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COGNITIVE STATUS AND INITIATION OF LIFESTYLE CHANGES
FOLLOWING ACUTE CORONARY SYNDROME

A Dissertation Presented

By

ALEXANDRA MARIE HAJDUK, MPH

Submitted to the Faculty of the
University of Massachusetts Graduate School of Biomedical Sciences, Worcester
In partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

March 27th, 2014

Clinical & Population Health Research

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Clinical & Population Health Research
March 27th, 2014

This work is dedicated to my parents and grandparents, who escaped the oppression of communist Europe to seek freedom and a better life in the United States. It is only through their sacrifices that I've had the opportunity to pursue my dreams.

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ABSTRACT

Background: Cognitive impairment is prevalent in survivors of acute coronary syndrome (ACS) and increases risk for poor outcomes. Lifestyle changes are recommended to patients after ACS to reduce their risk for recurrent events, but cognitively impaired patients may encounter difficulties initiating these changes. This dissertation had three aims: (1) to examine cognitive status as a predictor of lifestyle changes after ACS, (2) to examine whether caregiver support moderates the association of cognitive status and initiation of lifestyle changes, and (3) to assess the reliability of self-reported lifestyle changes in cognitively impaired patients through comparison of their reports of lifestyle change with those from their caregivers.

Methods: For aims 1 and 2, Poisson regression with robust error variance was used to examine the association of cognitive status and caregiver support with patient-reported initiation of five lifestyle changes (improving diet, increasing exercise, quitting smoking, reducing stress, and attending cardiac rehabilitation) in 881 patients from TRACE-CORE, a prospective longitudinal observational study of outcomes in ACS. For aim 3, pilot data from 78 patient-caregiver dyads from TRACE-CARE, an ancillary substudy, were used to examine whether patient-caregiver congruence on reports of lifestyle changes varied according to patients' cognitive function.

Results: Patient-reported rates of lifestyle change did not vary according to cognitive status, except for participation in cardiac rehabilitation. Caregiver support improved patient-reported rates of lifestyle change among cognitively intact patients but not cognitively impaired patients. Patients' cognitive function was positively associated with patient-caregiver congruence on reports of initiation of lifestyle changes and patients with decreased cognitive function tended to over-report initiation of lifestyle changes compared to reports by their caregivers.

Conclusion: Although cognitive status was not associated with initiation of most lifestyle changes and the influence of caregiver support on initiation of lifestyle changes was only beneficial to cognitively intact patients in this cohort of ACS patients, these null findings may be explained by the questionable validity of self-report in cognitively impaired patients. This dissertation yields new knowledge about secondary prevention in ACS patients and provides insight into the challenges of conducting patient-reported outcomes research in cognitively compromised populations.

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ABBREVIATIONS

Abbreviation	Meaning
ACS	Acute coronary syndrome
CABG	Coronary artery bypass surgery
Cardiac rehab	Cardiac rehabilitation program
CCOR	Center for Cardiovascular Outcomes Research
CI	Cognitive status
CI	Confidence interval
CVA	Cerebrovascular accident
GRACE	Global Registry of Acute Coronary Events
IQR	Interquartile range
MI	Myocardial infarction
MVPA	Moderate to vigorous physical activity
NSTEMI	No ST-elevation myocardial infarction
PA	Physical activity
PCI	Percutaneous coronary intervention
SD	Standard deviation
SE	Standard error
STEMI	ST-elevation myocardial infarction
TICS	Telephone Interview for Cognitive Status
TRACE-CORE	Transitions, Risks, and Actions in Coronary Events- Center for Outcomes Research and Education
UA	Unstable angina

CHAPTER I

INTRODUCTION

I.1 Acute Coronary Syndrome

The term acute coronary syndrome (ACS) defines a group of conditions characterized by cardiac ischemia and necrosis that includes ST segment elevation myocardial infarction (STEMI), non-ST segment-elevation myocardial infarction (NSTEMI), and unstable angina (UA)¹. ACS is a common manifestation of underlying coronary disease that results in 1.2 million hospitalizations per year in the United States². Currently, the direct and indirect costs of ACS in the U.S. total approximately \$150 billion³. Due to the aging of the population, the incidence and prevalence of coronary heart disease (including ACS) is expected to increase by 26% and 47%, respectively, within the next three decades, with the largest increases occurring among Americans aged 75 to 84 years old⁴.

Short-term outcomes in ACS have improved markedly over the last twenty years⁵ so that more than 90% of ACS patients now survive their initial attack^{6,7}. Much of the decrease in short-term mortality is attributed to the proliferation of effective in-hospital treatments such as coronary reperfusion⁶ and use of cardioprotective medications⁸. However, risk for recurrent events and mortality remains high among survivors. Up to 20% of ACS patients are rehospitalized within one-year of discharge⁹⁻¹¹. One-year post-discharge mortality stands at approximately 7%^{10,11} and five-year mortality is approximately 15%^{12,13}, with the risk of death increasing with each recurrence of ACS⁹. Approximately one-third of all hospitalizations for ACS are due to recurrent attacks¹⁴ and 60% of the overall cost of ACS ensues from recurrent events³.

I.2 Lifestyle Changes after Acute Coronary Syndrome

Since 90% of cardiovascular risk is attributable to modifiable risk factors¹⁵, these risk factors are often targeted in secondary prevention of ACS. Health care providers often recommend that ACS patients make lifestyle changes in line with guidelines released by the American College of Cardiology and the American Heart Association^{16,17}, which include following a heart-healthy diet, increasing physical activity, quitting smoking, moderating alcohol use, reducing stress, managing depression, and attending cardiac rehabilitation.

Initiation of recommended lifestyle changes after ACS greatly reduces the risk of recurrent coronary events and mortality. Improving diet^{18,19}, increasing physical activity^{20,21}, quitting smoking^{22,23}, reducing^{24,25}, and attending a cardiac rehabilitation program^{26,27} have been independently associated with substantially lower morbidity and mortality in survivors of ACS. A recent meta-analysis²⁸ reported that lifestyle interventions to improve diet, exercise, and smoking were associated with a 25% reduction in overall mortality, a 37% reduction in cardiovascular mortality, and a 32% reduction in nonfatal cardiac events among patients with cardiovascular disease. Another study²⁹ found that changes to diet, exercise, smoking and stress were associated with a 41% reduction in recurrent coronary events and reduced cardiovascular mortality among survivors of coronary events that underwent percutaneous coronary intervention, suggesting that lifestyle changes improve outcomes in patients who have already received highly effective invasive therapies. Lifestyle changes meaningfully reduce the risk of cardiovascular events and death in ACS

patients within a few months of initiation³⁰ and the benefits of making multiple lifestyle changes are additive²⁹⁻³¹.

Despite the proven benefits of lifestyle changes after ACS, patients' initiation of these behaviors is suboptimal. Recent studies³²⁻³⁴ have found that almost two-thirds of ACS patients do not reach targets for recommended lifestyle changes and less than half of eligible patients participate in cardiac rehabilitation³⁵. ACS patients seem to be more successful in quitting smoking and making dietary changes than increasing physical activity or reducing stress^{32,34}, but room for improvement exists for initiation of all lifestyle changes^{32,36}. Socioeconomic factors (e.g., low income or education)^{37,38}, depression³⁸⁻⁴¹, anxiety^{41,42}, patients' erroneous beliefs about the impact of behaviors on health^{38,43}, and being recommended to initiate multiple lifestyle changes³³ have been identified as risk factors for suboptimal initiation of lifestyle changes in patients with ACS. However, attempts to intervene on these risk factors have met with limited success^{39,44}.

I.3 Cognitive Impairment in Acute Coronary Syndrome

One factor that has not been examined in depth with regard to initiation of lifestyle changes in ACS is patient's cognitive function. Cognitive impairment (CI), defined as a diminished function in one or more domains of mental action that may impact one's ability to remember, understand, or make decisions⁴⁵, is prevalent in cardiovascular disease^{46,47} and may be caused by cerebral hypoperfusion due to reduced cardiac output^{47,48} or inflammatory assault after myocardial ischemia^{46,47}. A recent study that

compared cognitive outcomes at 1-year in patients with ACS, minor stroke, and transient ischemic attack (TIA) reported that ACS patients had a two-fold risk of CI compared to patients recovering from TIA and had similar risk of CI compared to patients with minor stroke⁴⁹. Another population-based study⁵⁰ of adults age 55 and older found that participants who had a history of myocardial infarction (MI) had nearly twice the rate of CI (11.3 vs. 5.6%, $p=.003$) compared to those without a history of MI. Although prevalence data for CI in ACS are limited, one study suggests that CI may affect up to half of patients hospitalized for myocardial infarction⁵¹. Increases in survival and the aging of the ACS population will undoubtedly increase the prevalence of cognitive impairment among ACS survivors.

In addition to being examined as an outcome in ACS, CI has garnered increasing interest as a predictor of outcomes. CI has been associated with increased risk of mortality in ACS patients. Gharacholou, et al., reported that moderate or severe CI was associated with a two-fold increased risk of 1-year mortality in patients with MI⁵¹. Dementia, a severe form of CI, is a stronger predictor of one-year mortality after ACS than severe renal failure, PAD, heart failure, or previous myocardial infarction⁵². In spite of these compelling data for a link between CI and poor outcomes in ACS, the mechanisms by which CI may contribute to these poor outcomes are largely unknown.

1.4 Cognitive Impairment and Initiation of Lifestyle Changes after ACS

CI may confer increased risk of recurrent events and mortality in ACS patients through its effect on patients' ability to remember and adhere to recommendations for lifestyle

change issued by their providers. Although the influence of CI on lifestyle change has not been formally examined in ACS patients, CI has been associated with reduced adherence to therapeutic recommendations in other forms of cardiac disease^{53,54} and some studies have informally linked cognitive deficits to poor initiation of lifestyle changes in ACS. Poor recall of dietary recommendations and confusion regarding dietary advice has been associated with suboptimal diet change in patients with myocardial infarction⁵⁵. In a study assessing the influence of cognitive function on changes in exercise capacity in patients attending a cardiac rehabilitation program⁵⁶, CI was associated with poorer exercise training results, which the authors ascribed to cognitively impaired patients' inability to adhere to the prescribed diet and exercise regimens. These data provide preliminary evidence that patients' cognitive status may affect lifestyle changes following ACS, but focused research that explicitly examines this association is needed.

I.5 Role of Caregiver Support in Initiation of Lifestyle Changes after ACS

More than half of patients hospitalized for a cardiovascular event receive support from a family member, friend, or paid caregiver after discharge⁵⁷. The prevalence of caregiver support and its influence on adherence to therapeutic recommendations and outcomes is well-documented in other cardiac conditions such as heart failure⁵⁸ but has not been systematically examined in ACS. However, marital status, cohabitation status, and social support (oft-used surrogates for caregiver support) have been associated with

decreased mortality in patients with MI¹³ and increased initiation of physical activity⁵⁹ and attendance at cardiac rehabilitation⁶⁰ in patients with ACS.

Although limited empirical evidence exists to quantify the importance of caregiver support in affecting outcomes in cognitively impaired patients with ACS, the importance of caregiver support has long been appreciated by cardiologists (personal communication with Joel M. Gore, MD, January 2014). One recent study found that cognitively impaired MI survivors who lived alone (and were thus less likely to receive support from a caregiver) had a four- to ten-fold increased risk of rehospitalization within one year of discharge compared to patients without CI⁵¹. Due to the potentially beneficial influence of caregiver support on outcomes in ACS patients, the Hospital-to-Home Initiative of the American College of Cardiology recently called for increased involvement of caregivers in discharge education and discussions about disease management for patients with MI⁶¹, especially among patients with compromised cognition. However, more research is needed to understand the role that caregiver support plays in initiation of lifestyle changes among ACS patients with CI.

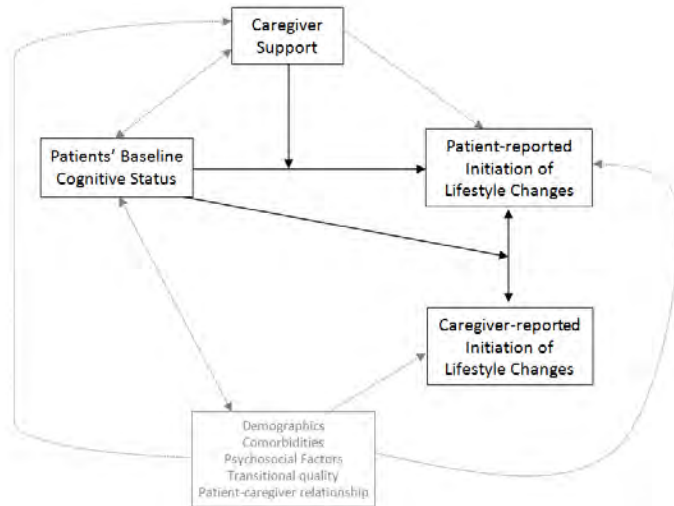
I.6 Dissertation Conceptual Model

The conceptual model depicted in Figure I.1 provides a schematic of the relationships between patients' cognitive status, caregiver support, and initiation of lifestyle changes being investigated in this dissertation. This work is guided by the theoretical framework of the Chronic Care Model, which posits that patients' clinical and functional outcomes are influenced by individual patient characteristics as well as support from others in a

patients' community and health system in managing and making decisions about health⁶². Patients' cognitive status at baseline may influence initiation of lifestyle changes, but other factors

such as demographics, the patient's physical and mental health, and the quality of information received about lifestyle changes during transition from hospital to home, may confound this

Figure 1.1. Conceptual Model



association. Support from a caregiver may directly influence patient's initiation of lifestyle changes or may interact with patients' cognitive status to impact lifestyle changes. Agreement between patients and caregivers in reports of initiation of lifestyle change may differ according the patients' cognitive status but may be also be affected by other patient-caregiver relationship factors, such as type of patient-caregiver relationship or relationship closeness.

1.7 Summary

The relationship between CI, caregiver support, and initiation of lifestyle changes in patients with ACS remains unclear. The purpose of this dissertation was to gain an understanding of how patients' cognitive status during hospitalization influences initiation of lifestyle changes at one-month post-discharge and what influence, if any,

caregiver support has on the association between cognitive status and lifestyle changes. The findings from this work will enhance our understanding of why cognitively impaired patients are at greater risk for poor outcomes after ACS than cognitively intact patients and will guide the development of interventions that target the unique needs of cognitively impaired patients to improve outcomes after ACS.

CHAPTER II

COGNITIVE STATUS AND PATIENT-REPORTED INITIATION OF PROVIDER-RECOMMENDED LIFESTYLE CHANGES FOLLOWING ACUTE CORONARY SYNDROME

Cognitive Status and Patient-Reported Initiation of Provider-recommended Lifestyle Changes following Acute Coronary Syndrome

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II.0 Abstract

Background: Lifestyle changes are often recommended to patients with acute coronary syndrome (ACS) to reduce their risk of recurrent events. We examined whether patient reports of providers' recommendations for lifestyle changes and initiation of recommended lifestyle changes vary by cognitive status.

Methods: Cognitive status was assessed during hospitalization in 881 ACS patients without dementia or delirium (mean age=62, 70% male) from the TRACE-CORE using the Telephone Interview for Cognitive Status (range=0-41, ≤ 28 signals impairment). During a one-month follow-up interview, patients reported whether they had received recommendations from a health care provider to change their diet, exercise more, quit smoking, reduce stress, or attend cardiac rehabilitation. Patients reporting a recommendation were asked whether they had initiated the change. Multivariable Poisson regression with robust error variance estimated the association between cognitive status and recommendation for and initiation of each lifestyle change.

Results: Ninety patients (10%) were cognitively impaired during hospitalization. One month post-discharge, cognitively impaired patients were 29% less likely (RR= 0.71, 95%CI=0.55-0.92) to report recommendation by a provider to attend cardiac rehab and were 42% less likely (RR=0.58, 95%CI=0.35-0.95) to report participating in cardiac rehab than unimpaired patients. Cognitive status was not associated with reports of provider recommendations for, or patients' initiation of, other lifestyle changes.

Conclusions: With the exception of cardiac rehab, patients with and without cognitive impairment were similarly likely to report recommendation and initiation of lifestyle changes. Future research should examine whether cognitively impaired ACS patients can accurately self-report on receipt of recommendations and initiation of lifestyle changes.

