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Changes in Functional Status and Health-Related Quality of Life in Older Adults After Surgical, Interventional, or Medical Management of Acute Myocardial Infarction

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Abstract

Functional status and health-related quality of life (HRQoL) are important outcomes, particularly among older patients. However, data on such patient-centered outcomes after cardiac surgery are limited. We evaluated the incidence and predictors of decline in functional status and HRQoL among older patients hospitalized for acute myocardial infarction (AMI). Participants were age 75

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years or older hospitalized for AMI at 94 US sites. We examined decline in functional status (defined as decline in 1 or more activities of daily living, ADLs), as well as mental (MCS) and physical component scales (PCS) of the SF-12 to assess HRQoL (5-point decline or greater in each scale) between 1 month prior to the hospitalization and 6 months after. Multivariable model compared the risk of decline after coronary artery bypass graft (CABG), percutaneous coronary intervention (PCI) and medical management. Among 3041 patients (1708 PCI, 362 CABG, and 971 medical management), 1525 (50.2%) experienced decline in 1 or more domain: 633 (20.8%) declined in ADLs, 786 (25.9%) declined in the MCS, and 1078 (35.5%) declined in the PCS. The unadjusted incidence of ADL decline was the lowest among patients who underwent CABG (n = 50, 13.8%) compared with PCI (n = 271, 15.9%) or medical management (n = 312, 32.1%). Patients who underwent CABG and PCI had lower adjusted risk of decline in functional and HRQoL compared with those who received medical therapy. The risks after CABG and PCI were not significantly different. Over half of older patients significantly declined in function or HRQoL after AMI. Compared with medical management, risk of decline was lower in those who underwent revascularization.

Keywords

Coronary artery bypass graft; CABG; Acute myocardial infarction; Health-related quality of life; Older adults

BACKGROUND

Coronary artery bypass graft (CABG) surgery is commonly performed in older patients, but limited data exist on changes in functional status or health-related quality of life (HRQoL) after this major surgery in the setting of acute myocardial infarction (AMI) in older adults. This knowledge gap is important to address because the population of patients undergoing cardiac surgery is aging,[1] with about a quarter of CABG for AMI being performed in patients with age 75 or older.[2] In addition, patient-centered outcomes, such as physical function and quality of life, are of great importance to older patients, and often prioritized even above survival.[3]

Older patients are more susceptible to functional decline following surgery compared with younger patients.[4,5] However, it remains unknown whether decline in functional status and HRQoL in older patients is more common after CABG compared with less invasive alternatives, such as percutaneous coronary intervention (PCI) or medical management. Existing studies have evaluated small cohorts enrolled at single or several sites,[5,6] limiting our understanding of the incidence and risk factors for decline in these areas. Moreover, such patient-centered outcomes following different treatment modalities have not been well characterized in the setting of AMI. Notably missing is an examination of a rich array of demographic, cardiac, and geriatric potential predictors of changes in functional status and HRQoL in a large, multicenter, contemporary cohort among older patients undergoing different treatment modalities in the setting of AMI.

The objectives of this study were to: (1) characterize the incidence of decline in functional status and HRQoL following CABG, PCI, or medical management in the setting of AMI and

(2) evaluate whether patients treated with CABG have different risk of decline in functional status and HRQoL compared with other treatment modalities. To achieve these objectives, we used data from participants aged 75 years and older enrolled in the SILVER-AMI (Comprehensive Evaluation of Risk in Older Adults with Acute Myocardial Infarction) study who were hospitalized for AMI at 94 sites across the United States.[7] This information can help inform clinicians and older patients' expectations about recovery in function and health status after undergoing different treatment approaches for AMI.

METHODS

Data Source and Patient Population

This is an analysis of patients enrolled in the SILVER-AMI study,[7] a multicenter, longitudinal cohort study of patients 75 years and older who were hospitalized for AMI (NIH R01HL115295). The study procedures of the SILVER-AMI have been previously described.[7,8] Briefly, participants were recruited from 94 teaching and community hospitals across the United States (64 centers contributed at least 1 CABG patient), where site coordinators reviewed hospital admission records daily to identify eligible participants. AMI diagnosis was defined in accordance with the Third Universal Definition of Myocardial Infarction.[9] Screening yielded 9049 potential candidates and 3041 patients were enrolled (Supplementary Fig. S1). All patients provided written informed consent. The San Diego Brief Assessment of Capacity to Consent[10] was administered to patients for whom site coordinators had concerns about decisional capacity, and proxy consent was obtained for patients with confirmed decisional capacity impairment. Patients were ineligible for study participation if they had initial troponin elevation >24 hours after admission, were transferred from another hospital after a >24-hour stay, were incarcerated, or were not able to provide informed consent with no proxy available. As all revascularization procedures occurred during the index hospitalization for AMI, the procedures were performed under nonelective settings. Baseline characteristics were obtained via in-person interview and assessments during the index hospitalization as well as medical record review. Telephone interviews were performed 6 months following the hospitalization to ascertain outcomes, including functional status and HRQoL. Death during the follow-up period (6 months) was ascertained by review of death certificates, hospital records, or obituaries. SILVER-AMI was approved by the Institutional Review Board at Yale and participating hospitals and was registered at www.clinicaltrials.gov (NCT01755052).

Study Overview

We first analyzed all 3041 patients enrolled in SILVER-AMI, which included older patients with AMI treated either by medical management alone, CABG, or PCI. We evaluated patient characteristics of those who did and did not have decline in functional and HRQoL measures, and developed multivariable models to test whether CABG was associated with risk of functional and HRQoL decline. We then analyzed a subgroup of patients to compare the risk of decline between those who underwent isolated CABG and PCI during the AMI hospitalization. In this subgroup analysis, we excluded those who were only treated medically, because that patient cohort likely differed significantly in risk profile from those who underwent more invasive treatments. The study protocol for SILVER-AMI did not specify treatment selection, and treatment decision was made by participating centers. Therefore, we attempted to minimize confounding related to treatment assignment by controlling for extensive sociodemographic, functional, and comorbidity variables.

