. Bendayan M, Bibas L, Levi M, Mullie L, Forman DE, Afilalo J. Therapeutic interventions for frail elderly patients, part II: ongoing and unpublished randomized trials. *Prog Cardiovasc Dis*. 2014;57:144–151.
11. Bibas L, Levi M, Bendayan M, Mullie L, Forman DE, Afilalo J. Therapeutic interventions for frail elderly patients, part I: published randomized trials. *Prog Cardiovasc Dis*. 2014;57:134–143.
12. Amsterdam EA, Wenger NK, Brindis RG, Casey DE Jr, Ganiats TG, Holmes DR Jr, Jaffe AS, Jneid H, Kelly RF, Kontos MC, Levine GN, Liebson PR, Mukherjee D, Peterson ED, Sabatine MS, Smalling RW, Zieman SJ; ACC/AHA Task Force Members. 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;130:e344–e426.
13. Marchionni N, Fattirolli F, Fumagalli S, Oldridge N, Del Lungo F, Morosi L, Burgisser C, Masotti G. Improved exercise tolerance and quality of life with cardiac rehabilitation of older patients after myocardial infarction: results of a randomized, controlled trial. *Circulation*. 2003;107:2201–2206.
14. Baldasseroni S, Pratesi A, Francini S, Pallante R, Barucci R, Orso F, Burgisser C, Marchionni N, Fattirolli F. Cardiac rehabilitation in very old adults: effect of baseline functional capacity on treatment effectiveness. *J Am Geriatr Soc*. 2016;64:1640–1645.
15. Arnold SV, Chan PS, Jones PG, Decker C, Buchanan DM, Krumholz HM, Ho PM, Spertus JA; Cardiovascular Outcomes Research Consortium. Translational Research Investigating Underlying Disparities in Acute Myocardial Infarction Patients' Health Status (TRIUMPH): design and rationale of a prospective multicenter registry. *Circ Cardiovasc Qual Outcomes*. 2011;4:467–476.
16. Brandt J, Spencer M, Folstein M. The telephone interview for cognitive status. *Neuropsychiatry Neuropsychol Behav Neurol*. 1988;1:111–117.
17. de Jager CA, Budge MM, Clarke R. Utility of TICS-M for the assessment of cognitive function in older adults. *Int J Geriatr Psychiatry*. 2003;18:318–324.
18. EuroQol G. EuroQol: a new facility for the measurement of health-related quality of life. *Health Policy*. 1990;16:199–208.
19. Eagle KA, Lim MJ, Dabbous OH, Pieper KS, Goldberg RJ, Van de Werf F, Goodman SG, Granger CB, Steg PG, Gore JM, Budaj A, Avezum A, Flather MD, Fox KA; GRACE Investigators. A validated prediction model for all forms of acute coronary syndrome: estimating the risk of 6-month postdischarge death in an international registry. *JAMA*. 2004;291:2727–2733.
20. Doll JA, Hellkamp A, Ho PM, Kontos MC, Whooley MA, Peterson ED, Wang TY. Participation in cardiac rehabilitation programs among older patients after acute myocardial infarction. *JAMA Intern Med*. 2015;175:1700–1702.
21. Suaya JA, Shepard DS, Normand SL, Ades PA, Prottas J, Stason WB. Use of cardiac rehabilitation by Medicare beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation*. 2007;116:1653–1662.
22. Beatty AL, Li S, Thomas L, Amsterdam EA, Alexander KP, Whooley MA. Trends in referral to cardiac rehabilitation after myocardial infarction: data from the National Cardiovascular Data Registry 2007 to 2012. *J Am Coll Cardiol*. 2014;63:2582–2583.
23. Oerkild B, Frederiksen M, Hansen JF, Prescott E. Home-based cardiac rehabilitation is an attractive alternative to no cardiac rehabilitation for elderly patients with coronary heart disease: results from a randomised clinical trial. *BMJ Open*. 2012;2:e001820.
24. Grace SL, Gravely-Witte S, Brual J, Monette G, Suskin N, Higginson L, Alter DA, Stewart DE. Contribution of patient and physician factors to cardiac rehabilitation enrollment: a prospective multilevel study. *Eur J Cardiovasc Prev Rehabil*. 2008;15:548–556.
25. Dunn SL, Dunn LM, Buursma MP, Clark JA, Vander Berg L, DeVon HA, Tintle NL. Home- and hospital-based cardiac rehabilitation exercise: the important role of physician recommendation. *West J Nurs Res*. 2016;29:214–233.
26. H.R.1155—to amend title XVIII of the Social Security Act to allow physician assistants, nurse practitioners, and clinical nurse specialists to supervise cardiac, intensive cardiac, and pulmonary rehabilitation programs. 2017. Available at: https://www.congress.gov/bill/115th-congress/house-bill/1155. Accessed February 13, 2018.
27. Anderson L, Sharp GA, Norton RJ, Dalal H, Dean SG, Jolly K, Cowie A, Zawada A, Taylor RS. Home-based versus centre-based cardiac rehabilitation. *Cochrane Database Syst Rev*. 2015(8):CD007130.
28. Oerkild B, Frederiksen M, Hansen JF, Simonsen L, Skovgaard LT, Prescott E. Home-based cardiac rehabilitation is as effective as centre-based cardiac rehabilitation among elderly with coronary heart disease: results from a randomised clinical trial. *Age Ageing*. 2011;40:78–85.
29. Lan C, Chen SY, Wong MK, Lai JS. Tai chi chuan exercise for patients with cardiovascular disease. *Evid Based Complement Alternat Med*. 2013;2013:983208.
30. Huang ZG, Feng YH, Li YH, Lv CS. Systematic review and meta-analysis: Tai Chi for preventing falls in older adults. *BMJ Open*. 2017;7:e013661.
31. Thorup C, Hansen J, Gronkjaer M, Andreasen JJ, Nielsen G, Sorensen EE, Dinesen BI. Cardiac patients' walking activity determined by a step counter in cardiac telerehabilitation: data from the intervention arm of a randomized controlled trial. *J Med Internet Res*. 2016;18:e69.