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II.1 Introduction

More than one million Americans are hospitalized each year for an acute coronary syndrome (ACS), a group of acute cardiac events including myocardial infarction and unstable angina that account for much of the morbidity and mortality associated with coronary heart disease⁶³. Although improvements in the clinical treatment of ACS have increased short-term survival after ACS⁷, the risk for poor health outcomes such as recurrent cardiac events, morbidity, and mortality remains high among survivors^{10,11}.

Physicians often recommend lifestyle changes to ACS survivors to reduce risk of recurrent events³⁰ and improve outcomes²⁹. Lifestyle changes such as following a heart-healthy diet^{28,30}, increasing physical activity^{20,28,30}, quitting smoking^{23,30}, reducing stress²⁵, and participating in cardiac rehabilitation²⁶ have been shown to reduce the risk of recurrent events and mortality and improve quality of life⁶⁴. For example, initiating diet and exercise changes or quitting smoking are associated with a 43% and 48% reduced risk, respectively, of experiencing a recurrent MI within six months of hospital discharge following ACS³⁰ and has been associated with significant increases in health-related quality of life⁶⁴. Participation in a cardiac rehabilitation program has been associated with a 47% reduced risk of all-cause mortality among patients with CHD⁶⁵.

Despite proven benefits, initiation of lifestyle changes remains low among patients with ACS. Studies have found that only 38% of ACS survivors engage in recommended levels of physical activity³², just over half (53%) meet guidelines for fruit and vegetable consumption³², and only one quarter attend cardiac rehab⁶⁶. Uncovering risk factors that put ACS patients at risk for poor adherence to lifestyle change

recommendations is paramount to identifying patients who may require more tailored discharge planning or intensive outpatient management after an ACS event. Several factors such as low income⁶⁷, depression³⁸, low perceived influence of lifestyle on health³⁸, and lack of social support³⁸ have been associated with decreased initiation of lifestyle changes after ACS⁶⁸. However, attempts to intervene on these risk factors have met with limited success⁶⁸.

One factor that has not been examined with respect to initiation of lifestyle changes after ACS is cognitive impairment (CI). CI has recently garnered increasing attention for its association with poor health outcomes in ACS⁵¹. The link between cardiovascular disease and risk of CI is well established⁴⁶ and CI is highly prevalent among patients with ACS. A recent study reported that more than half of MI patients age 65 and older were cognitively impaired during the first few weeks after hospital discharge and that patients with co-morbid MI and CI had a two-fold increase risk in one-year mortality compared to cognitively intact patients⁵¹. A potential reason for this increase in risk may be that cognitively impaired patients have difficulty understanding and initiating lifestyle changes after discharge. CI has been linked with a higher risk of poor self-management in other chronic diseases such as diabetes⁶⁹ and heart failure⁷⁰. However, the influence of CI on initiation of lifestyle changes in patients with ACS has not been examined. Thus, we aimed to examine the association between cognitive status during hospitalization for ACS and initiation of provider-recommended lifestyle changes one month after hospital discharge.

II.2 Methods

We used data from the TRACE-CORE (Transition, Risks, and Actions in Coronary Events-Center for Outcomes Research and Education) Study, a large longitudinal observational study of 2300 ACS patients from six hospitals in Massachusetts and Georgia. Details of the study have been described elsewhere⁷¹. For this manuscript, we used only data from patients enrolled in the 3 hospitals in Worcester, MA, which include all facilities with cardiac catheterization capacity in the Worcester area. Potentially eligible patients were identified by daily screening of ACS-related ICD-9 codes 410 (AMI), 411 (unstable angina), and 412 (chronic CHD) in computerized hospital, cardiac catheterization lab, and emergency department records by trained physician and nurse reviewers. Patients with applicable ICD-9 codes were approached in the hospital and further screened for eligibility. To be included, patients must have had a diagnosis of ACS consistent with the following criteria outlined by the American College of Cardiology and American Heart Association^{16,17} and used in previous epidemiologic studies⁷²: a history of prolonged chest pain or other symptoms consistent with ACS plus serial ECG changes (ST-segment changes and/or new Q waves) consistent with ACS or increases in biochemical markers of myocardial necrosis (e.g., troponin) past the upper limit of normal at the study hospital. Cases in which the ACS diagnosis was unclear were adjudicated by the nurse coordinator, site PI, and a physician panel. Additional eligibility criteria included age 21 years or older, ability to communicate in English or Spanish, and live hospital discharge after the index ACS event. Participants were excluded if they developed ACS secondary to another acute condition (e.g., surgery), screened positive for delirium by the

Confusion Assessment Method⁷³, had documented dementia, were pregnant, imprisoned, expected to move out of the area within 18 months, or were admitted for palliative care only. Informed consent was obtained in writing from all participants and the study was approved by institutional review boards at all study sites. Participants completed an in-person baseline interview while in the hospital and a computer-assisted telephone interview at one month after discharge. Information about patient's demographic characteristics, comorbidities, lifestyle changes, cognitive status, psychosocial measures, and experience of care during their hospitalization were collected at baseline and follow-up by trained study staff. Clinical characteristics and laboratory values were obtained via medical record review.

Assessment of Cognitive Status

Patients' cognitive status was assessed using the Telephone Interview of Cognitive Status (TICS)⁷⁴, a validated 11-item global cognitive screening instrument that can be administered in-person or over the phone. The TICS is similar to the Mini Mental State Examination (MMSE) in discriminating mild cognitive impairment from normal cognition³⁶. Cognitive status during hospitalization (baseline interview) was dichotomized into normal and impaired using a cutoff score of ≤ 28 (range=0-41, higher score indicates better cognition), consistent with a previous epidemiologic study³⁶. In secondary analyses, we also examined the TICS score as a continuous variable.

Patients' Reports of Providers' Recommendations to Initiate Lifestyle Changes

Patients' reports of providers' recommendations for five lifestyle changes (changing diet, exercising more, quitting smoking, reducing or managing stress, and attending a cardiac rehabilitation program) were collected at 1-month post-discharge by the following question: "When you were in the hospital or since you left, did a doctor or nurse suggest that you [initiate specific lifestyle change]?" This question was asked for each lifestyle change and possible responses were 'yes', 'no', and 'not sure'; the 'not sure' response was categorized as 'no'. Questions about provider recommendations for smoking cessation were only asked of participants who reported smoking at baseline.

Patient-reported Initiation of Provider-recommended Lifestyle Changes

Patient-reported initiation of provider-recommended lifestyle changes was collected during the one-month telephone follow-up interview. If a participant reported that a provider had recommended a lifestyle change (see above), the patient was asked the following question with three response options: "Which of the following best describes your thoughts about [initiating lifestyle change]? Would you say that you do not have plans to [initiate lifestyle change], that you are thinking about [initiating lifestyle change], or that you have started [initiating lifestyle change]?" for all behaviors.

Participants who responded that they had started initiating the lifestyle change were classified as having initiated the lifestyle change and participants who responded that they did not have plans to initiate the lifestyle change or were thinking about initiating the lifestyle change were classified as not having initiated the lifestyle change.

A composite variable that measures the degree of adherence to lifestyle change recommendations was calculated as the percentage of lifestyle changes recommended by a provider for which the patient reported initiating at one-month. Based on the sample distribution, we compared patients who reported initiating 100% of recommended lifestyle changes (fully adherent), and patients who reported adhering to <100% of recommended lifestyle changes (not fully adherent).

Covariates

Demographic data including age, sex, race, ethnicity, education, employment, and marital status were collected via self-report during the baseline interview. Data on medical history, ACS type, and in-hospital procedures were obtained via electronic medical record abstraction. ACS severity was calculated using the GRACE six-month mortality risk score⁷⁵. Physical function was assessed with the SF-36 Physical Component Survey⁷⁶ at baseline and health literacy and numeracy were assessed at 1-month using brief validated screens^{77,78}. Depressive and anxiety symptoms were assessed with the 9-item Patient Health Questionnaire⁷⁹ and 7-item Generalized Anxiety Disorder scale⁸⁰, respectively, using a score of 10 or greater on both scales to signify high depressive or anxiety symptoms. Perceived stress and social support were assessed with the 4-item Perceived Stress Scale⁸¹ and the Lubben Social Network Scale⁸², with a cutoff of 12 used to signal high social support. Patients' knowledge, skill, and confidence in managing their health was assessed using the 6-item Patient

Activation Measure⁸³. The “Starting the Conversation”⁸⁴ scale was used to assess dietary quality. Physical activity and smoking status were collected via self-report.

Statistical Analyses

Cases with complete data on cognitive status and initiation of lifestyle changes were included in the main analyses. The distributions of all dependent variables were examined to confirm normality. Chi-square (Fisher’s exact if cell n’s <5), Mann-Whitney U, and t-tests were used to examine baseline differences in study variables between participants with and without CI.

Due to the common nature of each outcome (i.e., >10%) and the advantage of providing relative risk estimates, multivariable Poisson regression models with robust error variance⁸⁵ were used to examine the association between cognitive status and recommendation/initiation of each recommended lifestyle change, controlling for demographic, clinical and psychosocial confounders. Results from the multivariable models are reported in terms of rate ratios (RR), interpreted similarly to relative risk. Model covariate selection was guided by both statistical significance for the outcome ($p < .20$) and prior knowledge, based on the literature, of covariates’ association with cognitive status or lifestyle changes in ACS. Correlation statistics were examined among covariates to avoid collinearity; if two variables had a correlation of $\geq .80$, only one variable was used in the final model. Forward and backward stepwise regression was used to select covariates included in final adjusted models. Goodness-of-fit was analyzed with deviance residuals.

Secondary analyses were performed to examine whether changes in subjective measures of lifestyle behaviors varied significantly by cognitive status. Mean changes in dietary quality scores and perceived stress scores were examined between cognitively impaired and intact participants who reported changing their diet or reducing/managing stress, respectively, using t-tests. Among patients who had reported increasing physical activity or attempting to quit smoking, changes in the proportion of participants who achieved ≥ 150 minutes of moderate to strenuous physical activity per week and the proportion of patients who were not smoking at one-month were examined according to cognitive status using chi-square tests. All analyses were performed using Stata SE 11.

II.3 Results

Study Sample

Of the 1138 patients from the Massachusetts sites who had data from the baseline interview and medical record, seven patients with missing cognitive data at baseline were excluded. One-month post-discharge interviews were completed in 889 (79%) of patients. Seven patients with missing data on lifestyle changes and one patient who was living in a nursing home at the time of the one-month interview were excluded from analysis, resulting in a sample of 881 patients. Participants not included were older and were more likely to be cognitively impaired at baseline, non-white, depressed, anxious, smoke at baseline, and have a history of coronary heart disease.

Sample Characteristics

Characteristics of the study sample are summarized in Table II.1. The average age of patients was 62 years (SD= 11) and 43% of the sample was age 65 or older. Seventy percent of the sample was male, 89% was white, and 4% was of Latino ethnicity. Approximately one-third of patients had at least a college degree and 34% were employed full-time at the time of hospitalization. Most patients were admitted for NSTEMI (59%), followed by unstable angina (24%), and STEMI (13%). Seventy percent of patients had a history of hypertension and 27% had a history of MI. Moderate to severe depressive and anxiety symptoms were present in 17% and 19% of patients, respectively. All but 4% of patients underwent catheterization and 11% of patients underwent coronary artery bypass surgery (CABG) during hospitalization.

Ninety patients (10%) were cognitively impaired during hospitalization.

Cognitively impaired patients were older, more likely to be female, non-white, and of Latino ethnicity than non-impaired patients (Table II.1). Cognitively impaired patients were less likely to have a college education, be married, or be employed full-time. Several comorbidities including history of MI, stroke, heart failure, depressive symptoms, and anxiety symptoms were more common, and ACS severity (i.e., risk of six-month post-discharge mortality) was higher, among patients with CI. Cognitively impaired patients reported lower functional status, higher stress, poorer hospital-to-home transition quality, and lower health literacy, health numeracy, and patient activation. Cognitively impaired patients were less likely to undergo catheterization during hospitalization but rates of other interventions (i.e., percutaneous coronary intervention, stenting, and CABG) did not differ between patients with and without CI.

Cognitive Status and Providers' Recommendations to Initiate Lifestyle Changes

Almost 90% of patients reported receiving at least one recommendation from a provider to initiate a lifestyle change. Patients' reports of recommendations from a provider to initiate lifestyle changes ranged from 35% for reducing/managing stress to 86% for smoking cessation (among the 168 smokers in the sample); 61% reported receiving a recommendation to attend a cardiac rehabilitation program (Table II.2). Despite having higher cardiovascular risk than unimpaired patients, cognitively impaired patients reported receiving, on average, 1.8 (SD=1.4) recommendations for lifestyle changes while cognitively intact patients reported receiving 2.2 (SD=1.3) recommendations ($p=.004$). Patients' TICS scores correlated weakly with the number of recommendations reported as received ($r=.10$, $p=.004$). Although rates of recommendations to initiate each lifestyle change were lower among patients who were cognitively impaired during hospitalization, only recommendation to attend a cardiac rehab program differed significantly by cognitive status at the $p < 0.05$ level; 63% of patients with intact cognition during hospitalization reported receiving a recommendation to attend cardiac rehab by one-month post-discharge, compared with 41% of patients who were cognitively impaired during hospitalization ($p < .001$). After adjusting for demographic, clinical, and psychosocial factors in multivariable models, cognitively impaired patients remained less likely to have received a recommendation to attend cardiac rehab (RR=0.71, 95%CI=0.55-0.92; Table II.2). Patients' reports of providers'

recommendations to initiate dietary changes, increase physical activity, quit smoking, and reduce stress did not differ according to cognitive status.

Cognitive Status and Initiation of Provider-recommended Lifestyle Changes

Patient-reported initiation of lifestyle changes was high overall, ranging from 53% for attending cardiac rehab to 93% for initiating changes to diet among patients who reported receiving recommendations to initiate these behaviors (Figure II.1). More than one half of patients (52%) reported adhering to all recommended lifestyle changes. In unadjusted analyses, patient-reported initiation of lifestyle changes did not differ significantly according to cognitive status with the exception of attending a cardiac rehabilitation program (Table II.3). In the unadjusted model, cognitively impaired patients who received a recommendation to attend a cardiac rehab program were about half as likely (RR=0.54 (95%CI 0.32-0.91) to report attending such a program at one-month post-discharge; results were similar after controlling for potential confounders (RR=0.58, 95% CI=0.35-0.95; Table II.3). Initiation of all other lifestyle changes, including overall adherence to providers' recommendations for lifestyle changes, did not differ according to cognitive status.

Results were similar in secondary analyses using the continuous TICS score as a predictor of initiation of lifestyle changes: likelihood of attending cardiac rehab fell an average of 5% for each one-point decrease in TICS score (RR=0.95, 95%CI=0.93-0.98) and initiation of all other lifestyle changes (including overall adherence to lifestyle

change recommendations) did not vary significantly according to TICS score (data not shown).

Behavior Changes among Patients Reporting Initiation of Lifestyle Changes

We performed additional analyses to examine whether changes in validated measures of lifestyle behaviors varied by cognitive status in patients who reported initiating lifestyle changes at 1-month post-discharge. We examined mean changes in the Starting the Conversation diet quality score from baseline to one-month to assess the magnitude of diet change among patients reporting they had started to make dietary changes.

Differences between baseline and 1-month reports of the proportion of patients attaining 150+ minutes of physical activity per week (per American Heart Association-recommended guidelines⁸⁶) were examined among patients who had reported trying to increase physical activity. We assessed differences in the proportion of patients who reported no smoking at one-month among baseline smokers who reported they had initiated attempts to quit smoking in the month after discharge. Lastly, we assessed mean changes in score on the Perceived Stress Scale from baseline to one-month among patients who reported that they had started trying to reduce or manage their stress level. Behaviors corresponding to attendance at a cardiac rehab program were not available so secondary analysis was not performed for this variable.

Patients reporting initiation of diet changes improved their dietary quality scores from baseline to one-month, irrespective of cognitive status. However, mean changes in dietary quality were more modest in cognitively impaired patients compared to

cognitively intact patients (mean change = -2.03 vs. -2.99 on a 16-point scale, $p=.035$). Among patients who reported increasing physical activity, patients with CI were less likely than patients with intact cognition to attain the recommended level of activity (5% vs. 14%), but the differences between groups were not statistically significant. Smoking cessation rates did not differ according to cognitive status among patients who reported having started trying to quit ($p=.91$). Interestingly, although the proportion of patients with and without CI who reported initiating attempts to reduce or manage stress were similar, mean stress scores decreased among cognitively impaired patients and increased among cognitively intact patients (-0.48 vs. 1.01 points on a 16-point scale, higher score indicates higher stress, $p=.045$).