Baseline Measures

We collected baseline measures via patient interview and medical record review. Sociodemographic factors included age, gender, race, ethnicity, and marital status. Comorbid diseases ascertained at baseline included coronary disease, prior MI, stroke, heart failure, diabetes, arrhythmia, lung disease, peripheral artery disease, and renal failure. Presenting clinical status, including AMI classification (ie, ST elevation MI vs non-ST elevation MI), and time from symptom onset to presentation, were ascertained via medical record review, as were length of index hospitalization, and operative details including the extent of coronary arteries involved, concomitant operations (valve or aortic), and redo sternotomy. Fall history (occurrence of 1 or more fall in the year preceding AMI), and hearing impairment[11] were ascertained by participant report.

We evaluated functional status by assessing the number of essential ADLs[12] that the patient was able to perform without assistance 1 month prior to the hospitalization. The ADLs included: bathing, dressing, rising from a chair, and ambulating.[13] Response options for ADLs were “no help,” “help,” and “unable to do.” We evaluated HRQoL using SF-12, which consists of mental and physical health components. Each component has a linearly transformed score ranging from 0 to 100, with 100 indicating the best health status, and 50 and 10 being the mean and standard deviation values, respectively, of the cohort from which the instrument was developed.[14] Both baseline ADLs and SF-12 measures were anchored to elicit report of status 1 month prior to the hospitalization. This time point is commonly used in studies of older adults as it is distant enough to encompass the baseline status before the onset of the acute illness but recent enough that recall of the baseline functional status is reliable and valid.[15]

Functional and HRQoL Decline Measures as Outcomes

Decline in ADLs was defined as any decrease in ability to perform these tasks from baseline to 6 months postdischarge, that is, transition from “no help” to “help,” “help” to “unable to do,” or “no help” to “unable to do.” The primary outcome was decline in 1 or more ADLs. We designated ADLs as the primary outcome because maintaining independence is the most important health outcome for most older adults.[16] Two secondary outcomes were 5-point decline or greater in the mental component score (MCS) of SF-12 and at least 5-point decline in the physical component score (PCS) of SF-12. We selected these cut-points because a 5-point decline in these scales is the minimal clinically important difference.[17,18] To account for competing risk of death, we categorized death during the follow-up period as having experienced the outcomes, because patients who died were ineligible to report functional decline but likely experienced it. As a sensitivity analysis, we also fitted multivariable models defining death as no decline and reported coefficients in Supplementary Table S3. We also descriptively reported those who improved in MCS and PCS by at least 5 points. We did not evaluate improvement in ADL because the majority of the patients did not have any ADL impairment at baseline. We limited multivariable analysis to functional and HRQoL declines as characterizing the decline was the main aim of the study.

In the multivariable models analyzing all 3 treatment modalities, we excluded patients who survived but did not complete 6-month follow-up assessment for the outcome of interest, including: *n* = 156 (5.1%) for functional status, *n* = 168 (5.5%) for MCS, and *n* = 169 (5.6%) for PCS. This resulted in 2885, 2873, and 2872 patients to be included in the multivariable analysis for functional decline, HRQoL mental component, and HRQoL physical component, respectively.

Statistical Analysis and Variable Selection

We used descriptive statistics to describe the preoperative, operative, and postoperative characteristics of the cohort. We conducted a bivariate analysis using chi-square tests for categorical measures and continuous variables were described in median and interquartile range (IQR), with the significance of differences tested using Wilcoxon rank-sum test, stratified by those who did or did not experience functional decline for each of the 3 functional outcome measures. Exploratory analysis suggested that the nonoutcome data were missing-at-random and missing data occurred in <3% of values. We used multiple imputation by chained equations and imputed the data 20 times. Only potential predictors were imputed; we did not impute outcomes.

We used multivariable logistic regression to identify independent predictors of functional and HRQoL decline. Variables incorporated in regression models were chosen based on three criteria: (1) clinical importance based on prior literature, (2) assessment of the predictor occurred prior to CABG or PCI, and (3) *P* values <0.2 in bivariate analyses with each outcome. The final coefficients and standard errors were calculated using Rubin's combination rules.[19] The final included variables for each model, based on the above criteria, are listed in Tables 2-4. The number of variables included in the final model complied with prior recommendation.[20] Goodness of fit was assessed using pseudo R^2 values. We conducted all analyses with Stata version 15 (StataCorp LLC, College Station, TX).

RESULTS

Unadjusted Incidence of Functional and HRQoL Decline by Treatment Modalities

Among the 3041 patients aged 75 years or older who were hospitalized for AMI, 362 (12%) underwent CABG, 1708 (56%) underwent PCI, and 971 (32%) underwent medical treatment. Among each treatment modality, death occurred during the 6-month follow-up in 20/362 CABG patients (5.5%), 109/1708 PCI patient (6.4%), and 172/971 (17.7%) patients who were treated medically. Including death as decline in each domain, the incidence of at least one decline in functional or HRQoL domain occurred in 145 (40%) CABG patients, 796 (47%) PCI patients, and 585 (60%) medically treated patients (Fig. 1). Among all treatment modalities, CABG had the lowest incidence of decline in ADL and PCS in both cases where the definition of decline included death and did not include death (Supplementary Fig. 2). CABG patients had the lowest incidence of improvement in MCS but had the highest incidence of improvement in PCS (Supplementary Fig. 3). Patients with higher baseline SF-12 scores tended to have a larger decline at 6 months in both MCS (Fig. 2) and PCS scores (Fig. 3). While all 3 treatment modalities showed a similar relationship between baseline and 6-month measures in MCS, CABG patients at low baseline PCS scores showed greater increase in PCS score compared with patients treated by PCI of medical management (Fig. 3). The median number of patients who underwent CABG at each center was 3.5 (IQR: 2, 7).

Characteristics of Participants With and Without Functional Decline

The decline measures were missing in 156 (5.1%) patients for ADL, 168 (5.5%) for SF-12 MCS, and 169 (5.6%) for SF-12 PCS. There were 420 patients (13.8%) who had baseline impairment in at least 1 ADL. Compared with those who did not experience functional decline, those who declined were older, had higher proportion of non-white female who lived alone, low education level, had lower SF-12 MCS and PCS at baseline, low activity level, hearing and vision impairments, more frequently had falls, more comorbidities, and had longer length of stay (Table 1).