SUPPLEMENTAL MATERIAL

Table S1. Baseline patient characteristics by gait speed and cardiac rehabilitation status. Data are reported as N.

		Slow Gait Speed		Normal Gait Speed		
	Total N=329 N (%)	**CR N=48** N (%)	**No CR N=129** N (%)	**CR N=61** N (%)	**No CR N=91** N (%)	**P-value**
Encouraged to participate in CR	202 (61.8)	48 (100)	50 (39.1)	61 (100)	43 (47.8)	<0.001
Age (mean ± SD)	73.7 ± 6.2	74.1 ± 6.1	75.2 ± 6.7	72.5 ± 5.7	72.2 ± 5.3	0.001
Female	137 (41.6)	19 (39.6)	75 (58.1)	18 (29.5)	25 (27.5)	<0.001
Race						<0.001
White	257 (78.1)	44 (91.7)	82 (63.6)	56 (91.8)	75 (82.4)	
Black	61 (18.5)	3 (6.3)	40 (31.0)	3 (4.9)	15 (16.5)	
Other	11 (3.3)	1 (2.1)	7 (5.4)	2 (3.3)	1 (1.1)	
High School Education	254 (77.4)	42 (87.5)	85 (66.4)	56 (91.8)	71 (78.0)	<0.001
Married	189 (57.4)	30 (62.5)	55 (42.6)	39 (63.9)	65 (71.4)	<0.001
Medical costs a burden	69 (21.0)	6 (12.5)	38 (29.4)	8 (13.1)	17 (18.7)	0.095
Lives alone						
Atrial fibrillation	21 (6.4)	5 (10.4)	9 (7.0)	3 (4.9)	4 (4.4)	0.536
Heart failure	30 (9.1)	3 (6.3)	19 (14.7)	2 (3.3)	6 (6.6)	0.045
Hypertension	247 (75.1)	37 (77.1)	105 (81.4)	42 (68.9)	63 (69.2)	0.122
Diabetes	101 (30.7)	13 (27.1)	51 (39.5)	12 (19.7)	25 (27.5)	0.029
Chronic lung disease	31 (9.4)	0 (0.0)	22 (17.1)	2 (3.3)	7 (7.7)	<0.001
Chronic kidney disease	26 (7.9)	4 (8.3)	13 (10.1)	0 (0.0)	9 (9.9)	0.031
Peripheral vascular disease	24 (7.3)	2 (4.2)	13 (10.1)	4 (6.6)	5 (5.5)	0.537
Depression	13 (4.0)	1 (2.1)	10 (7.8)	0 (0.0)	2 (2.2)	0.044
Smoker	156 (47.4)	26 (54.2)	54 (41.9)	26 (42.6)	50 (54.9)	0.164
Cognitive impairment	59 (18.1)	5 (10.9)	34 (26.4)	5 (8.2)	15 (16.7)	0.030
GRACE score (mean ± SD)	126.3 ± 22.3	127.9 ± 22.5	131.5 ± 20.9	117.6 ± 18.4	123.7 ± 24.4	<0.001
STEMI	128 (28.9)	20 (41.7)	39 (30.2)	36 (59)	22 (36.3)	0.001
AMI Treatment						0.005