II.4 Discussion

We found that ACS patients who were cognitively impaired during hospitalization were significantly less likely than non-impaired patients to receive a recommendation from a provider to attend a cardiac rehabilitation program. Furthermore, among patients receiving a recommendation to attend cardiac rehab, cognitively impaired patients were less likely to report having started attending cardiac rehab by one month after hospital discharge. Cognitive status during hospitalization was not associated with patient-reported receipt of recommendation or initiation of diet change, improvement in physical activity, smoking cessation, stress reduction, or overall adherence to providers' recommendations to initiate lifestyle changes.

The prevalence of cognitive impairment observed in our sample is lower than previous studies, which have reported rates of CI as high as 56% among patients hospitalized with acute MI⁵¹. Our finding of a 10% prevalence of CI during hospitalization in our sample is most likely an underestimate of the true prevalence of CI in ACS patients and may be attributable to the exclusion of patients with delirium and documented dementia, the higher prevalence of baseline CI (19%) among the 249 participants who were not included in this analysis due to lack of data at one-month follow-up, or the relatively young age and high educational attainment of our sample. Less than half of our study sample was older than age 65 and more than 60% had an educational level beyond high school, in contrast to the aforementioned study⁵¹ in which all patients were 65 years or older, the mean age was 73, only 52% of the sample was educated beyond high school, and delirium was not used as an exclusion criterion. Finding a 10% rate of CI in this young and well-educated sample supports prior evidence that CI is most likely highly prevalent in the ACS population and should be screened for during hospitalization.

Reports of initiation of provider-recommended lifestyle changes were high among patients in this study. With the exception of attending a cardiac rehab program, more than 70% of patients who reported receiving recommendations to initiate lifestyle changes reported initiating these behaviors at one month post-discharge. These rates are higher than those reported by Chow, et al.,³⁰ which found that 47%, 44%, and 54% of ACS patients living in North America reported adhering to providers' recommendations to improve diet, exercise three times a week, and quit smoking,

respectively, at one month after discharge. The difference in reported rates of lifestyle change between studies cannot be attributed to data collection methods, as both studies used simple self-report questions to collect data on initiation of lifestyle changes. However, the sample in the study by Chow, et al., was markedly older and less likely to have undergone revascularization during the index hospitalization, factors that were associated with likelihood of initiating lifestyle changes in our cohort. Also, our reported rates of initiation of provider-recommended lifestyle changes may be artificially inflated due to lack of information on initiation of lifestyle changes among patients who were not included in our study due to missing one-month follow-up data, which may be lower than in our study sample. Our study supports previous findings that there is room for improvement in ACS patients' initiation of diet changes, physical activity changes, smoking cessation, and attendance at a cardiac rehab program in the month after discharge for ACS and adds new evidence about patient-reported adherence to recommendations for stress reduction after ACS.

Our findings for lower rates of recommendation and attendance at a cardiac rehabilitation program at one month among cognitively impaired patients are consistent with results from a recent study of MI patients which reported rates of referral and participation in cardiac rehabilitation of 41% and 23%, respectively, among patients with moderate or severe CI compared to 62% and 47% among cognitively normal patients⁵¹. Lower reported rates of provider referral to cardiac rehabilitation programs in cognitively impaired ACS patients is troubling, as there is evidence in other cardiac conditions that cognitively impaired patients may be particularly vulnerable to

difficulties managing their condition after discharge⁷⁰ and thus may be in greatest need of the education and support offered through cardiac rehabilitation programs. Cardiac rehabilitation has been shown to reduce mortality²⁶ and improve cognitive function⁸⁷ in patients with cardiovascular disease, important benefits that may fail to reach cognitively impaired patients.

There are many potential reasons why patients with CI may be less likely to report receiving recommendations for and participating in cardiac rehabilitation: cognitively impaired patients may not fully comprehend the benefits of cardiac rehab or may lack the ability to navigate issues related to attendance, such as following up on providers' referrals or coordinating schedules and transportation. They may also fail to remember recommendations by a provider to attend cardiac rehabilitation. Future research should elucidate the reasons why patients are less likely to report receiving a recommendation to participate in cardiac rehab and the mechanisms that put cognitively impaired ACS patients at risk for non-attendance in cardiac rehab programs.

Our findings for non-significant differences in recommendation and initiation of diet changes, physical activity changes, smoking cessation, and stress reduction between patients with and without CI do not support our a priori hypotheses that cognitively impaired patients would be less likely to be recommended and initiate these behaviors during the month after hospital discharge. We present several potential explanations for these null results.

First, cognitively impaired patients may truly not differ from cognitively intact patients with respect to remembering providers' recommendations for lifestyle changes

and initiating these recommended behaviors. This may be especially true in our sample, of which the vast majority (95%) of cognitively impaired patients were only mildly impaired (mean TICS= 25.7), so any cognitive difficulties they may have experienced as a result of this impairment may not have been severe enough to preclude them from initiating these behavior changes. However, since even minor cognitive deficits have been associated with poorer adherence to objectively measured disease management behaviors⁸⁸, we do not place our confidence in this explanation. Second, cognitively impaired patients may not accurately report providers' recommendations for lifestyle changes and initiation of these behaviors due to memory problems, as evidenced by our finding that cognitively impaired patients, despite having higher cardiovascular risk, reported having received fewer recommendations for lifestyle change, on average, than unimpaired patients. Third, patients with CI may report similar rates of recommendation and initiation due to assistance they receive from a caregiver with initiating these behaviors. Indeed, more than one third of CHD patients report receiving support from a paid or unpaid caregiver after a hospitalization⁵⁷ and caregiver support, such as from a spouse, has been shown to influence initiation of lifestyle changes after ACS⁵⁹. Future research should examine the influence of caregiver support on initiation of lifestyle changes among cognitively impaired patients with ACS.

As suggested by our secondary analyses, patients with CI who report recommendations for and initiation of lifestyle changes may encounter difficulties in successfully performing these behaviors well enough to produce meaningful changes in their cardiovascular risk profiles. Our secondary analyses, which examined differences

in the magnitude of behavior change between patients with and without CI who had reported initiating each lifestyle change, showed that cognitively impaired patients were less successful in improving diet quality than cognitively intact patients. Future research is needed to more closely examine cognitively impaired patients' abilities to change their lifestyle behaviors to meaningfully reduce their risk for recurrent events and mortality.

Strengths and Limitations

Our findings are strengthened by the use of the large longitudinal TRACE-CORE dataset which is rich in clinical, demographic, and psychosocial data on ACS patients. We used a validated screening instrument that can be administered in-person or over the phone to assess cognition at several time points. We used measurements of CI collected during hospitalization, not at one month after discharge as has been done in prior studies⁵¹, to best characterize patients' cognitive status during the time when they undergo discharge education and are likely to receive recommendations to initiate lifestyle changes. We examined the influence of cognitive status on recommendation and initiation of five different lifestyle changes which are known to influence risk of recurrent events and mortality and were able to conduct secondary analyses to examine the magnitude of some behavior changes among patients who reported initiating lifestyle changes in the month after hospital discharge.

The findings of our study should be interpreted in the context of several potential limitations. First, all reports of recommendation and initiation of lifestyle

changes, as well as reports of behavior measures, were collected via self-report and thus may be subject to recall or social desirability bias; however, self-reports of disease self-management have been shown to be robust against this type of bias⁸⁹. The loss of 21% of the initial sample due to incomplete one-month follow-up may have introduced selection bias, as excluded patients were more likely to be cognitively impaired than included participants (18.6% vs. 10.1%, $p < .001$). However, the exclusion of cognitively impaired patients likely underestimates the association between cognitive status and initiation of lifestyle changes, thus biasing our findings towards the null. Because our study design excluded demented and delirious patients, most patients with CI were only mildly impaired, and thus we were not able to examine the influence of moderate or severe CI on recommendation and initiation of lifestyle changes. However, results from our secondary analyses of TICS score as a predictor of initiation of lifestyle changes suggest a linear relationship between cognitive function and likelihood of initiating lifestyle changes.

Conclusions

Cognitive impairment is prevalent among patients hospitalized for ACS and influences patient-reported receipt of recommendation for and participation in cardiac rehabilitation programs. Providers should be mindful that cognitively impaired patients may face difficulties with attending cardiac rehabilitation. Future research is warranted to investigate how accurate ACS patients with CI are in reporting recommendations for and initiation of lifestyle changes, how successful they are in making adequate

behavioral changes to meaningfully change their cardiac risk profiles, and to examine the role of caregiver support in initiation of lifestyle changes among cognitively impaired patients.

II.5 Tables & Figures

Table II.1. Baseline Characteristics, by Cognitive Status: TRACE-CORE, 2011-13

Covariates	Total sample (n=881)	Cognitively Intact (n=791)	Cognitively Impaired (n=90)	p
Age, mean (SD)	62 (11)	62 (11)	68 (12)	<.001
Age Group, n(%)				
<50	124 (14)	117 (15)	7 (8)	<.001
50-59	239 (27)	224 (28)	15 (18)	
60-69	282 (32)	256 (32)	26 (29)	
70-79	169 (19)	142 (18)	27 (30)	
80+	67 (8)	52 (7)	15 (17)	
Gender, Male, n(%)	618 (70.0)	562 (71)	56 (62)	.083
Race, White, n(%)	786 (89)	714 (90)	72 (80)	.005
Latino Ethnicity, n(%)	36 (4)	23 (3)	13 (15)	<.001
Education, College degree or higher, n(%)	278 (32)	268 (34)	10 (11)	<.001
Health Literacy*, median(IQR)	2 (1-3)	2 (1-3)	2 (1-4)	<.001
Health Numeracy*, median(IQR)	2 (2-3)	2 (2-3)	3 (2-3)	<.001
Full-time employment, n(%)	301 (34)	284 (36)	17 (19)	.001
Married/living as married, n(%)	551 (63)	510 (65)	41 (46)	<.001
ACS subtype, n(%)				
STEMI	113 (13)	107 (14)	6 (7)	.251
NSTEMI	516 (59)	457 (58)	59 (66)	
Unstable Angina	211 (24)	191 (24)	20 (22)	
ACS Severity , GRACE Risk Score*, mean(SD)	93 (26)	92 (25)	107 (29)	<.001
Medical History, n(%)				
Hypertension	621 (70)	551 (70)	70 (78)	.110
Myocardial Infarction	237 (27)	205 (26)	32 (36)	.051
PCI	221 (25)	194 (25)	27 (30)	.256
CABG	103 (12)	90 (11)	13 (14)	.391
Angina/CHD	265 (30)	234 (29)	31 (34)	.341
Stroke	71 (8)	55 (7)	16 (18)	<.001
Dyslipidemia	602 (68)	535 (68)	67 (74)	.188
Diabetes	270 (31)	242 (31)	28 (31)	.920
Congestive Heart Failure	75 (9)	61 (8)	14 (16)	.012
Arthritis	145 (16)	127 (16)	18 (20)	.339
Physical Function, SF-36 PCS*, mean(SD)	44 (10)	45 (10)	41 (11)	<.001
Psychosocial Factors, n(%)				
Depressive symptoms	144 (17)	122 (16)	22 (25)	.026
Anxiety symptoms	161 (19)	132 (17)	29 (33)	<.001
Above-average stress	338 (39)	296 (38)	42 (50)	.031
Low social support	143 (17)	124 (16)	19 (22)	.160
Patient Activation, ≥ “taking action” phase	377 (43)	348 (44)	29 (32)	.032
Lifestyle Factors				
Diet Quality* (mean, SD)	6.3 (2.5)	6.3 (2.6)	6.3 (2.3)	.960
≥150 min MVPA/wk, n(%)	160 (18)	154 (19)	6 (7)	.007
Current Smoker n(%)	167 (19)	149 (19)	18 (20)	.790
Hospital-home Transition Quality*,	75 (16)	75 (16)	71 (16)	.017
Procedures Performed in-hospital, n(%)				
Cath	850 (96)	768 (97)	82 (91)	.004
PCI	637 (72)	576 (73)	61 (68)	.311
CABG	97 (11)	87 (11)	10 (11)	.974

*Health literacy and numeracy scales are ordinal, scores range from 1 to 5, higher scores indicate worse literacy/numeracy. GRACE risk scores range from 1 to 263, higher scores indicate worse ACS severity. SF-36 PCS scores range from 0 to 100, higher scores indicate better physical function. Dietary quality score ranges from 0 to 16, higher scores indicate worse diet quality. Hospital-to-home scores range from 0 to 100, higher scores indicate better transition.

Table II.2. Patient Reports of Providers' Recommendations to Initiate Lifestyle Changes- N(%) and Adjusted Rate Ratios (RRs): TRACE-CORE, 2011-13

Lifestyle Change	All (n=881) n(%)	Cognitively intact (n=791) n(%)	Cognitively impaired (n=90) n(%)	p	Adjusted RR (95%CI) for CI patients to receive recommendation
Change diet	502 (57)	458 (58)	44 (50)	.144	0.99 (0.81-1.22) ^a
Exercise more/be more active	429 (49)	393 (50)	36 (41)	.099	0.80 (0.61-1.04) ^b
Quit smoking	143 (86)*	128 (86)*	15 (83)*	.769†	0.98 (0.79-1.21) ^c
Reduce/manage stress	310 (35)	280 (36)	30 (33)	.661	0.94 (0.69-1.27) ^d
Attend a cardiac rehab program	533 (61)	497 (63)	36 (41)	<.001	0.71 (0.55-0.92)^e

*among 168 smokers at baseline, n=149 in cognitively intact group, n=18 in cognitively impaired group

†Fisher's exact test used to obtain p-value

a- adjusted for age, ethnicity, marital status, physical activity level, in-hospital stenting, and transitional quality

b- adjusted for education, ethnicity, employment status, marital status, history of hypertension, history of dyslipidemia, in-hospital cath, patient activation, current physical activity level, patient activation, transitional quality

c- adjusted for sex, education, employment, depression, anxiety, social support, history of MI, history of heart failure, history of hyperlipidemia, transitional quality

d- adjusted for age, sex, ethnicity, marital status, history of CVA, anxiety, stress, GRACE risk score

e- adjusted for education, marital status, history of hypertension, history of MI, stress, patient activation, in-hospital stenting

Table II.3. Crude and Multivariable-adjusted Rate Ratios (RRs) for Cognitive Status and Patient-reported Initiation of Lifestyle Changes: TRACE-CORE 2011-13

Lifestyle Change	Unadjusted RR (95% CI)	Model 1* RR (95% CI)	Model 2 RR (95% CI)
Change diet	1.03 (0.96-1.10)	1.03 (0.96-1.11)	1.03 (0.95-1.11) ^a
Exercise more/be more active	0.84 (0.64-1.09)	0.86 (0.66-1.12)	0.91 (0.68-1.22) ^b
Quit smoking	0.95 (0.75-1.29)	0.94 (0.73-1.22)	0.87 (0.71-1.07) ^c
Reduce/manage stress	0.97 (0.79-1.19)	0.99 (0.80-1.22)	0.93 (0.74-1.17) ^d
Attend cardiac rehab program	0.54 (0.32-0.91)	0.50 (0.29-0.88)	0.58 (0.35-0.95)^e
Perfect adherence to Lifestyle Changes	0.87 (0.67-1.14)	0.88 (0.67-1.16)	0.96 (0.83-1.10) ^f

*adjusted for age, gender, race, ethnicity, education, marital status, employment status

a- adjusted for race, education, employment, history of hypertension, history of MI, history of CABG, anxiety, patient activation, in-hospital cath, in-hospital CABG, transitional quality, physical activity

b- adjusted for sex, ethnicity, history of CHD, depression, anxiety, stress, , in-hospital stenting transitional quality, diet quality, physical activity