The median baseline MCS score was 54.8 (IQR 46.6, 60.0). At 6 months, 786 patients (25.9%) experienced 5-point or greater decline in MCS. Compared with those without decline, those who experienced decline were more likely to be older, non-white race, living alone, lower education level with higher baseline MCS score and lower PCS score. Hearing, vision, ADL impairment and comorbidities were also more commonly present in those who declined in MCS. (Supplementary Table S1).

The median baseline PCS score was 41.3 (IQR 33.8, 49.4). At 6 months, 1078 patients (35.5%) experienced decline in PCS. Compared with those without decline, those who experienced decline were more commonly older, non-white race, female, lived alone, had lower education level, had lower baseline SF-12 MCS, had higher baseline PCS scores, more commonly had vision, hearing and ADL impairment, had more comorbidities, and had longer hospital length of stay (Supplementary Table S2).

Predictors of ADL, MCS, and PCS Decline

In multivariable model, older age, non-white race, baseline ADL impairment, prior fall, low activity, and comorbidities were significantly associated with higher risk of ADL decline. Living with someone, higher baseline PCS and MCS scores and having undergoing prior revascularization were associated with lower risk of ADL decline (Table 2). For MCS decline, older age, non-white race, baseline ADL impairment, prior fall, low activity, higher baseline MCS score and comorbidities were significantly associated with higher risk of MCS decline while living with someone and having higher baseline PCS score were associated with lower risk of MCS decline (Table 3). The model for decline in PCS demonstrated similar predictors, except higher baseline PCS was associated with higher risk of PCS decline while lower baseline MCS was associated with higher risk of PCS decline. Higher baseline MCS score was protective against PCS decline (Table 4).

In all 3 domains, risk of decline was significantly lower among patients who underwent CABG or PCI compared with medical management, but did not differ significantly between

CABG and PCI for ADL (Table 2), HRQoL MCS (Table 3) or HRQoL PCS (Table 4, Fig. 4). Sensitivity analysis of the model that defined death as no decline showed similar results (Supplementary Table S3).

Decline After Isolated CABG or PCI

In the multivariable models that used the same model specification but only included patients revascularized via isolated CABG (n = 314) or PCI (n = 1708), revascularization approach was not significantly associated with the risk of decline in ADL (odds ratio [OR] 1.0, 95% confidence interval [CI] [0.7–1.5], P = 0.86) or MCS (OR 1.1, 95% CI [0.8–1.6], P = 0.42). However, isolated CABG was associated with a lower risk of PCS decline compared with PCI (OR 0.7, 95% CI [0.5–1.0], P = 0.032).

Unadjusted Incidence of HRQoL Improvement by Treatment Modalities

The incidence of MCS improvement was the highest in medical management group (44%), followed by PCI (40%) and CABG (39%). The incidence of PCS improvement was the highest in CABG (45%), followed by medical management (39%) and PCI group (34%), (Supplementary Fig. S3).

DISCUSSION

In this prospective, multicenter study of older patients hospitalized for AMI, approximately half of the patients experienced significant decline in at least 1 of 3 functional and HRQoL domains within 6 months after the operation. In multivariable models, CABG and PCI were both associated with lower risk of decline in all 3 domains compared with medical management, while the risk of decline did not differ significantly between CABG and PCI.

Our study offers novel insight into the changes in functional status and HRQoL in patients hospitalized for AMI with a specific focus on different treatment approaches. Prior studies evaluating patient-reported outcome commonly excluded patients undergoing CABG in nonelective settings.[5,21-23] Therefore, our study focusing on patients who had AMI offers insight into the recovery experienced by older adults who undergo CABG in a more acute setting. Additionally, by focusing on decline between baseline and follow-up assessments, we were able to characterize changes that occurred after surgery. This is in contrast with studies that evaluated postoperative functional status but did not include information about baseline functional status and HRQoL,[24] limiting the ability to evaluate change. In a study evaluating functional decline after AMI with or without CABG in patients with all age groups, CABG was not an independent predictor of decline.[25] In contrast, our analysis focusing on older adults demonstrated that the risk of decline was lower in CABG or PCI compared with those treated medically and the risk of decline was similar between CABG and PCI.

Characterization of patient-centered outcomes following major health event, such as AMI, in older adults is important for several reasons. At the national level, there is a strong interest in improving the quality of postoperative recovery and postacute phase of care through efforts such as the Centers for Medicare and Medicaid Services' hospital readmission reduction program[26,27] and new reimbursement schedules for activities related to coordination of posthospital care.[28] Patient-centered outcomes serve as important metrics to evaluate the effectiveness of such efforts. In a survey of the importance of health outcomes in adults age 65 and older, maintaining independence was identified as the most important outcome, followed by survival, relief of pain, and relief of other symptoms.[3] Therefore, our study may provide an important base to provide expectation of recovery after AMI.

Our data demonstrated that decline in at least 1 of the 3 domains occurred in about a half of the cohort at 6 months following AMI. Although this incidence is difficult to compare directly with existing literature owing to heterogeneity of the study characteristics, a single-center study evaluating patients who underwent cardiac surgery reported 50% incidence of ADL decline at 1 year,[6] which was much higher than the 14% ADL decline at 6 months in our study. The discrepancy could be due to the prior study being conducted in a different era, different country, and in a single-center setting. In the entire cohort of SILVER-AMI, the incidence of ADL decline was 13% and those with decline more commonly presenting with non-ST elevation MI. Importantly, our evaluation of decline in different domains showed that declines in MCS and PCS occurred more commonly than decline in ADL, and the majority of patients experiencing ADL decline also experienced decline in either MCS or PCS. This indicates that the SF-12 instrument may be more sensitive in capturing declines than ADL, or that ADL decline is phenotypically more extreme, especially when examining the essential ADLs with limited number of items. Although the relative importance of these 3 domains from patient perspective is unknown, our findings underscore the importance of comprehensive assessment of patient-centered outcomes to understand postoperative decline in this population.