CABG	31 (9.4)	4 (6.3)	5 (3.9)	11 (18)	11 (12.1)	
PCI	217 (66)	34 (70.8)	82 (63.6)	43 (70.5)	58 (63.7)	
Medical therapy only	81 (24.6)	10 (20.8)	42 (32.6)	7 (11.5)	22 (24.2)	

CR = cardiac rehabilitation; SD = standard deviation; GRACE = Global Registry of Cardiac Events; STEMI = ST-elevation myocardial infarction; AMI = acute myocardial infarction; CABG = coronary artery bypass surgery; PCI = percutaneous coronary intervention

Figure S1. Selection of the Study Population.

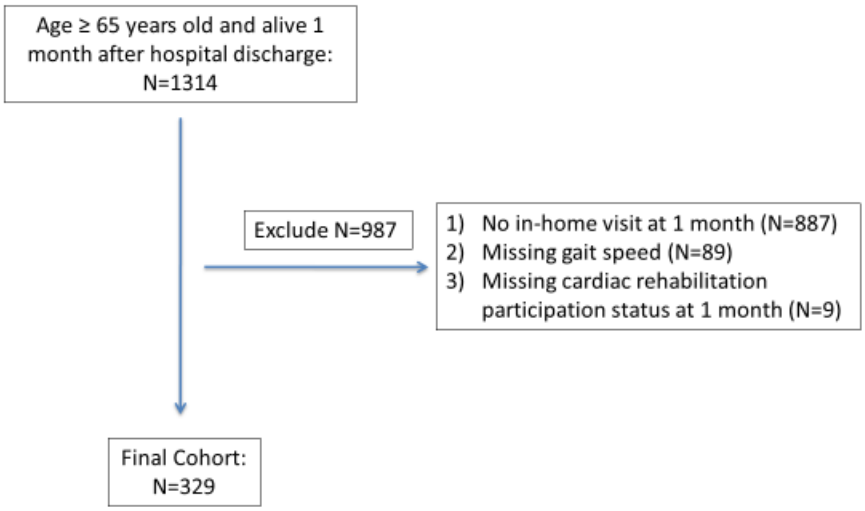
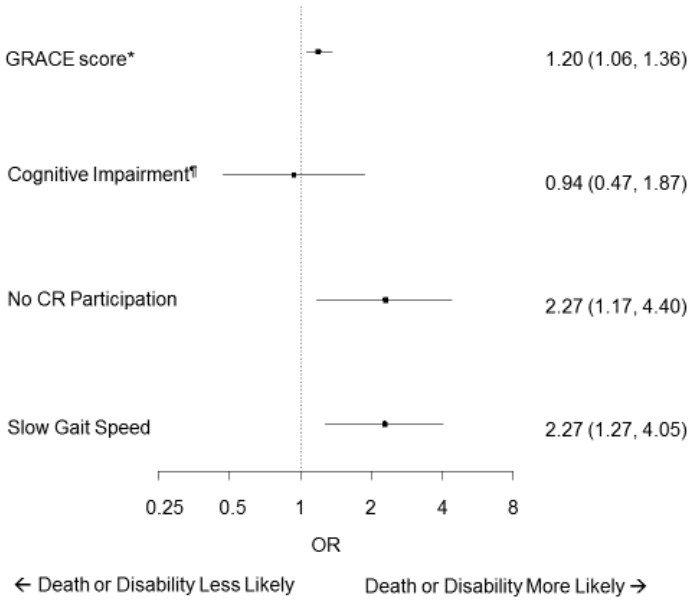


Figure S2. Cardiac Rehabilitation Participation and Slow Gait Speed are Associated with Death or Disability 1 Year after AMI Independent of GRACE score or Cognitive Impairment.



*For every 10 point-increase; ¶Defined as Telephone Interview for Cognitive Status-modified score ≤ 19; Disability was assessed with the mobility and self-care questions from the Euroqol-5 Dimensions; CR = cardiac rehabilitation; GRACE = Global Registry of Cardiac Events

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