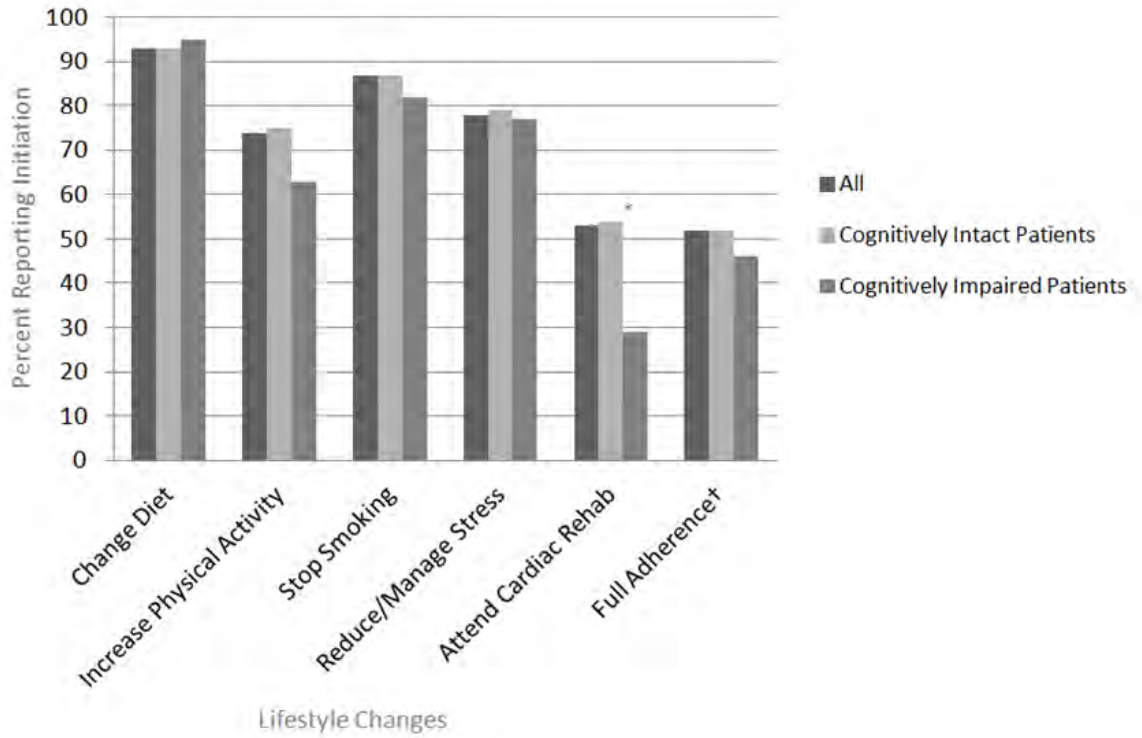
c- adjusted for race, history of CHD, history of CVA, depression, anxiety, stress, patient activation, transitional quality, in-hospital stenting

d- adjusted for age, history of MI, history of heart failure, GRACE risk score, anxiety, patient activation, transitional quality

e- adjusted for age, race, education, marital status, history of MI, history of PCI, history of arthritis, GRACE risk score, depression, in-hospital PCI

f- adjusted for history of MI, history of CABG, transitional quality, health literacy

Figure II.1. Percent of Patients Initiating Provider-Recommended Lifestyle Changes, by Cognitive Status: TRACE-CORE 2011-13



*denotes statistically significant difference in rates of initiation by cognitive status
 †adherent to 100% of recommended lifestyle changes

Appendix Table II.1. Multivariable-adjusted Rate Ratios (RR) for Covariates and Patient-reported Initiation of Provider-recommended Lifestyle Changes after ACS

Covariates	Change diet RR (95% CI)	Increase Physical Activity RR (95% CI)	Quit Smoking RR (95% CI)	Reduce Stress RR (95% CI)	Attend cardiac rehab RR (95% CI)	Full Adherence RR (95% CI)
Cognitive status	1.03 (0.95-1.11)	0.91 (0.68-1.22)	0.87 (0.71-1.07)	0.93 (0.74-1.17)	0.58 (0.35-0.95)	0.96 (0.74-1.25)
Age	--	--	--	0.99 (0.98-1.00)	0.97(0.96-0.99)	--
Gender, female	--	0.81 (0.71-0.94)	--	--	--	--
Race, white	1.00 (1.00-1.00)	--	1.00 (1.00-1.00)	--	1.00 (1.00-1.01)	--
Latino ethnicity	--	0.85 (0.69-1.05)	--	--	--	--
Education	1.01 (1.00-1.03)	--	--	--	1.05 (1.00-1.10)	--
Full-time employment	1.03 (0.98-1.08)	--	--	--	--	--
Married/living as	--	--	--	--	0.97 (0.92-1.01)	--
ACS subtype STEMI (reference)						
NSTEMI	--	--	--	--	--	--
UA	--	--	--	--	--	--
GRACE risk score		--	--	1.00 (1.00-1.01)	1.01 (1.01-1.02)	--
History of hypertension	0.97 (0.92-1.02)	--	--	--	--	--
History on MI	0.88 (0.81-0.96)	--	--	0.82 (0.68-0.99)	0.77 (0.54-1.09)	0.76 (0.63-0.92)
History of PCI	--	--	--	--	0.70 (0.50-0.98)	--
History of CABG	1.10 (1.01-1.20)	--	--	--	--	0.85 (0.64-1.12)
History of CHD	--	0.84 (0.73-0.98)	0.83 (0.67-1.03)	--	--	--
History of stroke	--	--	1.18 (0.95-1.48)	--	--	--
History of dyslipidemia	--	--	--	--	--	--
History of diabetes	--	--	--	--	--	--
History of heart failure	--	--	--	1.24 (1.00-1.55)	--	--
History of arthritis	--	--	--	--	1.25 (1.02-1.53)	--
History of spinal disease	--	--	--	--	--	--
Functional status	--	--	--	--	--	--
High depressive symptoms	--	1.13 (0.94-1.34)	0.73 (0.57-0.95)	--	1.33 (1.09-1.62)	--
High anxiety symptoms	1.04 (0.99-1.09)	0.90 (0.75-1.08)	1.10 (0.93-1.29)	1.08 (0.96-1.22)	--	--
Above average stress	--	1.09 (0.96-1.23)	0.92 (0.81-1.05)	--	--	--
Low social support	--	--	--	--	0.82 (0.64-1.05)	--
Patient activation	1.00 (1.00-1.00)	--	1.00 (0.99-1.00)	1.00 (1.00-1.01)	--	--
Health literacy						0.95 (0.89-1.01)
Health numeracy						--
Diet quality	--	0.95 (0.93-0.97)				
Physical activity	0.97 (0.94-1.01)	1.00 (1.00-1.00)	--	--	--	--
Smoker at baseline	--					
In-hospital catheterization	0.92 (0.86-0.99)	--		--	--	--
In-hospital PCI	--	--	--		1.46 (1.15-1.85)	
In-hospital stents	--	1.28 (1.09-1.50)	1.14 (0.97-1.33)	--	--	
In-hospital CABG	1.11 (1.06-1.15)	--				
Transitional quality	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.01)	1.00 (1.00-1.01)	--	1.01 (1.00-1.01)

Notes: covariates were included in stepwise regression models if they were associated ($p < .20$) with cognitive status or initiation of each lifestyle change. Bolded RRs represent covariates that were independently predictive of initiation of each outcome at $p < .05$, non-bolded RRs represent covariates that were independently predictive of initiation of each outcome at $.05 < p < .20$, and "--" represents covariates that were included in the stepwise model but were not independently associated with initiation of each outcome at $p < .20$.

CHAPTER III

COGNITIVE FUNCTION AND INITIATION OF LIFESTYLE CHANGES AFTER ACS: THE ROLE OF CAREGIVER SUPPORT

Cognitive Function and Initiation of Lifestyle Changes after ACS:
The Role of Caregiver Support

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III.0 Abstract

Background: Lifestyle changes are often indicated in patients following acute coronary syndrome (ACS) to reduce their risk for recurrent events. Few previous studies have reported that ACS patients' cognitive status may influence their initiation of some lifestyle changes. We examined whether caregiver support moderates the association between cognitive status and initiation of lifestyle changes after ACS.

Methods: Cognitive status was assessed during hospitalization in 880 ACS patients free of dementia or delirium (mean age=62, 70% male) from the TRACE-CORE study using the Telephone Interview for Cognitive Status (range=0-41, ≤ 28 signals impairment). Patients were asked one month after discharge about initiation of five lifestyle changes (changing diet, exercising more, quitting smoking, reducing stress, or attending cardiac rehabilitation). Receipt of caregiver support was also assessed at one-month. Multivariable-adjusted modified Poisson models with interaction terms and stratified analyses assessed caregiver support as a moderator of cognitive status and patient-reported initiation of lifestyle changes.

Results: Ninety patients were cognitively impaired. The association between cognitive status and patient-reported initiation of lifestyle changes did not vary by caregiver support. However, caregiver support was associated with higher likelihood of participation in cardiac rehabilitation (RR= 1.22, 95% CI=1.04-1.44) and marginally, diet changes (RR=1.04, 95% CI=0.99-1.11) in cognitively intact patients but not cognitively impaired patients.

Conclusion: Caregiver support may enhance initiation of some lifestyle changes among cognitively intact, but not cognitively impaired, patients in the month following discharge for ACS. Future research should examine whether cognitively impaired ACS patients can accurately self-report on initiation of lifestyle changes.

Words: 248

III.1 Introduction

More than one million Americans are hospitalized each year for acute coronary syndrome (ACS), a group of diseases including myocardial infarction and unstable angina that account for a major proportion of morbidity and mortality associated with coronary heart disease (CHD)⁶³. Although improvements in clinical treatment of ACS have increased short-term survival⁷, the risk for poor health outcomes such as recurrent cardiac events, morbidity, and mortality remains high for survivors^{10,11}.

Lifestyle changes are often recommended to ACS patients by providers in order to maintain disease stability and improve prognosis²⁹. Initiation of lifestyle changes such as following a heart healthy diet, increasing physical activity, quitting smoking, reducing stress and attending a cardiac rehabilitation program have been associated with substantial reductions in recurrent events and mortality among patients with CHD^{26,28-30}. However, initiation of these behaviors in the weeks and months after ACS is suboptimal, with less than half of patients reaching targets for lifestyle modification at six months after discharge³².

Many ACS patients are not alone as they embark on initiating lifestyle changes after being discharged from the hospital. The majority of CHD patients report receiving help from paid or unpaid caregivers in managing their disease⁵⁷. Caregiver support plays an important role in outpatient management of general CHD^{38,90} and heart failure^{58,91,92}, and limited work in patients with ACS shows that support from family and friends is associated with increased initiation of lifestyle changes such as physical activity⁵⁹.

Support from caregivers in making lifestyle changes after ACS may be especially important for patients who are cognitively impaired during hospitalization. Up to one-half of ACS patients are cognitively impaired during hospitalization and in the critical transitional period from hospital to home⁵¹. Cognitive impairment during this time may hinder ACS patients' abilities to comprehend, remember or implement lifestyle change recommendations received from providers as part of discharge education. Support from caregivers has been found to increase the quality of disease management and treatments in cognitively impaired patients with Alzheimer's disease⁹³ and heart failure⁹². Therefore, the Hospital-to-Home Initiative of the American College of Cardiology recently set forth the following guidelines for disease management in patients with myocardial infarction⁶¹:

"The need to involve caregivers cannot be overemphasized. This is especially important in patients with cognitive impairment or depression. If possible, caregivers should be present for all educational sessions (both inpatient and outpatient). Doing so can ensure that recommendations are understood and increase the chance of their implementation and adherence." (page 562)

Despite this call to action, little information exists about the influence of caregiver support on initiation of lifestyle changes in cognitively impaired ACS patients. In aim 1, we found that cognitively impaired patients reported less frequently adhering to a recommendation to initiate cardiac rehabilitation post-ACS. This study examined caregiver support as a moderator of cognitive status and initiation of lifestyle changes in patients with ACS, including cardiac rehabilitation. We hypothesized that cognitively impaired patients without caregiver support would be less likely to report initiation of lifestyle changes than cognitively intact patients without caregiver

support and that cognitively impaired patients with caregiver support and cognitively intact patients without caregiver support would be somewhere in between the two extreme groups regarding reports of lifestyle change initiation (Figure III.1).

III.2 Methods

Data

We used data from the TRACE-CORE (Transition, Risks, and Actions in Coronary Events-Center for Outcomes Research and Education) Study, a large longitudinal observational study of outcomes in 2300 ACS patients from six hospitals in Massachusetts and Georgia. Details of the study have been described elsewhere⁷¹. For this manuscript, we used only data from patients enrolled in the 3 hospitals in Worcester, MA, which include all facilities with cardiac catheterization capacity in the Worcester area. To be included in the study, patients must have had a diagnosis of ACS consistent with criteria outlined by the American College of Cardiology and American Heart Association^{16,17} and used in previous epidemiologic studies⁷². Cases in which ACS diagnosis was unclear were adjudicated by a consensus panel. Additional eligibility criteria included age 21 years or older, ability to communicate in English or Spanish, and live hospital discharge after the index ACS event. Participants were excluded if they developed ACS secondary to another acute condition (e.g., surgery), screened positive for delirium⁷³ by the Confusion Assessment Method⁷³, had documented dementia, were pregnant, imprisoned, expected to move out of the area within 18 months, or were admitted for palliative care only. Informed consent

was obtained in writing from all participants and the study was approved by institutional review boards at all study sites.

Participants completed an in-person baseline interview while in the hospital and a computer-assisted telephone interview at one month after discharge. Information about patient's demographic characteristics, comorbidities, lifestyle changes, cognitive status, and psychosocial measures were collected at baseline and follow-up by trained study staff. Clinical characteristics and laboratory values were obtained via medical record review. For this manuscript, we used only data from patients enrolled in the 3 hospitals in Worcester, MA, which include all facilities with cardiac catheterization capacity in the Worcester area.

Assessment of Cognitive Status

Patients' cognitive status was assessed using the Telephone Interview for Cognitive Status⁷⁴ (TICS), a validated 11-item global cognitive screening instrument that can be administered in-person or over the phone. The TICS is similar to the Mini Mental State Examination (MMSE) in discriminating mild cognitive impairment from normal cognition³⁶. Cognitive status during hospitalization (baseline interview) was dichotomized into normal and impaired using a cutoff score of ≤ 28 (range=0-41, higher score indicates better cognition), consistent with a previous epidemiologic study³⁶. In secondary analyses, we also examined the TICS score as a continuous predictor of initiation of lifestyle changes.

Patient-reported Initiation of Provider-recommended Lifestyle Changes

Patient-reported initiation of provider-recommended lifestyle changes was collected during a one-month follow-up telephone interview. If a participant reported that a provider had recommended a lifestyle change, the patient was asked the following question with three response options: “Which of the following best describes your thoughts about [initiating lifestyle change]? Would you say that you do not have plans to [initiate lifestyle change], that you are thinking about [initiating lifestyle change], or that you have started [initiating lifestyle change]?” for all behaviors. Among participants reporting receiving a recommendation for a lifestyle change, those who responded that they had started initiating the lifestyle change were classified as having initiated the change and those who responded that they did not have plans to initiate the lifestyle change or were thinking about initiating the lifestyle change were classified as not having initiated the change.

A composite variable of the degree of adherence to providers’ recommendations for lifestyle change was calculated as the percentage of lifestyle change recommendations reported as initiated by the patient at one-month (range: 0-100%) for patients who reported receiving at least one recommendation to make a lifestyle change. Based on the sample distribution, we compared patients who reported initiating 100% of recommended lifestyle changes (fully adherent), and patients who reported adhering to <100% of recommended lifestyle changes (not fully adherent).

Assessment of Caregiver Support

Caregiver support was assessed with the following yes/no question during the 1-month telephone interview: “Have you received assistance from one or more caregivers since you’ve been sent home from the hospital?”. Data on whether caregiving support was paid or unpaid (or both) was collected as well.

Covariates

Demographic data including age, sex, race, ethnicity, education, employment, and marital status were collected via self-report during the baseline interview. Data on medical history, ACS type, and in-hospital procedures were obtained via electronic medical record abstraction. ACS severity was calculated using the GRACE six-month mortality risk score⁷⁵. Physical function was assessed during hospitalization with the SF-36 Physical Component Survey⁷⁶ and health literacy and numeracy were assessed at 1-month using brief validated screens^{77,78}. Depressive and anxiety symptoms were assessed with the 9-item Patient Health Questionnaire⁷⁹ and 7-item Generalized Anxiety Disorder scale⁸⁰, respectively, using a score of 10 or greater on both scales to signify high depressive or anxiety symptoms. Perceived stress and social support were assessed with the 4-item Perceived Stress Scale⁸¹ and the Lubben Social Network Scale⁸², respectively, with a cutoff of 12 used to signal high social support. Patients’ knowledge, skill, and confidence in managing their health was assessed using the 6-item Patient Activation Measure⁸³. The “Starting the Conversation”⁸⁴ scale was used to assess dietary quality and physical activity and smoking status were collected via self-report.