Our study also provides important information about distinct predictors for decline in ADLs, as well as mental and physical HRQoL. Older age and history of COPD and stroke predicted functional decline. This is concordant with findings of a systematic review on functional decline in older adults, which demonstrated that older age, chronic comorbidities, and lower cognitive function at baseline were predictive of functional decline.[29] The observed association between higher baseline MCS score and higher risk of MCS decline may indicate that starting at a higher MCS score allowed for more room for decline along the linear scale, rendering the definition of 5-point decline more sensitive to those with higher baseline score. Notably, higher baseline MCS was protective against PCS decline, suggesting that mental well-being at baseline may be important to physical recovery after AMI. We did not include off-pump CABG status as a covariate because it did not meet the prespecified criteria on bivariate analysis. The similar proportion of off-pump use between those with and without decline may corroborate the finding of GOPCABE trial that exclusively enrolled older adults and showed similar outcomes between off and on-pump CABG.[30]

Finally, a significant proportion of participants experienced improvement in MCS and PCS. While CABG had the highest incidence of PCS improvement among all treatment approaches, CABG had the lowest incidence of MCS improvement, highlighting the importance of multidomain characterization of patient experience postacute phase. Relatively high incidence of improvement across all treatment approaches is an important and encouraging information to clinicians and patients.

Strengths and Limitations

The multicenter nature of our study, including a large number of both academic and community hospitals across the country, offers greater generalizability than prior studies, which were mostly single center or multicenter studies including several centers in Japan, a country with healthcare system that differs significantly from that of United States.[31,32]

As with all studies assessing patient-reported outcomes, some patients were lost to follow-up, although our follow-up rate of >94% compares highly favorably to existing studies.[25] We were unable to calculate the Society of Thoracic Surgeons (STS) risk scores, because our data collection form was not aligned with that of the STS. However, our inclusion criteria by the age and AMI status likely homogenized the STS risk in a higher risk stratum. The study's focus on older adults precluded the assessment of outcomes in relation to a wider age spectrum. Additionally, potential selection bias associated with treatment assignment must be considered when interpreting our data. While we adjusted for many covariates that captured the risk for decline, a strong selection was likely at play in deciding the treatment approach and the degree of residual confounding may be substantive. Consistent with the prior literature, the majority of patients with AMI were treated with PCI[33] and patients selected to undergo CABG may be compromised from cardiovascular perspective but with a higher functional reserve than those not selected. Patients who underwent revascularization had higher baseline function and less comorbidities compared with those managed medically. Because functional decline was defined as decline identified at the 6-month interview, we were unable to identify the precise timing of when the functional decline occurred within the 6-month period. We also acknowledge that some participants may have experienced decline in function or HRQoL shortly after hospitalization but subsequently recovered before the 6-month assessment.[34] However, we believe that capturing the immediate decline after hospitalization that recovers shortly after may not be as important as decline that persists beyond the immediate postacute phase, and 6 months presented a balanced timeframe to provide meaningful information on this phenomenon.

CONCLUSION

In older patients hospitalized for AMI, over a half of the patients experienced significant decline in at least 1 of the 3 functional and HRQoL domains within 6 months of hospitalization. Risk of decline was lower in those treated by PCI or CABG compared with medical management.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

ADL	activity of daily living
AMI	acute myocardial infarction
CABG	coronary artery bypass graft
HRQoL	health-related quality of life
MCS	SF-12 mental component score
PCI	percutaneous coronary intervention
PCS	SF-12 physical component score

REFERENCES

1. Ivanov J, Weisel RD, David TE, et al.: Fifteen-year trends in risk severity and operative mortality in elderly patients undergoing coronary artery bypass graft surgery. Circulation 97:673–680, 1998 [PubMed: 9495303]
2. Acharya D, Gulack BC, Loyaga-Rendon RY, et al.: Clinical characteristics and outcomes of patients with myocardial infarction and cardiogenic shock undergoing coronary artery bypass surgery: Data from the Society of Thoracic Surgeons National Database. Ann Thorac Surg 101:558–566, 2016 [PubMed: 26718859]
3. Fried TR, Tinetti M, Agostini J, et al.: Health outcome prioritization to elicit preferences of older persons with multiple health conditions. Patient Educ Couns 83:278–282, 2011 [PubMed: 20570078]
4. Covinsky KE, Palmer RM, Fortinsky RH, et al.: Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: Increased vulnerability with age. J Am Geriatr Soc 51:451–458, 2003 [PubMed: 12657063]
5. Niemeyer-Guimaraes M, Cendoroglo MS, Almada-Filho CM: Course of functional status in elderly patients after coronary artery bypass surgery: 6-month follow up. Geriatr Gerontol Int 16:737–746, 2016 [PubMed: 26178448]
6. Govers AC, Buurman BM, Jue P, et al.: Functional decline of older patients 1 year after cardiothoracic surgery followed by intensive care admission: A prospective longitudinal cohort study. Age Ageing 43:575–580, 2014 [PubMed: 24850542]
7. Dodson JA, Geda M, Krumholz HM, et al.: Design and rationale of the comprehensive evaluation of risk factors in older patients with AMI (SILVER-AMI) study. BMC Health Serv Res 14:506, 2014 [PubMed: 25370536]
8. Dodson JA, Hajduk AM, Murphy TE, et al.: Thirty-day readmission risk model for older adults hospitalized with acute myocardial infarction. Circ Cardiovasc Qual Outcomes 12:e005320, 2019 [PubMed: 31010300]
9. Thygesen K, Alpert JS, Jaffe AS, et al.: Third universal definition of myocardial infarction. Eur Heart J 33:2551–2567, 2012 [PubMed: 22922414]
10. Jeste DV, Palmer BW, Appelbaum PS, et al.: A new brief instrument for assessing decisional capacity for clinical research. Arch Gen Psychiatry 64:966–974, 2007 [PubMed: 17679641]
11. Gates GA, Murphy M, Rees TS, et al.: Screening for handicapping hearing loss in the elderly. J Fam Pract 52:56–62, 2003 [PubMed: 12540314]
12. Gill TM, Desai MM, Gahbauer EA, et al.: Restricted activity among community-living older persons: Incidence, precipitants, and health care utilization. Ann Intern Med 135:313–321, 2001 [PubMed: 11529694]

13. Katz S: Assessing self–maintenance: Activities of daily living, mobility, and instrumental activities of daily living. J Am Geriatr Soc 31:721–727, 1983 [PubMed: 6418786]
14. Ware JE Jr, Kosinski M, Keller SD: A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. Med Care 34:220–233, 1996 [PubMed: 8628042]
15. Covinsky KE, Palmer RM, Counsell SR, et al.: Functional status before hospitalization in acutely ill older adults: Validity and clinical importance of retrospective reports. J Am Geriatr Soc 48:164–169, 2000 [PubMed: 10682945]
16. Fried TR, Tinetti ME, Iannone L, et al.: Health outcome prioritization as a tool for decision making among older persons with multiple chronic conditions. Arch Intern Med 171:1854–1856, 2011 [PubMed: 21949032]
17. Busija L, Pausenberger E, Haines TP, et al.: Adult measures of general health and health-related quality of life: Medical outcomes study Short Form 36-Item (SF-36) and Short Form 12-Item (SF-12) Health Surveys, Nottingham Health Profile (NHP), Sickness Impact Profile (SIP), Medical Outcomes Study Short Form 6D (SF-6D), Health Utilities Index Mark 3 (HUI3), Quality of Well-Being Scale (QWB), and Assessment of Quality of Life (AQoL). Arthritis Care Res (Hoboken) 63(suppl 11):S383–S412, 2011 [PubMed: 22588759]
18. Ware J Jr., Kosinski M, Keller SD: A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. Med Care 34:220–233, 1996 [PubMed: 8628042]
19. Rubin DB: Multiple Imputation for Nonresponse in Surveys. John Wiley & Sons; 2004
20. Vittinghoff E, McCulloch CE: Relaxing the rule of ten events per variable in logistic and Cox regression. Am J Epidemiol 165:710–718, 2007 [PubMed: 17182981]
21. Sundermann S, Dademasch A, Rastan A, et al.: One-year follow-up of patients undergoing elective cardiac surgery assessed with the Comprehensive Assessment of Frailty test and its simplified form. Interact Cardiovasc Thorac Surg 13:119–123, 2011.. discussion 123 [PubMed: 21378017]
22. Lee DH, Buth KJ, Martin BJ, et al.: Frail patients are at increased risk for mortality and prolonged institutional care after cardiac surgery. Circulation 121:973–978, 2010 [PubMed: 20159833]
23. Afilalo J, Mottillo S, Eisenberg MJ, et al.: Addition of frailty and disability to cardiac surgery risk scores identifies elderly patients at high risk of mortality or major morbidity. Circ Cardiovasc Qual Outcomes 5:222–228, 2012 [PubMed: 22396586]
24. Treasure T, Holmes L, Loughead K, et al.: Survival and quality of life in patients with protracted recovery from cardiac surgery. Can we predict poor outcome? Eur J Cardiothorac Surg 9:426–431, 1995.. discussion 431–2 [PubMed: 7495586]
25. Arnold SV, Alexander KP, Masoudi FA, et al.: The effect of age on functional and mortality outcomes after acute myocardial infarction. J Am Geriatr Soc 57:209–217, 2009 [PubMed: 19170779]
26. Wadhera RK, Yeh RW, Joynt Maddox KE: The rise and fall of mandatory cardiac bundled payments. JAMA 319:335–336, 2018 [PubMed: 29327034]
27. Khera R, Dharmarajan K, Wang Y, et al.: Association of the hospital readmissions reduction program with mortality during and after hospitalization for acute myocardial infarction, heart failure, and pneumonia. JAMA Netw Open 1:e182777, 2018 [PubMed: 30646181]
28. Centers for Medicare and Medicaid Services. Telehealth services. http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/TelehealthSrvcsfctsht.pdf. 2019, Accessed March 3, 2019
29. McCusker J, Kakuma R, Abrahamowicz M: Predictors of functional decline in hospitalized elderly patients: A systematic review. J Gerontol A Biol Sci Med Sci 57:M569–M577, 2002 [PubMed: 12196493]
30. Diegeler A, Börgermann J, Kappert U, et al.: Five-year outcome after off-pump or on-pump coronary artery bypass grafting in elderly patients. Circulation 139:1865–1871, 2019 [PubMed: 30732456]
31. Rudolph JL, Inouye SK, Jones RN, et al.: Delirium: An independent predictor of functional decline after cardiac surgery. J Am Geriatr Soc 58:643–649, 2010 [PubMed: 20345866]
32. Itagaki A, Saitoh M, Okamura D, et al.: Factors related to physical functioning decline after cardiac surgery in older patients: A multicenter retrospective study. J Cardiol 74:279–283, 2019. [PubMed: 31230900]

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33. Kolte D, Khera S, Aronow WS, et al.: Trends in incidence, management, and outcomes of cardiogenic shock complicating ST-elevation myocardial infarction in the United States. J Am Heart Assoc 3:e000590, 2014 [PubMed: 24419737]

34. Boyd CM, Ricks M, Fried LP, et al.: Functional decline and recovery of activities of daily living in hospitalized, disabled older women: the Women's Health and Aging Study I. J Am Geriatr Soc 57:1757–1766, 2009 [PubMed: 19694869]

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Central Message

In older adults hospitalized for AMI, risk of decline in functional status and health-related quality of life at 6 months was lower in patients treated with either PCI or CABG compared with medical management.

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Perspective Statement

Limited data exist on changes in functional status or health-related quality of life (HRQoL) in older patients hospitalized for acute myocardial infarction (AMI). We showed that a half of older adults declined in functional and HRQoL domains within 6 months of AMI. Compared with medical management, risk of decline was lower in those treated by PCI or CABG.