Statistical Analyses

Patients with complete data on cognitive status, lifestyle changes, and caregiver support were included in main analyses. T-, Mann-Whitney U, and chi-square tests were used to examine differences in demographic and clinical characteristics between cognitively impaired and intact patients and patients with and without caregiver support.

Due to the common nature of each outcome (i.e., >10%) and the advantage of providing relative risk estimates, multivariable Poisson regression models with robust error variance⁸⁵ were used to examine the association of cognitive status and caregiver support with recommendation/initiation of each lifestyle change, controlling for demographic, clinical and psychosocial confounders. Model covariate selection was guided by statistical significance with cognitive status, caregiver support, or each lifestyle change outcome ($p < .10$). Correlation statistics were examined among covariates to avoid collinearity. Stepwise regression was used to select covariates included in final adjusted models. Goodness-of-fit was analyzed with deviance residuals. Results from the multivariable models are reported in terms of rate ratios (RR), interpreted similarly to relative risk.

Caregiver support was analyzed as a dichotomous moderator of the association of cognitive status and initiation of lifestyle changes in two ways. First, hierarchical multiple regression was used to test for moderation by creating a multivariable-adjusted model of the association of both independent variables (i.e., cognitive status and caregiver support) with lifestyle changes and, in a separate step, adding an interaction

term (i.e., cognitive status*caregiver support) to the model. Correlation statistics assessed collinearity between the interaction term and its components before adding these terms to the models. When collinearity was found, sensitivity analyses were performed using interaction terms created from centered variables in an attempt to minimize the potential influence of collinearity on interaction estimates⁹⁴. Second, models examining the association of cognitive status with initiation of lifestyle changes were stratified by caregiver support and Wald tests were used to examine differences in the association of cognitive status with initiation of lifestyle changes between patients with and without caregiver support.

Secondary analyses were performed to examine whether changes in subjective measures of initiation of lifestyle changes varied significantly among four groups categorized by participants' joint cognitive and caregiver support status: cognitively intact patients without caregiver support, cognitively intact patients with caregiver support, cognitively impaired patients without caregiver support, and cognitively impaired patients with caregiver support. Mean changes in dietary quality (measured with the Starting the Conversation⁸⁴ score) and perceived stress (measured with the Perceived Stress Scale⁸¹) were examined among patients in the four cognitive status/caregiver support groups who reported trying to change their diet or reduce stress, respectively, using analyses of variance. Among patients who had reported increasing physical activity or attempting to quit smoking, changes in the proportion of participants who achieved ≥ 150 minutes of moderate to strenuous physical activity per week and the proportion of patients who were not smoking at one-month were

examined in the four cognitive status/caregiver support groups using chi-square tests. All analyses were performed using Stata SE 12.1.

III.3 Results

Study Sample

Of the 1138 patients from the Worcester sites who had data from the baseline interview and medical record, seven patients with missing cognitive data at baseline were excluded. One-month post-discharge interviews were completed in 889 (79%) of patients. Seven patients with missing data on lifestyle changes, one patient with missing data on caregiver support, and one patient who was living in a nursing home at the time of the one-month interview were excluded from analysis, resulting in a sample of 880 patients. Participants not included in analyses were older and were more likely to be cognitively impaired at baseline, non-white, depressed, anxious, smoke at baseline, and to have a history of coronary heart disease.

Characteristics of the study sample are summarized in Table III.1. The average age of participants was 62 years (SD=11) and 70% were male. Almost 90% of participants were white, 4% were of Latino ethnicity, and approximately one third were college-educated and employed full-time. Three quarters of the sample had a prior history of cardiovascular disease and the majority of patients were admitted for NSTEMI (59%), followed by unstable angina (24%) and STEMI (13%). Mean GRACE score was 93 (SD=26), indicating a moderate risk of six-month mortality within the sample. High depressive and anxiety symptoms were present in 17% and 19% of patients,

respectively. Ninety participants (10%) were cognitively impaired during hospitalization and 385 (44%) reported receiving support from a caregiver during the month after discharge, with 217 (25%) reporting receiving paid support. Almost 90% (n=776) of the sample reported receiving a recommendation from a provider to initiate at least one lifestyle change.

Cognitively impaired participants were older, less likely to be white, more likely to be Latino, and were less educated than cognitively intact participants (Table III.1). Cognitively impaired participants had worse cardiovascular risk profiles (evidenced by GRACE score and cardiac comorbidities) and reported worse physical function, depression, anxiety, stress, and hospital-to-home transition quality. Receipt of caregiver support during the month after discharge was more commonly reported by cognitively impaired participants compared to cognitively intact patients (57% vs 42%; $p=.009$), as was receipt of paid caregiver support (33% versus 24%, $p=.043$).

Participants who reported receiving caregiver support were older, less likely to be employed full-time, had higher ACS severity and lower physical function, and were more likely to be cognitively impaired than patients not receiving caregiver support (Table III.2). Participants reporting caregiver support were also more likely to have undergone CABG and have been cognitively impaired during hospitalization.

Cognitive Status & Initiation of Lifestyle Changes

As previously reported in aim 1, reports of initiation of recommended lifestyle changes were not significantly different between participants with and without CI except for

participation in cardiac rehabilitation, for which participants with CI were 45% less likely to report initiation of cardiac rehab than non-impaired participants (RR=0.55, 95%CI=0.33-0.93; Table III.3). Results for the association of continuous TICS score with initiation of lifestyle changes were similar (Appendix Table III.1).

Caregiver Support and Recommendation/Initiation of Lifestyle Changes

Patient-reported initiation of cardiac rehabilitation was more likely in participants reporting caregiver support (multivariable-adjusted RR=1.22, 95%CI=1.03-1.43; Table III.3). Initiation of all other lifestyle changes did not vary significantly according to caregiver support.

Moderation of Cognitive Status-Lifestyle Change Association by Caregiver Support

Based on interpretation of the interaction terms in multivariable-adjusted models, caregiver support did not differentially influence rates of initiation of lifestyle changes between patients with and without CI (Table III.3); results from analyses assessing the interaction of TICS score and caregiver support were similar (Appendix Table III.1). However, since collinearity could not be eliminated from interaction models using standard methods⁹⁴, residual inflated variance in the models may have contributed to these non-significant findings. Thus, examination of models stratified by caregiver support was indicated. Stratified analyses reported similarly null findings (Table III.4).

In post-hoc analyses examining pairwise comparisons of the association of caregiver support with initiation of lifestyle changes in patients with and without CI,

caregiver support was associated with an increased likelihood of participation in cardiac rehabilitation at one month among cognitively intact patients (RR=1.22, 95%CI=1.04-1.44) but not cognitively impaired participants (RR=1.03, 95%CI 0.36-2.09). Similar findings were noted for the association of caregiver support with reports of initiation of diet change among cognitively intact (RR=1.04, 95%CI=0.99-1.11) and impaired (RR=1.01, 95%CI=0.88-1.16) patients.

Secondary analyses

We performed exploratory analyses to examine whether changes in validated measures of lifestyle behaviors at 1-month post-discharge varied among four groups defined by participants' joint cognitive and caregiver support status: cognitively intact participants without caregiver support (n=456), cognitively intact participants with caregiver support (n=334), cognitively impaired participants without caregiver support (n=39), and cognitively impaired participants with caregiver support (n=51). No significant differences in subjective measures of diet, physical activity, smoking status, or stress level were noted between the four groups in omnibus tests (Appendix Table III.2), so pairwise comparisons were not performed.

III.4 Discussion

The current study examined whether caregiver support moderates the association of cognitive status during hospitalization and reports of initiation of lifestyle changes at one-month post-discharge among patients with acute coronary syndrome. In our

modest sample of cognitively impaired patients, we did not find that cognitively impaired participants with caregiver support were more likely than cognitively impaired participants without caregiver support to report initiation of any lifestyle changes. However, in our larger sample of cognitively intact patients, caregiver support was associated with higher reported rates of initiation of diet changes and participation in cardiac rehabilitation.

We have previously reported that CI is associated with patient-reported attendance at cardiac rehabilitation but not initiation of other lifestyle changes. Our findings for better reported initiation of cardiac rehabilitation among participants with caregiver support, especially amongst cognitively intact patients, indicates that support from caregivers, mainly family and friends, may promote initiation of some lifestyle changes. Previous studies examining the influence of marital status⁵⁹ or social support⁶⁰ (factors often used as proxies for caregiver support) have reported similar benefits. A 2008 study⁶⁰ found that ACS patients with high social support were twice as likely to attend cardiac rehabilitation than patients with low social support. A more recent study⁵⁹ examining the influence of cohabitation with a spouse or partner on physical activity after ACS found that patients living with a partner were 20% more likely to engage in daily exercise at one-month post-discharge than patients not living a spouse or partner.

Family members and friends may increase ACS patients' initiation of lifestyle changes by providing practical support, such as assisting with transportation to cardiac rehabilitation, by providing encouragement or reminders to initiate lifestyle changes, or

participating in lifestyle changes with patients, such as cooking heart-healthy meals or taking walks together⁹⁵. This study, along with others, provides evidence that the beneficial influence of support from family and friends in initiation of lifestyle changes may mediate the observed association between social support and improved outcomes in ACS¹³. However, since some studies have found family and friends to be barriers to lifestyle change in cardiac patients⁹⁶ and caregiver support has been associated with worse outcomes in ACS in some studies⁹⁷, further research is needed to understand how patient characteristics interact with caregiver support to influence outcomes in ACS.

The association between cognitive status and initiation of lifestyle changes did not vary by the presence of caregiving support. On the other hand, we found that caregiver support was associated with higher reported rates of initiation of diet changes and attendance at cardiac rehabilitation in cognitively intact patients but not cognitively impaired patients. Although these findings may appear paradoxical, they are in line with results from a study of the joint association of cognitive status and caregiver support in managing diabetes, which found an improvement in diabetes care adherence among cognitively intact patients with caregiver support but not cognitively impaired patients with caregiver support⁹⁸. Of note, this study reported significantly lower disease management among cognitively impaired patients, which we did not. The discrepancy in findings may be due to differences in the methods used to collect information of disease management (i.e., self-reported versus caregiver-reported) or differences between cognitively impaired ACS and diabetic patients in disease management ability.

There are several potential explanations for finding an association between caregiver support and initiation in lifestyle changes among cognitively intact patients but not cognitively impaired patients. To begin with, our sample of cognitively impaired patients was small (n=90), compared with the cognitively intact (n=790). Thus, statistically non-significant findings amongst the cognitively impaired need to be interpreted with caution. As usual, absence of evidence should not to be taken for evidence of absence.

Several additional arguments make it plausible that the effect of caregiver support on changes in lifestyle may be modest, even if present, among cognitively impaired patients. First, caregiver support may not significantly impact initiation of lifestyle changes until patients are moderately or severely cognitively impaired. By design, the majority of cognitively impaired patients in our study sample were only mildly impaired and may have been able to initiate lifestyle changes independently, so caregiver support may not have conferred any additional benefits for these patients. However, since even very minor cognitive impairment has been found to influence patients' ability to accomplish objectively measured disease management behaviors⁸⁸, we are reluctant to believe that caregiver support is less beneficial to cognitively impaired patients than cognitively intact patients. Second, patients with intact cognition may report higher rates of lifestyle change when they are supported by family and friends because they are too busy with other life demands, such as work or family responsibilities, to initiate these changes on their own. Competing life demands have been suggested as an explanation for poorer self-care in cognitively intact heart failure

patients than cognitively impaired patients⁹⁹. We found that cognitively impaired patients were half as likely to be employed full time as cognitively intact patients, so cognitively impaired patients may have had more time and energy to devote to lifestyle changes. Third, caregivers of cognitively impaired patients may experience heavier caregiver burden than caregivers of cognitively intact patients and thus may prioritize other caregiving needs over supporting patients with making lifestyle changes; this explanation was offered as a potential explanation for the positive association of caregiver support in diabetes management among cognitively intact but not cognitively impaired diabetes patients⁹⁸. One last potential explanation is that cognitively impaired patients, both with and without caregiver support, may not accurately report initiation of these lifestyle changes. Misreporting of lifestyle changes by cognitively impaired participants may have obscured a significant influence of caregiver support on initiation of lifestyle changes in these patients. The plausibility of this potential explanation is strengthened by our finding that caregiver support only benefited cognitively intact patients, who may have more accurately reported initiation of lifestyle changes. Future studies that collect more objective measures of lifestyle change and caregiver support are warranted to disentangle the potential effect of misreporting on the association between cognitive status, caregiver support, and initiation of lifestyle changes.

Strengths and Limitations

Our findings are strengthened by the use of the large longitudinal TRACE-CORE dataset which characterizes ACS patients with respect to clinical, demographic, and psychosocial

factors. Use of this large sample allowed examination of lifestyle change initiation across four separate patient groups characterized by cognitive status and caregiver support. We used a validated screening instrument that can be administered in-person or over the phone to assess cognition at several time points and systematically collected information on initiation of lifestyle changes.

However, our findings must be interpreted in the context of several potential limitations. First, all reports of initiation of lifestyle changes, as well as reports of caregiver support, were collected via self-report and thus may be subject to recall or social desirability bias. The loss of 21% of the initial sample due to incomplete one-month follow-up may have introduced selection bias, as excluded patients were more likely to be cognitively impaired at baseline than included participants (18.6% vs. 10.2%, $p < .001$); since caregiver support was reported during the one-month interview, the prevalence of caregiver support in excluded participants cannot be estimated. The number of patients in our sample with moderate or severe CI was too small to allow independent analysis of this group, which may have revealed different results for the association of cognitive status and caregiver support on lifestyle changes. Our use of a general question about caregiver support did not capture whether this support included help with making lifestyle changes, which may have misclassified some patients who received caregiver support not related to lifestyle changes. We also did not ascertain the amount of caregiver support received. However, we considered other classifications of caregiver support, including the use of a modified question from the Medical Outcomes Study Social Support Survey¹⁰⁰ which asks patients how often they had

someone to help them with daily activities if they needed it, and all yielded similar results (data not shown). Nonetheless, future investigations that more closely examine caregiver support in terms of the amount of care and types of care received are warranted.

Conclusions

Cognitive status and receipt of caregiver support are independent predictors of participation in cardiac rehabilitation in the month following discharge for ACS.

Caregiver support improved patient-reported initiation of some lifestyle changes in cognitively intact patients but not cognitively impaired patients. Future research is warranted to investigate the accuracy of self-reported lifestyle changes and receipt of caregiver support in ACS patients with cognitive impairment.