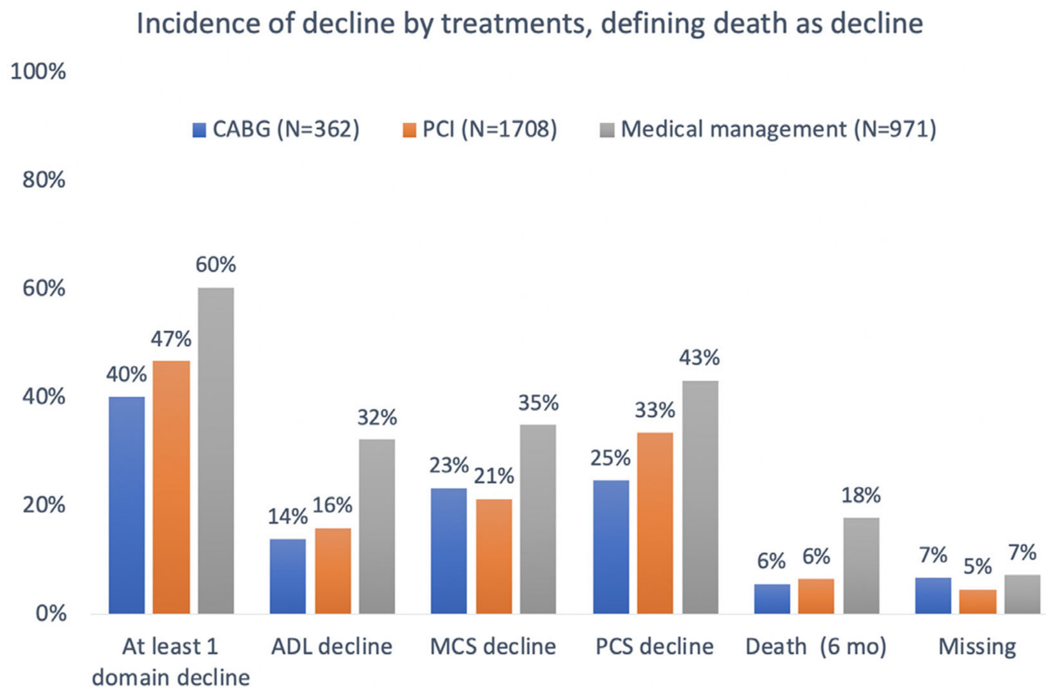

Figure 1.

Incidence of functional and health-related quality of life measures by treatment approach after AMI. The bar chart shows incidence of decline in activities of daily living (ADL), mental component score (MCS), and physical component score (PCS) of 12-item short form measures after different treatment approach after hospitalization for acute myocardial infarction. Death that occurred within 6 months is also defined as decline in each domain.

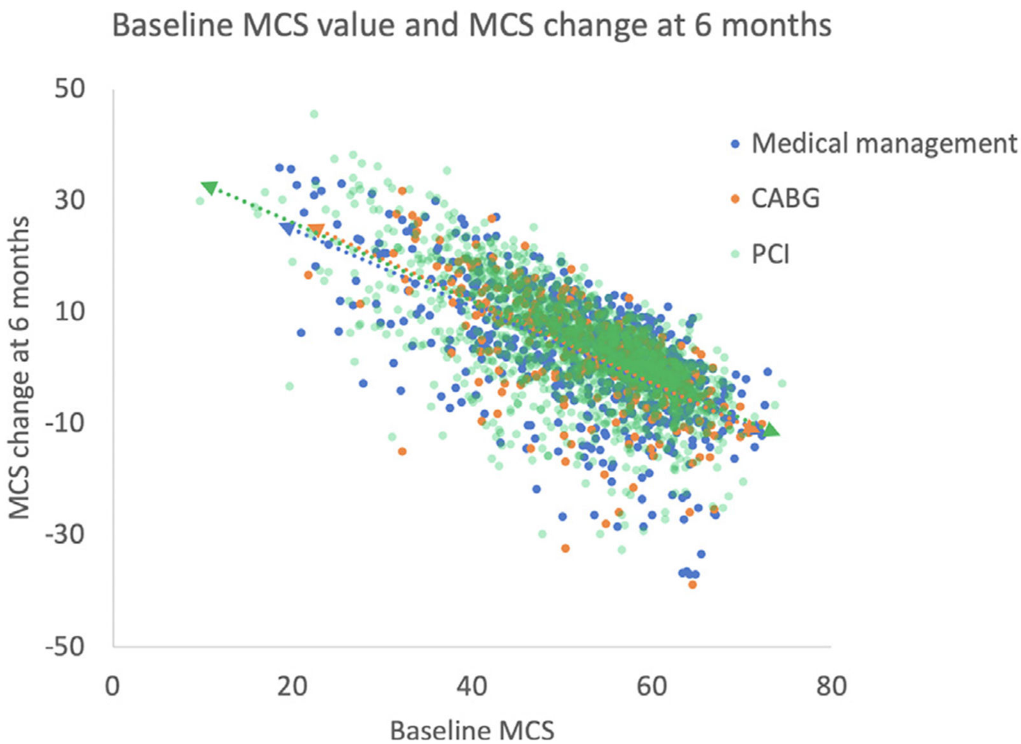

Figure 2.

Scatter plot of baseline 12-item short form health survey mental component score and change at 6 months. The figure shows change in mental component score (MCS) at 6 months (*y*-axis) in relation to the baseline MCS values (*x*-axis). Higher baseline MCS scores tended to result in greater decline in the score and the relationship was similar across patients who underwent CABG (red), PCI (green) and medical management (blue). Dotted arrow lines are the regression line for each treatment group of corresponding color.