Table III.1. Demographic and Clinical Characteristics of the Sample, by Cognitive Status: TRACE-CORE 2011-13

	Total sample (n=880)	Cognitively Intact (n=790)	Cognitively Impaired (n=90)	p
Age, mean (SD)	62 (11)	62 (11)	68 (12)	<.001
Age Group, n(%)				
<50	123 (14)	116 (15)	7 (8)	<.001
50-59	239 (17)	224 (28)	15 (17)	
60-69	282 (32)	256 (32)	26 (29)	
70-79	169 (19)	142 (18)	27 (30)	
80+	67 (8)	52 (7)	15 (17)	
Gender, Male, n(%)	618 (70)	562 (71)	56 (62)	.08
Race, White, n(%)	785 (89)	713 (90)	72 (80)	.003
Latino Ethnicity, n(%)	36 (4)	23 (3)	13 (15)	<.001
Education, College degree or higher, n(%)	278 (32)	268 (34)	10 (11)	<.001
Health Literacy*, median(IQR)	2 (1-3)	2 (1-3)	2 (1-4)	<.001
Health Numeracy*, median(IQR)	2 (2-3)	2 (2-3)	3 (2-3)	<.001
Full-time employment, n(%)	301 (34)	284 (36)	17 (19)	.001
Married/living as married, n(%)	551 (63)	510 (65)	41 (46)	<.001
ACS subtype, n(%)				
STEMI	113 (13)	107 (14)	6 (7)	.25
NSTEMI	515 (59)	456 (58)	59 (66)	
Unstable Angina	211 (24)	191 (24)	20 (22)	
ACS Severity , GRACE Risk Score*, mean(SD)	93 (26)	92 (25)	107 (29)	<.001
Prior Cardiac History†, n(%)	653 (74)	579 (73)	74 (82)	.07
Number of cardiac comorbidities*, mean(SD)	2.1 (1.6)	2.1 (1.5)	2.5 (1.6)	.016
Physical Function, mean(SD)	44 (10)	45 (10)	41 (11)	<.001
Psychosocial Factors, n(%)				
Depressive symptoms	144 (17)	122 (16)	22 (25)	.026
Anxiety symptoms	161 (19)	132 (17)	29 (33)	<.001
Above-average stress	337 (39)	295 (38)	42 (50)	.030
Low social support	142 (16)	123 (16)	19 (22)	.15
Patient Activation, ≥ “taking action” phase	377 (43)	348 (44)	29 (32)	.031
Caregiver support	385 (44)	334 (42)	51 (57)	.009
Unpaid caregiver support	217 (25)	187 (24)	30 (33)	.043
Lifestyle Factors				
Diet Quality (mean, SD)	6.3 (2.5)	6.3 (2.6)	6.3 (2.3)	.96
≥150 min MVPA/wk, n(%)	160 (18)	154 (19)	6 (7)	.003
Current Smoker n(%)	166 (19)	148 (19)	18 (20)	.77
Hospital Home Transition Quality*,	75 (16)	75 (16)	71 (16)	.016
Procedures Performed in-hospital, n(%)				
Cath	849 (96)	767 (97)	82 (91)	.004
PCI	636 (72)	575 (73)	61 (68)	.32
CABG	96 (11)	86 (11)	10 (11)	.95

*health literacy and numeracy scores range=1-5, lower score denotes better literacy/numeracy; GRACE risk score range=0-263, higher score denotes worse prognosis; transitional quality measured with Care Transitions Measure, range=0-100, higher score denotes better transition

†includes history of hypertension, MI, angina/CHD, atrial fibrillation, dyslipidemia, heart failure

Table III.2. Sample Characteristics, by Caregiver Status: TRACE-CORE 2011-13

Covariates	Patients without Caregiver Support (n=465)	Patients with Caregiver Support (n=385)	p
Age, mean (SD)	61 (11)	64 (11)	<.001
Age Group, n(%)			
<50	79 (16)	44 (11)	.016
50-59	145 (29)	94 (24)	
60-69	158 (32)	124 (32)	
70-79	83 (17)	86 (22)	
80+	30 (60)	37 (10)	
Gender, Male, n(%)	355 (72)	263 (68)	.27
Race, White, n(%)	438 (88)	347 (90)	.44
Latino Ethnicity, n(%)	16 (3)	20 (5)	.14
Education, College degree or higher, n(%)	160 (32)	118 (31)	.61
Health Literacy, median(IQR)	2 (1-3)	2 (1-3)	.04
Health Numeracy, median(IQR)	2 (2-3)	2 (2-3)	.75
Full-time employment, n(%)	193 (39)	108 (28)	.001
Married/living as married, n(%)	312 (63)	239 (62)	.77
ACS subtype, n(%)			
STEMI	68 (14)	45 (12)	.71
NSTEMI	282 (57)	233 (61)	
Unstable Angina	121 (24)	90 (23)	
ACS Severity, GRACE Risk Score, mean(SD)	89 (25)	99 (26)	<.001
Prior Cardiac History [†] , yes, n(%)	362 (73)	291 (76)	.41
Number of cardiac comorbidities*, mean(SD)	2.1 (1.6)	2.1 (1.6)	.79
Physical Function, mean(SD)	46 (10)	42 (11)	<.001
Psychosocial Factors, n(%)			
Depressive symptoms	80 (16)	64 (19)	.86
Anxiety symptoms	83 (17)	78 (21)	.18
Above-average stress	179 (37)	158 (42)	.11
Low social support	84 (17)	58 (15)	.39
Cognitive Impairment	39 (8)	51 (13)	.009
Patient Activation, ≥ “taking action” phase	213 (43)	164 (43)	.92
Lifestyle Factors			
Diet Quality (mean, SD)	6.3 (2.6)	6.2 (2.4)	.89
≥150 min MVPA/wk, n(%)	96 (19)	64 (17)	.29
Current Smoker n(%)	100 (20)	66 (17)	.25
Hospital Home Transition Quality, mean(SD)	76 (16)	74 (16)	.09
Procedures Performed in-hospital, n(%)			
Cath	481 (97)	368 (96)	.21
PCI	396 (80)	240 (62)	<.001
CABG	11 (2)	85 (22)	<.001

*notes: health literacy and numeracy scores range=1-5, lower score denotes better literacy/numeracy; GRACE risk score range=0-263, higher score denotes worse prognosis; transitional quality measured with Care Transitions Measure, range=0-100, higher score denotes better transition

[†]includes history of hypertension, MI, angina/CHD, atrial fibrillation, dyslipidemia, heart failure

Table III.3. Crude and Multivariable-adjusted Rate Ratios (RR) for Cognitive Status, Caregiving Support, and their Interaction with Patient-reported Initiation of Recommended Lifestyle Changes: TRACE-CORE 2011-13*

	RR (95% CI) for Initiation of Lifestyle Change					
	Change diet	Increase Physical Activity	Quit smoking	Reduce stress	Attend Cardiac Rehab	Fully Adherent
N in each model [†]	498	426	157	307	524	776 [‡]
Unadjusted						
Cognitive Impairment (CI)	1.02 (0.96-1.10)	0.85 (0.66-1.10)	0.94 (0.75-1.18)	0.97 (0.79-1.19)	0.53 (0.31-0.90)	0.87 (0.67-1.13)
Caregiver Support	1.04 (0.99-1.09)	0.90 (0.80-1.01)	0.95 (0.83-1.09)	1.03 (0.91-1.15)	1.13 (0.96-1.33)	1.04 (0.91-1.19)
Cognitive Impairment x Caregiver Support						
No CI, no caregiver support	0.96 (0.86-1.06)	1.04 (0.77-1.39)	1.07 (0.82-1.39)	0.90 (0.72-1.14)	1.53 (0.74-3.17)	1.05 (0.73-1.54)
No CI, caregiver support	1.00 (0.90-1.10)	0.95 (0.70-1.28)	1.01 (0.76-1.34)	0.95 (0.75-1.19)	1.75 (0.85-3.63)	1.11 (0.76-1.63)
CI, no caregiver support	Ref	Ref	Ref	Ref	Ref	Ref
CI, caregiver support	1.00 (0.88-1.14)	0.70 (0.42-1.17)	0.96 (0.58-1.59)	0.80 (0.54-1.19)	0.79 (0.28-2.23)	0.90 (0.54-1.50)
Multivariable-adjusted						
Cognitive Impairment (CI)	1.03 (0.95-1.11) ^a	0.93 (0.71-1.21) ^b	0.97 (0.79-1.19) ^c	0.98 (0.78-1.22) ^d	0.55 (0.33-0.93)^e	0.93 (0.71-1.21) ^f
Caregiver Support	1.03 (0.98-1.09) ^a	0.94 (0.84-1.06) ^b	0.98 (0.86-1.12) ^c	1.05 (0.93-1.18) ^d	1.22 (1.03-1.43)^e	1.06 (0.93-1.22) ^f
Cognitive Impairment x Caregiver Support						
No CI, no caregiver support	0.96 (0.86-1.07) ^a	0.97 (0.71-1.33) ^b	1.05 (0.84-1.32) ^c	0.89 (0.71-1.11) ^d	1.66 (0.79-3.49) ^e	0.99 (0.68-1.45) ^f
No CI, caregiver support	0.99 (0.89-1.11)	0.93 (0.68-1.28)	1.03 (0.79-1.34)	0.96 (0.77-1.20)	2.03 (0.96-4.25)	1.07 (0.73-1.57)
CI, no caregiver support	ref	ref	ref	ref	Ref	Ref
CI, caregiver support	1.01 (0.88-1.16)	0.76 (0.45-1.29)	1.03 (0.64-1.63)	0.81 (0.54-1.21)	1.03 (0.36-2.91)	0.93 (0.56-1.54)

*stepwise regression with cognitive status and caregiver support entered simultaneously, and the interaction term entered in a second step

[†] number of patients reporting having received a recommendation for each lifestyle change and thus included in each model

[‡] number of patients reporting having received at least one recommendation for lifestyle change

a- adjusted for race, employment, health literacy, anxiety, transitional quality, in-hospital cardiac catheterization, in-hospital CABG

b- adjusted for sex, ethnicity, diet quality, baseline physical activity, transitional quality, in-hospital percutaneous intervention

c- adjusted for race, education, depression, in-hospital cardiac catheterization

d- adjusted for age, ACS severity, patient activation, transitional quality

e- adjusted for age, race, depression, health literacy, ACS severity, social support, in-hospital percutaneous intervention

f- adjusted for health literacy, transitional quality

Table III.4. Multivariable-adjusted Risk Ratios (RR) for the Association of Cognitive Status and Initiation of Lifestyle Changes, Stratified by Caregiving Support: TRACE-CORE 2011-13

Lifestyle Changes	No Caregiving Support		Caregiving Support		P*
	n [†]	RR(95 %CI)	n [†]	RR(95 %CI)	
Change diet	271	1.07 (0.95-1.20) ^a	227	1.03 (0.91-1.16) ^b	.63
Increase physical activity	250	1.01 (0.73-1.40) ^c	176	0.65 (0.40-1.04) ^d	.13
Quit smoking	102	0.90 (0.71-1.15) ^e	55	0.94 (0.48-1.82) ^f	.92
Reduce stress	168	1.14 (0.90-1.45) ^g	139	0.80 (0.53-1.22) ^h	.15
Attend cardiac rehab	285	0.61 (0.28-1.35) ⁱ	239	0.51 (0.24-1.08) ^j	.73
Fully adherent [‡]	433	1.04 (0.72-1.51) ^k	343	0.83 (0.57-1.20) ^l	.39

*p-value for significance of differences in RR's between groups with and without caregiver support

† number of patients in each model, based on receipt of recommendation for lifestyle change and caregiver support status

‡ model compares RR for 100% adherence to all lifestyle change recommendations versus <100% adherence

a- adjusted for race, employment, health literacy, ACS severity, cardiac history, transitional quality, in-hospital cath and CABG

b- adjusted for ethnicity, health numeracy, in-hospital CABG

c- adjusted for health numeracy, physical activity, transitional quality, in-hospital percutaneous intervention

d- adjusted for ethnicity, marital status, perceived stress, physical activity

e- adjusted for race, physical function, ACS severity, depression, anxiety, transitional quality

f- adjusted for age, sex, education, physical function, anxiety, perceived stress, in-hospital cardiac catheterization

g- adjusted for age, sex, ACS severity, physical activity

h- adjusted for prior cardiac history, physical function, depression, transitional quality

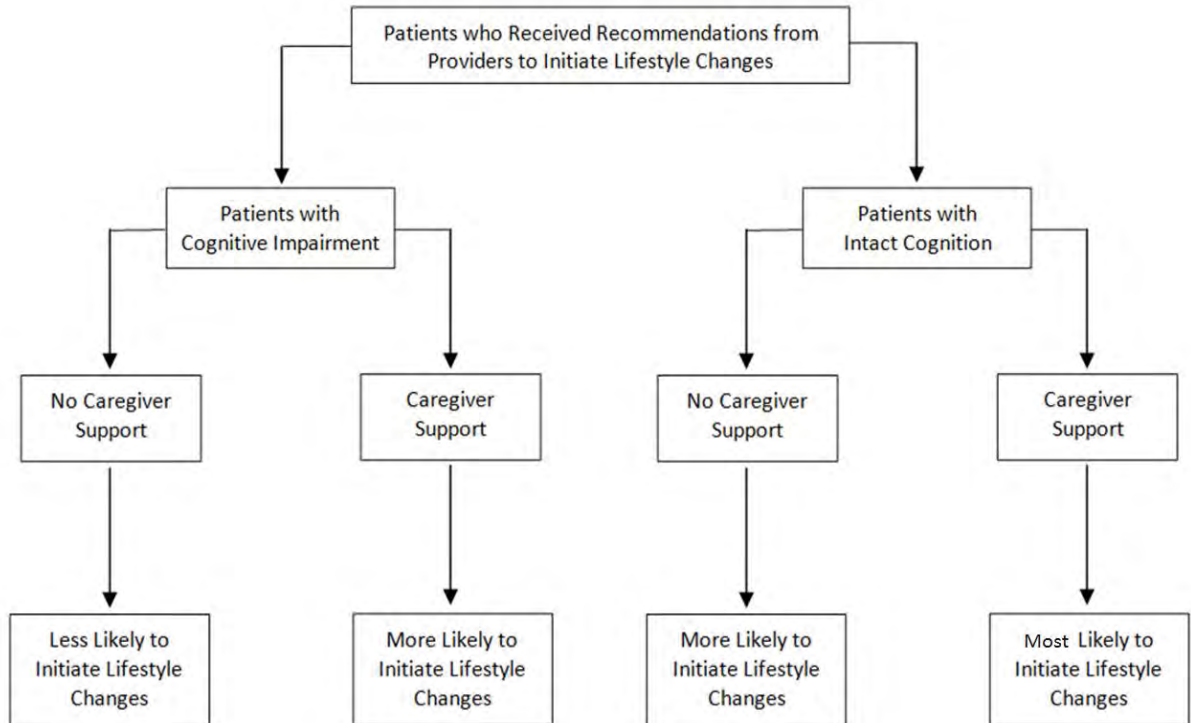
i- adjusted for age, race, ethnicity, in-hospital CABG

j- adjusted for race, health literacy, in-hospital CABG

k- adjusted for age, physical function, patient activation, transitional quality

l- adjusted for ethnicity, health literacy

Figure III.1. The Hypothesized Moderating Influence of Caregiver Support on the Relationship between Cognitive Status and Initiation of Lifestyle Changes



Appendix Table III.1. Crude and Multivariable-adjusted Rate Ratios (RR) for TICS Score, Caregiving Support, and their Interaction with Patient-reported Initiation of Recommended Lifestyle Changes: TRACE-CORE 2011-13*

	RR (95% CI) for Initiation of Lifestyle Change for Each 1-point Decrease in TICS Score					
	Change diet	Increase Physical Activity	Quit smoking	Reduce stress	Attend Cardiac Rehab	Fully Adherent
Unadjusted						
TICS score (reversed)	0.99 (0.99-1.00)	0.99 (0.97-1.01)	0.99 (0.98-1.01)	0.99 (0.97-1.01)	0.95 (0.92-0.98)	0.98 (0.95-1.00)
Caregiver Support	1.04 (0.99-1.09)	0.90 (0.80-1.01)	0.94 (0.82-1.08)	1.03 (0.91-1.15)	1.14 (0.97-1.33)	1.04 (0.91-1.19)
Cognitive Function x Caregiver Support†	0.99 (0.98-1.01)	1.01 (0.98-1.05)	1.03 (0.99-1.07)	0.98 (0.94-1.02)	1.00 (0.94-1.06)	1.01 (0.96-1.06)
Multivariable-adjusted						
Cognitive Status	1.00 (0.99-1.00) ^a	0.99 (0.97-1.01) ^b	1.00 (0.98-1.02) ^c	0.99 (0.97-1.01) ^d	0.95 (0.93-0.98)^e	0.98 (0.96-1.01) ^f
Caregiver Support	1.03 (0.98-1.09) ^a	0.94 (0.84-1.06) ^b	0.99 (0.86-1.13) ^c	1.04 (0.93-1.18) ^d	1.21 (1.03-1.43)^e	1.07 (0.93-1.22) ^f
Cognitive Function x Caregiver Support†	1.01 (0.99-1.02) ^a	1.01 (0.98-1.05) ^b	1.03 (0.99-1.07) ^c	0.97 (0.93-1.01) ^d	1.01 (0.95-1.06) ^e	0.98 (0.95-1.01) ^f

*stepwise regression with cognitive status and caregiver support entered simultaneously, and the interaction term entered in a second step