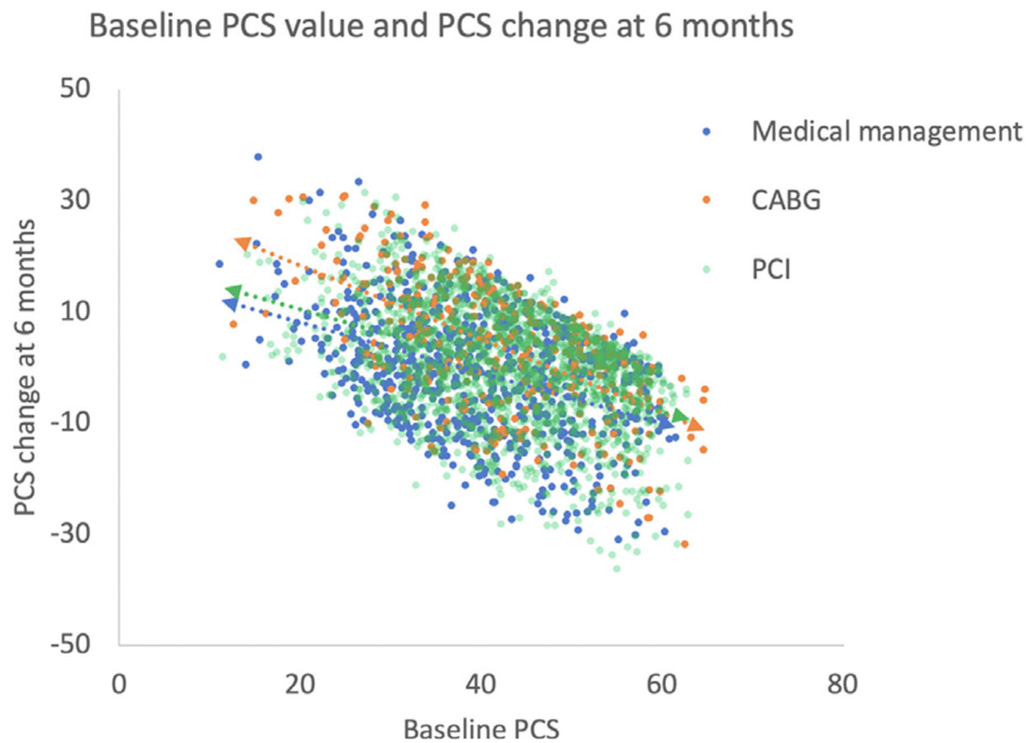

Figure 3.
Scatter plot of baseline 12-item short form health survey physical component score and change at 6 months. The figure shows change in physical component score (PCS) at 6 months (*y*-axis) in relation to the baseline PCS values (*x*-axis). Dotted arrow lines are the regression line for each treatment group of corresponding color. Higher baseline PCS scores tended to result in greater decline at 6 months. At lower baseline scores, CABG patients (red) showed larger improvement in PCS score at 6 months compared with patients with the same baseline score undergoing PCI (green) or medical management (blue).

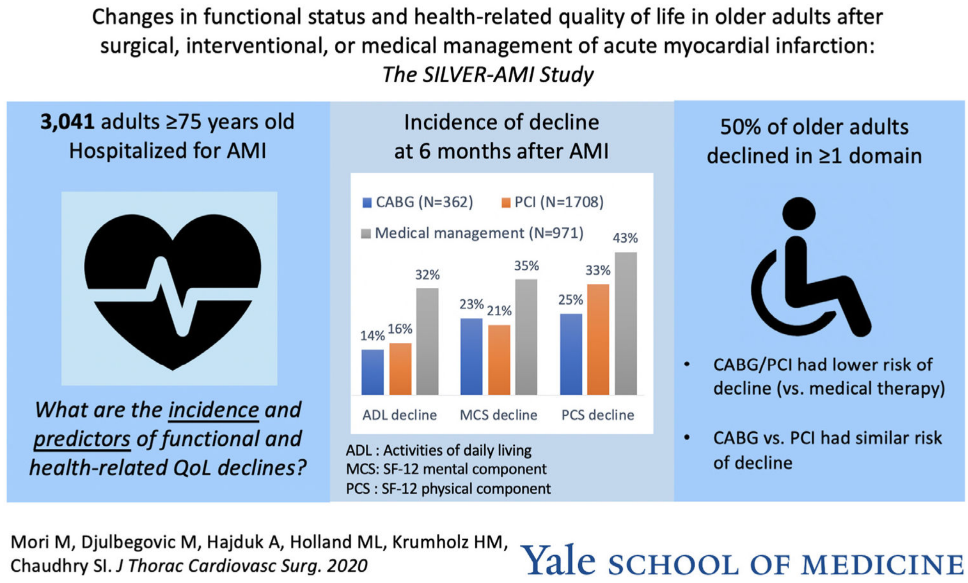

Figure 4.

Study summary. The figure summarizes the main findings of the study, which were that over half of older adults after acute myocardial infarction experienced decline and that those who underwent revascularization had a lower risk of decline compared with those managed medically.

Table 1.

Patient and Operative Characteristics

Variables	Overall	No Change in ADL	Decline in ≥1 ADL (or Death)	*P* Value
Overall, *N*	3041	2252 (74.1%)	633 (20.8%)	-
Demographics				
Age: median (IQR)	81.0 (77.0–85.0)	80 (77–84)	82 (78–87)	<0.001
Female sex: *N* (%)	1346 (44.3%)	951 (42.2%)	313 (49.4%)	0.001
Nonwhite race: *N* (%)	325 (10.9%)	204 (9.2%)	96 (15.4%)	<0.001
Married or living with partner: *N* (%)	1528 (50.3%)	1,200 (53.4%)	266 (42.1%)	<0.001
Completed ≤ high school education	1723 (57.1%)	1,257 (56.2%)	381 (61.0%)	0.04
Baseline sensory, cognitive, and physical impairments				
Prehospital ADL impairment (any): *N* (%)	420 (13.8%)	215 (9.5%)	170 (26.9%)	<0.001
SF-12* (mental health component): median (IQR)	54.8 (46.6–60.0)	55.37 (47.7–60.2)	52.74 (43.6–59.1)	<0.001
SF-12* (physical health component): median (IQR)	41.3 (33.8–49.4)	42.56 (35.4–50.3)	36.48 (30.1–43.5)	<0.001
≥2 falls within past year: *N* (%)	600 (19.8%)	371 (16.5%)	190 (30.4%)	<0.001
Low physical activity compared to peers: *N* (%)	485 (15.9%)	286 (12.7%)	167 (26.4%)	<0.001
Hearing impairment: *N* (%)	413 (13.8%)	270 (12.1%)	114 (18.2%)	<0.001
Vision impairment: *N* (%)	256 (8.4%)	157 (7.0%)	81 (12.8%)	<0.001
Medical history				
BMI (kg/m^2): median (IQR)	26.8 (24.0–30.3)	27.0 (24.4–30.3)	26.3 (23.2–30.7)	0.006
Charlson index (range: 1–18), median (IQR)	3.0 (2.0–5.0)	3 (2–5)	4 (3–6)	<0.001
Prior coronary disease: *N* (%)	1,623 (53.4%)	1,169 (51.9%)	370 (58.5%)	0.004
Prior myocardial infarction: *N* (%)	829 (27.3%)	595 (26.4%)	198 (31.3%)	0.02
Prior revascularization: *N* (%)	1,237 (40.7%)	910 (40.4%)	266 (42.0%)	0.5
Prior cerebrovascular disease: *N* (%)	475 (15.6%)	295 (13.1%)	147 (23.2%)	<0.001
Prior heart failure: *N* (%)	572 (18.8%)	327 (14.5%)	208 (32.9%)	<0.001
Prior diabetes: *N* (%)	1,128 (37.1%)	800 (35.5%)	264 (41.7%)	0.004
Prior arrhythmia: *N* (%)S	760 (25.0%)	503 (22.3%)	213 (33.6%)	<0.001
Prior chronic obstructive pulmonary disease: *N* (%)	434 (14.3%)	272 (12.1%)	131 (20.7%)	<0.001
Prior peripheral arterial disease: *N* (%)	366 (12.0%)	236 (10.5%)	101 (16.0%)	<0.001