†relative risk of initiation of lifestyle change for each 1-point decrease in TICS score for patients with caregivers versus those without, 95% CI not including 1.0 signal significant interaction

a- adjusted for race, employment, health literacy, anxiety, transitional quality, in-hospital cardiac catheterization, in-hospital CABG

b- adjusted for sex, ethnicity, diet quality, physical activity, transitional quality, in-hospital PCI

c- adjusted for race, education, depression, in-hospital cardiac catheterization

d- adjusted for age, ACS severity, patient activation, transitional quality

e- adjusted for age, race, health literacy, ACS severity, depression, social support, in-hospital percutaneous intervention

f- adjusted for health literacy, transitional quality

Appendix Table III.2. Changes in Lifestyle Behaviors among Patients Reporting Initiation of Lifestyle Changes at 1-month, by Cognitive Status and Caregiving Support

	Changes in Subjective Measures of Lifestyle Change				p
	Cognitively Intact Patients		Cognitively Impaired Patients		
	No Caregiving Support	Caregiving Support	No Caregiving Support	Caregiving Support	
Diet quality ^a	-3.1 (2.6)	-2.9 (2.7)	-1.8 (2.8)	-2.2 (3.4)	.15
Physical activity ^b	27 (15)	15 (14)	1 (10)	0(0)	.78
Smoking status ^c	37 (53)	22 (55)	6 (67)	1 (3)	.76
Stress level ^d	1.3 (3.2)	0.7 (3.5)	-0.2 (3.4)	-0.8 (3.9)	.12

a- mean change (SD) in "Starting the Conversation" dietary quality score (range=0-16, higher score indicates worse diet quality) from baseline to 1-month among patients who reported adhering to providers' recommendation to change diet

b- number (%) of patients achieving at least 150 minutes of exercise/week from baseline to 1-month among patients who reported adhering to providers' recommendation to increase physical activity

c- number (%) of patients reporting no cigarette use at one-month among smokers at baseline who reported adhering to providers' recommendation to quit smoking

d- mean change (SD) in Perceived Stress Scale (range=0-24, higher score indicates more stress) from baseline to one-month among patients who reported adhering to providers' recommendation to reduce stress

CHAPTER IV

CONGRUENCE OF PATIENT-CAREGIVER REPORTS OF INITIATION OF LIFESTYLE CHANGES FOLLOWING ACUTE CORONARY SYNDROME: ASSOCIATION WITH PATIENTS' IN-HOSPITAL COGNITIVE STATUS

Congruence of Patient-Caregiver Reports of Initiation of Lifestyle Changes Following Acute Coronary Syndrome: Association with Patients' In-hospital Cognitive Status

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IV.0 Abstract

Background: Accurate reporting by patients on initiation of lifestyle changes following acute coronary syndrome (ACS) is important clinically and for research, but the validity of self-report may be compromised in patients with lower cognitive function. We examined whether congruence between patients' and their caregivers' reports of lifestyle changes differed according to patients' cognitive function.

Methods: 78 ACS patients and their caregivers were interviewed one month after hospital discharge about the patient's initiation of five lifestyle changes: changing diet, exercising more, quitting smoking, reducing stress, and attending cardiac rehabilitation. Patients' cognitive function was assessed during hospitalization using the Telephone Interview for Cognitive Status (TICS; range=0-41, higher score=better cognition). McNemar's χ^2 and kappa statistics examined congruence of patients' and caregivers' reports of lifestyle changes. Poisson regression with robust error variance and ordinal regression estimated the association between cognitive function and congruence.

Results: Patients and caregivers exhibited reasonable agreement on reports of initiation of lifestyle changes except that caregivers reported initiation of stress reduction for 52% of patients while 83% of patients reported initiation (McNemar's $\chi^2=7.3$, $p=.012$). Each one-point decrease in TICS score reduced the likelihood of congruence on reports of exercising by 17% (RR=0.83, 95%CI=0.70-0.98) and reduced the odds of agreeing on all lifestyle changes by 23% (OR=0.77, 95%CI=0.60-0.98).

Conclusions: ACS patients and caregivers generally report similar rates of lifestyle change, but agreement decreases when patients have lower cognitive function. Collecting caregiver reports may be helpful in obtaining accurate reports of lifestyle change in ACS patients with lower cognitive function.

Words: 248

IV.1 Introduction

Acute coronary syndrome (ACS), a group of ischemic cardiovascular diseases including myocardial infarction and unstable angina, is a leading cause of death and disability in the United States². Although improvements in clinical treatment of ACS have increased short-term survival rates⁷, the risk for poor health outcomes such as recurrent cardiac events, morbidity, and mortality remains high for survivors.

Since approximately 90% of cardiovascular risk is attributed to modifiable risk factors¹⁵ (e.g., smoking, poor diet, sedentary lifestyle, and psychosocial stressors), health care providers often recommend lifestyle changes to ACS patients to improve their cardiovascular risk profiles¹⁰¹. Initiation of lifestyle changes such as following a heart healthy diet, increasing physical activity, quitting smoking, reducing stress and attending a cardiac rehabilitation program have been associated with substantial reductions in recurrent events and mortality among patients with CHD^{26,28-30}.

Given the influence of lifestyle changes on outcomes in ACS, it is important that providers be aware of whether their patients are adhering to their counsel to initiate these behaviors. Providers who know that their patients are not adhering to recommendations to initiate lifestyle changes may make an extra effort to motivate patients to comply, perhaps by explaining the risks of non-adherence or attempting to identify and overcome barriers to the patients' adherence^{102,103}. Since providers are not present in the daily lives of patients to witness their engagement in lifestyle changes, self-report by patients is often the only practical way providers can obtain this information. Therefore, it is important that providers be able to trust patients' reports

of lifestyle changes. Furthermore, as research becomes increasingly focused on the association of patient-reported factors with disease outcomes¹⁰⁴, ensuring the validity of self-report of lifestyle changes in patients with ACS is paramount to drawing valid conclusions about their association with outcomes.

One approach to assessing the validity of patient self-report is to compare it to reports from proxies. The term “proxy” in health research refers to a person who has an ongoing relationship with a patient, is knowledgeable about the patient’s condition or health, and can report on the patient’s behalf. Paid caregivers, such as visiting nurses, can serve as proxies, but more often the role of proxy is assumed by a family member or friend who has a close relationship with the patient and is involved in the day-to-day care of a patient’s condition. Proxy validation of patient self-report is ubiquitous in the literature, particularly when a patient’s ability to accurately self-report is potentially compromised by developmental or cognitive issues such as young age¹⁰⁵, depression^{106,107}, substance use¹⁰⁸, or cognitive impairment^{109,110}. Patients’ reports of outcomes such as functional status^{106,111}, disease symptoms^{109,112,113}, quality of life^{105,107,114}, and disease self-management^{115,116} have been compared to proxies’ reports in order to validate patient reports^{106,109} or, in some cases, to identify discrepancies between patient and proxy reports^{111,113,114}.

Caregivers of patients with ACS may serve as appropriate proxies against which patients’ reports of initiation of lifestyle changes can be compared. More than half of patients report receiving help from paid or unpaid caregivers in managing their disease⁵⁷ after a cardiac event. Caregivers of cardiac patients have been found to be

knowledgeable about, and extensively involved in, patients' disease management activities^{58,117}, and congruent patient-caregiver perspectives and shared decision-making regarding self-care have been linked to better disease management in heart failure¹¹⁸. However, patient-caregiver congruence on reports of initiation of lifestyle changes after ACS has not been examined, nor has the difference in congruence by cognitive function been described.

This study examined congruence between ACS patients' and caregivers' reports of the patients' initiation of lifestyle changes (making diet changes, increasing physical activity, quitting smoking, managing stress, and attending a cardiac rehabilitation program) in the month after discharge for ACS and compared congruence by level of cognitive function. We hypothesized that lower cognitive status would be associated with lower congruence on patient-caregiver reports of initiation of lifestyle changes.

IV.2 Methods

Sample

Patient Data. Data were drawn from the TRACE-CORE (Transition, Risks, and Actions in Coronary Events-Center for Outcomes Research and Education) Study, a large longitudinal observational study of 2300 ACS patients from six hospitals in Massachusetts and Georgia, and its ancillary sub-study, TRACE-CARE. Details of TRACE-CORE have been described elsewhere⁷¹. Potentially eligible patients were identified by daily screening of ACS-related ICD-9 codes 410 (AMI), 411 (unstable angina), and 412 (chronic CHD) in computerized hospital records and were approached in the hospital for

further screening of eligibility. To be included, patients must have had a diagnosis of ACS consistent with criteria outlined by the American College of Cardiology and American Heart Association^{16,17} and used in previous epidemiologic studies⁷²; cases in which the ACS diagnosis was unclear were adjudicated by a consensus panel. Additional eligibility criteria included age 21 years or older, ability to communicate in English or Spanish, and live hospital discharge after the index ACS event. Participants were excluded if they developed ACS secondary to another acute condition (e.g., surgery), screened positive for delirium by the Confusion Assessment Method⁷³, had documented dementia or delirium, were pregnant, imprisoned, expected to move out of the area within 18 months, or were admitted for palliative care only. Informed consent was obtained in writing from all participants and the study was approved by institutional review boards at all study sites. Participants completed an in-person baseline interview while in the hospital and a computer-assisted telephone interview at one month after discharge. Information about patient's demographic characteristics, lifestyle changes, cognitive status, psychosocial measures, and experience of care during their hospitalization were collected at baseline and follow-up by trained study staff. Clinical characteristics were obtained via medical record review.

Caregiver Data. Caregiver data were obtained from TRACE-CARE, an ancillary study of TRACE-CORE which captured additional data on a subsample of patients and their caregivers from the TRACE-CORE sites in Worcester, Massachusetts. TRACE-CARE was designed in part to collect pilot data from caregivers of ACS survivors for the purpose of exploratory analyses investigating caregiver support as a predictor of outcomes in

patients with ACS. Approximately two thirds of the 340 TRACE-CARE participants who identified a caregiver who had helped them with everyday tasks and disease management since discharge for their ACS event provided contact information for the caregiver. Caregivers were contacted by phone approximately one month after the patient's discharge. After agreeing to participate and providing informed consent, caregivers underwent a 45-minute interview to collect information on their perception of the patient's health, cognitive status, care needs, disease management behaviors, and relationship closeness.

Assessment of Cognitive Status

Patients' cognitive status was assessed during hospitalization using the Telephone Interview of Cognitive Status (TICS)⁷⁴, a validated 11-item global cognitive screening instrument that can be administered in-person or over the phone. The TICS has been used in large epidemiologic studies¹¹⁹ and is similar to the Mini Mental State Examination (MMSE) in discriminating mild cognitive impairment from normal cognition³⁶. TICS scores range from 0 to 41, with higher scores indicating better cognition.

Patient-reported Initiation of Lifestyle Changes

Data on patient-reported initiation of provider-recommended lifestyle changes (changing diet, increasing physical activity, quitting smoking, reducing or managing stress, and attending a cardiac rehabilitation program) were collected during a one-

month telephone follow-up interview. If a patient responded affirmatively to a question asking whether a provider (while in the hospital or after discharge) had recommended that the patient initiate a specific lifestyle change, the patient was then asked, “Which of the following best describes your thoughts about [initiating lifestyle change]? Would you say that you do not have plans to [initiate change], that you are thinking about [initiating change], or that you have started [initiating lifestyle change]?”. Patients who responded that they had started initiating a lifestyle change were classified as “yes” and patients who responded that they did not have plans to initiate a lifestyle change or were thinking about initiating a lifestyle change were classified as “no” to create dichotomous measures of initiation of lifestyle changes. Only patients who reported smoking at baseline were asked about provider recommendations to quit smoking.

Caregiver-reports of Patients’ Initiation of Lifestyle Changes

Caregiver reports of patient’s initiation of lifestyle changes were collected during a separate interview completed approximately one month after the patient’s discharge. Similar to the question asked of patients, caregivers were asked “Which of the following best describes [the patient’s name]’s thoughts about [initiating lifestyle change]? Would you say that [the patient] does not have plans to [initiate change], that [the patient] is thinking about [initiating change], or that [the patient] has started [initiating change]?” Caregivers who responded that the patient had started initiating a lifestyle change were classified as “yes” and caregivers who responded that the patient did not

have plans to initiate the behavior or were thinking about initiating the behavior were classified as “no”.

Measure of Patient-Caregiver Congruence in Reports of Initiation of Lifestyle Changes

Patient-caregiver congruence on reports of lifestyle changes was examined in two ways. First, congruence (yes/no) was assessed individually for each of the five lifestyle changes for which the patient reported receiving a recommendation. Second, a composite congruence score, ranging from 0%-100%, was calculated as the proportion of responses regarding initiation of lifestyle changes for which a dyad was congruent. Composite congruence scores were categorized into low, moderate and perfect congruence. Each dyad was classified as “perfectly congruent” if its composite congruence score was 100% (i.e., patients and caregivers were congruent on reports of all lifestyle changes), “moderately congruent” if congruence score was >50% but <100%, or “poorly congruent” if congruence score was ≤50%.

Covariates

Demographic data including age, sex, race, education, and marital status were collected via self-report during the baseline patient and caregiver interviews. Data on patients’ medical history, ACS type, and in-hospital procedures were obtained via electronic medical record abstraction; caregivers’ medical history was collected via self-report. ACS severity was calculated using the GRACE six-month mortality risk score⁷⁵. Patients’ and caregivers’ health literacy and numeracy were assessed using brief validated

screens^{77,78}. Depressive and anxiety symptoms were assessed with the Patient Health Questionnaire⁷⁹ (9-item scale in patients, 2-item scale in caregivers) and Generalized Anxiety Disorder scale⁸⁰ (7-item scale in patients, 2-item scale in caregivers), respectively, using a score ≥ 10 for patients (≥ 3 for caregivers) on both scales to signify high depressive or anxiety symptoms. Perceived stress was assessed in patients and caregivers with the 4-item Perceived Stress Scale⁸¹. Patients' social support was examined using the Lubben Social Network Scale⁸², with a cutoff of < 12 used to signal low social support. Patients' knowledge, skill, and confidence in managing their health was assessed using the 6-item Patient Activation Measure⁸³. Caregiving burden was measured in caregivers using the modified Zarit Burden Interview¹²⁰ with a score ≥ 8 signaling high caregiver burden. Hospital-to-home transition quality was assessed at 1-month in both patients and caregivers with the Care Transitions Measure¹²¹. Caregiver-reported relationship closeness with the patient was examined using the Relationship Closeness Scale^{122,123}.

Statistical Analyses

Patient-caregiver dyads with complete data on cognitive status and lifestyle changes were included in analyses. Analyses of variance, Kruskal-Wallis, and chi-square tests were used to examine differences in baseline characteristics between dyads with poor, moderate, and perfect congruence on reports of lifestyle changes; Cuzick's test¹²⁴ was applied to analyses of variance and Kruskal-Wallis tests and the Cochran-Armitage test¹²⁵ was applied to chi-square tests to examine linear trends across categories of

congruence. T-, Mann-Whitney U, and chi-square-tests were used to examine differences in covariates between congruent and incongruent dyads for each lifestyle change. Exact statistics were used as appropriate in analyses with small cell sizes. Proportion of positive agreement, proportion of negative agreement, McNemar's and kappa statistics were calculated to examine congruence between patients' and caregivers' reports of each lifestyle change; interpretation of the strength of association determined by kappa was based on criteria outlined by Landis and Koch¹²⁶.

To allow interpretation of regression results as the likelihood of patient-caregiver congruence on reports of lifestyle changes associated with lower cognitive function, TICS score was reversed and used as a continuous predictor in all regression analyses. To account for the common nature of each outcome and to allow reporting of relative risks, multivariable Poisson regression with robust error variance⁸⁵ was used to examine the association of cognitive status with the likelihood of patient-caregiver agreement on reports of lifestyle changes, controlling for potentially influential patient and caregiver characteristics. Ordinal logistic regression was used to examine the association of cognitive status with the three-level (low, moderate, perfect) congruence outcome. Inclusion of covariates in multivariable models was guided by the statistical significance of each covariate, with congruence on each lifestyle change, or with the three-level congruence outcome. Due to small sample size, a cutoff significance level of $p < .10$ for association with the congruence variables (i.e., the outcomes) was established for inclusion of covariates to create parsimonious multivariable models. As the main variable of interest, cognitive status was included as a predictor in all models regardless

of its association with the outcomes. Collinearity of variables was tested and only one variable was used when two variables displayed concordance >80%. Goodness of fit and the proportional odds assumption were tested using the Hosmer-Lemeshow and Brant tests, respectively.