Variables	Overall	No Change in ADL	Decline in ≥1 ADL (or Death)	*P* Value
Prior history of renal failure[†]: *N* (%)	79 (2.6%)	29 (1.3%)	41 (6.5%)	<0.001
Hospitalization characteristics				
MI classification, STEMI	797 (26.2%)	635 (28.2%)	132 (20.9%)	<0.001
Length of index admission: mean (SD) days	4.0 (3.0–8.0)	4.0 (2.0–7.0)	6.0 (3.0–9.0)	<0.001
Type of treatment				
PCI	1,708 (56.2%)	1,369 (60.8%)	271 (42.8%)	<0.001
CABG	362 (11.9%)	291 (12.9%)	50 (7.9%)	
Medical management	971 (31.9%)	592 (26.3%)	312 (49.3%)	
CABG-specific variables				
Concomitant operation	48 (1.6%)	38 (1.7%)	9 (1.4%)	0.6
Redo sternotomy: *N* (%)	5 (0.2%)	4 (0.2%)	1 (0.2%)	0.9

ADL, activity of daily living; BMI, body mass index in kg/m^2; COPD, chronic pulmonary obstructive disease; SD, standard deviation; STEMI, ST elevation MI.

[*] SF-12 refers to Short Form-12, a survey-based measure that generates the Physical and Mental Health Composite Scores (PCS & MCS). These are summative scores of the respondents' answer to the 12-item questionnaire, and range from 0 to 100 (where 0 indicates the lowest level of health and 100 indicates the highest level of health).

[†] Prior renal failure is defined as GFR <15 or on dialysis prior to admission. There were 156 (5.1%) patients missing decline measurements.

Table 2.

Multivariable Model of Decline in Activity of Daily Living (n = 2885)

Variables	OR	95% CI		P
Age (per 1-year increase)	1.08	1.06	1.10	<0.001
Non-white race (ref. White)	1.52	1.13	2.05	0.006
Live with someone	0.95	0.78	1.17	0.65
Any baseline ADL impairment	1.72	1.33	2.23	<0.001
Baseline MCS score (per 1 pt increase)	0.98	0.97	0.99	<0.002
Baseline PCS score (per 1 pt increase)	0.97	0.96	0.98	<0.003
≥2 falls within past year	1.45	1.15	1.83	0.002
Low activity	1.30	1.00	1.70	0.053
Prior revascularization	0.78	0.63	0.95	0.016
Prior stroke	1.41	1.10	1.81	0.006
Prior heart failure	1.85	1.46	2.34	<0.001
Prior COPD	1.40	1.08	1.81	0.011
Prior renal failure	3.69	2.15	6.33	<0.001
Treatment strategies				
PCI (ref. medical)	0.53	0.43	0.65	<0.001
CABG (ref. medical)	0.58	0.41	0.83	0.003

CHF, congestive heart failure; CI, confidence interval; COPD, chronic obstructive pulmonary disease; MCS, mental component score; ref, reference.

Table summarizes result of multivariable logistic regression for decline in the activity of daily living.

Table 3.

Multivariable Model of Decline in HRQoL Mental Component Score (n = 2873)

Variables	OR	95% CI		P
Age (per 1-year increase)	1.03	1.01	1.05	<0.001
Non-white race (ref. White)	1.47	1.11	1.95	0.007
Live with someone	0.93	0.78	1.12	0.46
Completed high school education	1.31	1.10	1.58	0.003
Any baseline ADL impairment	1.46	1.12	1.90	0.005
Baseline MCS score (per 1 pt increase)	1.07	1.06	1.08	<0.001
Baseline PCS score (per 1 pt increase)	0.98	0.97	0.99	<0.001
≥2 falls within past year	1.43	1.14	1.80	0.002
Low activity	1.42	1.09	1.85	0.009
Vision impairment	1.35	0.99	1.85	0.059
Prior renal failure	2.65	1.57	4.46	<0.001
Treatment strategies	1.00	1.00	1.00	
PCI (ref. medical)	0.59	0.49	0.71	<0.001
CABG (ref. medical)	0.74	0.55	1.00	0.05

CHF, congestive heart failure; CI, confidence interval; COPD, chronic obstructive pulmonary disease; MCS, mental component score; ref, reference.

Table summarizes result of multivariable logistic regression for decline in the mental component score of SF-12.

Table 4.

Multivariable Model of Decline in HRQoL Physical Component Score (n = 2872))

Variables	OR	95% CI		P
Age (per 1-year increase)	1.06	1.04	1.08	<0.001
Non-white race (ref. White)	1.30	0.99	1.69	0.057
Live with someone	0.78	0.66	0.93	0.005
Completed high school education	1.17	0.99	1.38	0.069
Any baseline ADL impairment	1.58	1.23	2.04	<0.001
Baseline MCS score (per 1 pt increase)	0.98	0.97	0.99	<0.001
Baseline PCS score (per 1 pt increase)	1.07	1.05	1.08	<0.001
≥2 falls within past year	1.39	1.13	1.72	0.002
Low activity	1.41	1.10	1.82	0.007
Prior heart failure	1.41	1.13	1.76	0.003
Prior diabetes	1.55	1.30	1.84	<0.001
Prior arrhythmia	1.21	1.00	1.47	0.051
Prior COPD	1.71	1.35	2.16	<0.001
Prior renal failure	2.39	1.40	4.08	0.001
Treatment strategies				
PCI (ref. medical)	0.67	0.56	0.80	<0.001
CABG (ref. medical)	0.52	0.39	0.70	<0.001

CHF, congestive heart failure; CI, confidence interval; COPD, chronic obstructive pulmonary disease; MCS, mental component score; ref, reference.

Table summarizes results of multivariable logistic regression for decline in the physical component score of SF-12.