Secondary analyses were performed to examine the association of patients' cognitive status with the likelihood of being in two groups: (1) dyads in which the patient reported a lifestyle change and the caregiver did not, or (2) dyads in which the caregiver reported a lifestyle change and the patient did not. Multinomial logistic regression was used to examine the association of cognitive status with likelihood of the patient or caregiver reporting initiation of lifestyle changes among incongruent dyads, using congruent dyads as the reference group. The purpose of these secondary analyses was to gain an understanding of which member of an incongruent dyad was more likely to report initiation of a lifestyle change in the context of decreasing cognitive status. All analyses were performed in Stata 12.1.

IV.3 Results

Sample Characteristics

Caregiver interviews were completed by 88 caregivers (family members and friends) of TRACE-CARE participants. Ten patient-caregiver dyads were excluded due to incomplete one-month patient interviews, leaving 78 dyads for analysis. Patients were primarily male (82%), white (91%) with a mean age of 60 (SD=10) years. Caregivers were also mostly white (96%) but were younger (mean age=57, SD=14) and more often

female (82%) than patients (Table IV.1). Caregivers were most often spouses of patients (85%) and the majority of patients and caregivers lived together (89%) or saw each other daily (91%). Almost one-third (30%) of patients and caregivers (28%) had at least a college degree. The most common ACS type in patients was NSTEMI (62%), followed by STEMI (21%) and unstable angina (18%). Patients' mean TICS score was 34 (SD=2.6) and only three patients (4%) were cognitively impaired during hospitalization. With the exception of anxiety, present in 22% and 24% of patients and caregivers, respectively, the prevalence of psychosocial issues (e.g., depression, high caregiver burden) was less than 10% among patients and caregivers. Patients and caregivers reported that the patient initiated an average of 1.9 (SD=1.3) and 1.7 (SD=1.1) of the average 2.5 (SD=1.3) recommendations for lifestyle changes in the month after discharge, respectively.

Patient-Caregiver Congruence on Reports of Initiation of All Lifestyle Changes

Six patients reported receiving no recommendations from a provider to initiate lifestyle changes and thus did not answer questions about initiation of lifestyle changes; these six dyads were not included in analyses of patient-caregiver congruence. Among the 72 remaining dyads, more than half (n=37, 51%) displayed perfect congruence, 18 (25%) displayed moderate congruence, and 17 (24%) displayed poor congruence in reports of lifestyle changes (Table IV.2). Baseline characteristics did not differ significantly among patients in poorly, moderately, and perfectly congruent dyads (Table IV.2). Caregiver-reported relationship closeness was associated with better congruence ($p=.012$ for trend; Table IV.3).

Patient-Caregiver Congruence on Reports of Initiation of Each Lifestyle change

Congruence of patient-caregiver reports were moderate to high for each of the five lifestyle changes, with agreement ranging from 62% for reducing stress to 87% for making dietary changes (Table IV.4). Only for patient and caregiver reports of initiating stress reduction/management was there a statistically significant difference in that 52% of caregivers reported that patients had initiated this lifestyle change whereas 83% of patients reported that they had done so (McNemar's $\chi^2=7.3$, $p=.012$). Kappa statistics ranged from 0.18 to 0.54 and were not statistically significant except for congruence on reports of attending a cardiac rehab program. This suggests that there was little agreement between reports of patients and caregivers beyond chance, except for attending cardiac rehab, where the agreement beyond chance was moderate ($\kappa=0.54$, 95%CI 0.30-0.78). However, since imbalances were noted in the marginal totals of the cross-tabulation tables of patient and caregiver reports of lifestyle changes, which is known to produce relatively low kappa statistics in spite of high percentage agreement¹²⁷, an examination of proportions of positive and negative agreement was indicated¹²⁸. Positive agreement is the proportion of agreement among all positive reports and negative agreement is the proportion of agreement among all negative reports. Proportions of positive agreement (PPA) for each lifestyle change ranged from 0.72 to 0.93, indicating good to very good positive agreement¹²⁶ between patients and caregivers on reports of lifestyle changes. Proportions of negative agreement (PNA) ranged from 0.25-0.72, indicating fair to good negative agreement. High PPAs and

lower PNAs indicate that patients and caregivers were good at agreeing about which lifestyle changes the patient initiated but struggled to agree on which lifestyle changes the patient did not initiate.

Patients' Cognitive Function and Composite Congruence

In bivariate analyses, a linear trend was noted for differences in baseline TICS score between patients in poorly, moderately, and perfectly congruent dyads (mean scores= 32.8, 33.8, and 34.4, respectively), but differences in scores were not statistically significant ($p=.07$; Table IV.2). After adjusting for patients' age, ACS severity, patients' anxiety, patients' perceived stress, caregivers' age, caregiver-reported hospital-to-home transitional quality, and relationship closeness, a one-point decrease in TICS score was associated with a 23% reduced odds of perfect congruence ($OR=0.77$, $95\%CI=0.60-0.98$) versus poor or moderate congruence (Table IV.5). In secondary analyses, lower baseline cognitive status was associated with an increased likelihood of patients reporting more lifestyle changes than their caregivers ($OR=1.23$, $95\%CI=1.00-1.52$ per one-point decrease in TICS score); this association was strengthened when reports of stress reduction (found to be differentially reported by patients and caregivers) were excluded ($RR=1.44$, $95\%CI=1.12-1.85$).

The only other statistically significant predictor of level of composite congruence was relationship closeness, with dyads reporting closer relationships having higher odds of perfect congruence than dyads reporting less close relationships ($OR=1.19$, $95\%CI 1.01-1.40$ per one-point increase on Relationship Closeness Scale; Appendix Table IV.1).

Patients' Cognitive Function and Congruence on Reports of Each Lifestyle Change

Lower cognitive function at baseline was associated with a decreased likelihood of congruence on reports of initiation of physical activity (RR=0.87, 95%CI 0.77-0.99 per one-point decrease in TICS score; Table IV.5). Results were similar after controlling for ACS severity, caregiver's education, sole caregiver status, and relationship closeness (RR=0.83, 95%CI 0.70-0.98). Cognitive status was not associated with congruence in other lifestyle changes. In secondary analyses, lower cognitive function was not associated with the likelihood that the patient reported initiation of physical activity changes when the caregiver did not.

Other variables associated with patient-caregiver congruence on reports of initiation of increases in physical activity included caregiver's education status, sole caregiver status, and relationship closeness (Appendix Table IV.1). Relationship closeness also positively predicted congruence of reports of quitting smoking between patients and caregivers.

IV.4 Discussion

We found that ACS patients and their caregivers were generally in good agreement regarding reports of patients' initiation of lifestyle changes one-month after hospital discharge. Congruence between patient-caregiver reports of making changes to reduce stress was lower than congruence for reports of other lifestyle changes, with patients reporting more stress reduction than caregivers. In this cohort, which excluded

demented patients by design, patients' cognitive status during hospitalization was associated with overall congruence of patient-caregiver reports of lifestyle changes and congruence on reports of initiation of physical activity, with lower cognition predicting lower congruence on these reports.

Our findings of moderate to good congruence in patient-caregiver dyads regarding initiation of lifestyle changes after ACS indicate that caregivers are knowledgeable about secondary preventive strategies being undertaken by patients, which puts them in a unique position to support patients in making most types of lifestyle changes. An exception to this may be caregivers' ability to acknowledge and support patients' efforts to reduce or manage stress. Stress reduction is largely an internal process that may not be as easily observed by caregivers compared to initiation of other lifestyle changes such as making diet changes or increasing physical activity. Improved communication between patients and caregivers regarding patients' attempts to reduce stress is warranted, as practical or social support from a caregiver may greatly help patients in achieving this lifestyle change.

Previous studies of cardiovascular disease management indicate that the burden of disease management does not fall solely on the patient's shoulders but is often a shared process^{118,129} between patient and caregiver. Agreement between patients and caregivers in perspectives and shared decision-making in disease management have been associated with better disease management and improved health status among patients with heart failure¹¹⁸, while incongruence in perspectives on disease management is considered a barrier to optimal disease management⁹¹. This study

provides evidence that patients and caregivers generally agree on patients' initiation of lifestyle changes after ACS, disease management activities that are extremely influential to prognosis in this population. Future research is warranted to evaluate the influence of patient-caregiver congruence on outcomes in patients with ACS.

We found that congruence in reports of lifestyle changes decreased as cognitive function decreased, despite the fact that cognitive status was higher in this pilot sample compared to the main TRACE-CORE sample and other ACS cohorts^{49,51}. Previous studies of the association of cognitive status with congruence of patient-caregiver reports^{110,111} have found that congruence is high among dyads in which the patient is mildly impaired but decreases sharply among dyads in which the patient is markedly impaired (e.g., from dementia or Alzheimer's), presumably due to the patient's inability to accurately self-report. Our findings suggest that even in a generally high functioning group of ACS survivors, lower cognitive function is associated with poorer congruence.

Patients with lower cognitive function may be more likely to over-report initiation of lifestyle changes than their caregivers, as evidenced in our secondary analyses of incongruent dyads which showed that patients with lower cognitive status were more likely to report initiating lifestyle changes than their caregivers. Alternatively, the association between patients' cognitive status and congruence on reports of lifestyle changes may be confounded or moderated by a factor not examined here, such as social desirability bias.

Clinical and Research Implications

This study provides evidence that, with the exception of changes in stress management, caregivers can accurately report on ACS patients' initiation of lifestyle changes and thus may be used as proxies in both clinical and research settings. From a clinical perspective, incongruence in reports of lifestyle changes may signal confusion in the dyad as to whether the patient is initiating the lifestyle change, poor communication within the dyad, or cognitive issues in the patient, any of which may negatively impact outcomes. From a research perspective, incongruence in patient-caregiver reports, such as that seen among dyads of patients with lower cognition, may call into question the validity of self-report of lifestyle changes and substantiate a need to use more objective, albeit costly, data collection methods to accurately obtain this information.

Strengths and Limitations

This study is strengthened by the use of data from the novel TRACE-CARE caregiver pilot study, one of the first studies to capture comprehensive data from the caregiver's perspective on experiences during and after hospitalization for ACS. We were able to examine congruence on five important lifestyle changes that are known to affect outcomes in ACS but are often neglected in secondary prevention research and provide new information about how patients' cognitive status during hospitalization may affect congruence. However, a number of limitations must be recognized. The small sample size likely resulted in reduced power to find significant predictors of congruence in this pilot study. We did not have data on objective measures of lifestyle change against which to judge the accuracy of patient and caregiver reports of lifestyle

change. We did not capture degree of social desirability bias in patients and caregivers, which is known to influence self-report and caregiver-report of health behaviors^{130,131}. Lastly, the cognitive status of caregivers was unknown, which could potentially impact their ability to reliably report their patients' lifestyle changes.

Conclusions

Patients and caregivers generally agree on patients' initiation of lifestyle change, but patients' cognitive status may influence these agreements. As the ACS population grows older and potentially more cognitively impaired, caregivers' knowledge of lifestyle changes may become critical to maintaining their patients' health and preventing poor outcomes. Future study of patient-, caregiver-, and relationship-related predictors of patient-caregiver congruence in reports of lifestyle changes in larger samples is warranted to identify and overcome barriers to lifestyle change in patients with ACS.

Table IV.1. Descriptive & Clinical Characteristics of Patients and Caregivers

Covariates	Patients (n=78)	Caregivers (n=78)
Age in years, mean (SD)	60 (11)	57 (14)
Age Group, n(%)		
<50	15 (19)	21 (27)
50-59	19 (24)	19 (25)
60-69	32 (41)	24 (31)
70-79	9 (12)	11 (14)
80+	3 (4)	2 (3)
Male Gender, n(%)	64 (82)	14 (18)
White Race, n(%)	71 (91)	74 (96)
College education or higher, n(%)	23 (30)	23 (28)
Health Literacy*, median(IQR)	1 (1-3)	1 (1-2)
Health Numeracy*, median(IQR)	2 (1-3)	2 (1-2)
Employed full-time, n(%)	30 (39)	21 (27)
Married, n(%)	68 (87)	66 (87)
ACS subtype, n(%)		
STEMI	16 (21)	-
NSTEMI	48 (62)	-
Unstable Angina	14 (18)	-
ACS Severity , GRACE Risk Score*, mean(SD)	93.4 (25)	-
History of cardiac disease†	63 (81)	31 (40)
Psychosocial Factors, n(%)		
Depressive symptoms	8 (10)	6 (8)
Anxiety symptoms	17 (22)	18 (24)
Above-average stress	31 (40)	35 (47)
Low social support	9 (12)	-
Cognitive impairment	3 (4)	-
TICS score during hospitalization, mean(SD)	33.7 (3)	-
Patient activation, ≥ “taking action” phase	30 (40)	-
High caregiving burden	-	6 (8)
Number of lifestyle changes reported as initiated, mean(SD)	1.9 (1.3)	1.7 (1.1)
In-hospital Procedures, n(%)		
Cath	78 (100)	-
CABG	11 (14)	-
Hospital Home Transition Quality*, mean(SD)	78 (20)	78 (17)
Caregiver’s Relationship to Patient, n(%)		
Spouse	-	66 (85))
Child	-	7 (9)
Caregiver’s Length of Relationship with patient in years, mean(SD)	-	33 (16)
Caregiver cohabitates with patient, n(%)	-	66 (89)
Frequency of contact with patient, at least daily, n(%)	-	69 (91)
Caregiver is patient’s sole caregiver, n(%)	-	55 (73)
Caregiver-patient Relationship Closeness*, mean(SD)	-	20 (3)

*Notes. “-” denotes data not available; health literacy and numeracy scores range=1-5, lower score denotes better literacy/numeracy; GRACE risk score range=0-263, higher denotes worse prognosis; transitional quality measured with Care Transitions Measure, range=0-100, high score denotes better transition; relationship closeness measured with Relationship Closeness Scale, range=0-24, higher score denotes closer relationship

†history of MI, heart failure, hypertension, coronary heart disease, or angina

Table IV.2. Patient Characteristics by Level of Agreement on Reports of Initiation of Lifestyle Changes

Covariates	Level of Congruence			P*
	Low (n=17)	Moderate (n=18)	Perfect (n=37)	
Age in years, mean(SD)	63 (11)	55 (11)	62 (9)	.55
Age >=65, n(%)	6 (35)	3 (17)	16 (43)	>.99
Male gender, n(%)	15 (88)	15 (83)	30 (81)	>.99
White race, n(%)	16 (100)	15 (83)	35 (95)	>.99
College education, n(%)	5 (29)	6 (33)	12 (32)	.99
Health literacy†, median(IQR)	1 (1-2)	2 (1-3)	1 (1-2)	.67
Health numeracy†, median(IQR)	2 (2-3)	2 (2-3)	2 (2-3)	.19
Married, n(%)	14 (82)	17 (94)	31 (84)	>.99
ACS subtype, n(%)				
STEMI	5 (29)	6 (33)	4 (11)	>.99
NSTEMI	8 (47)	10 (56)	25 (68)	
Unstable Angina	4 (24)	2 (11)	8 (22)	
GRACE risk score‡, mean(SD)	97 (30)	81 (23)	96 (21)	.44
Cardiac comorbidities‡, n(%)	15 (88)	13 (72)	30 (81)	>.99
TICS score†, mean(SD)	33 (3)	34 (3)	34 (2)	.07
Depressive symptoms, n(%)	2 (13)	2 (11)	3 (8)	.93
Anxiety symptoms, n(%)	5 (29)	6 (33)	4 (11)	.80
High stress, n(%)	9 (53)	9 (53)	10 (27)	.85
Low social support, n(%)	2 (13)	1 (6)	5 (14)	.97
High patient activation, n(%)	4 (24)	9 (50)	15 (42)	>.99
Care Transition Quality†, mean(SD)	74 (23)	81 (18)	79 (18)	.64
In-hospital procedures, n(%)				
Cath	17 (100)	18 (100)	37 (100)	>.99
CABG	2 (12)	1 (6)	8 (21.6)	>.99

*p-values are from tests for linear trends across groups of congruence

†health literacy and numeracy scores range=1-5, lower score denotes better literacy/numeracy; GRACE risk score range=0-263, higher denotes worse prognosis; cognition measured with Telephone Interview for Cognitive Status, score range=0-41, higher score denotes better cognition; transitional quality measured with Care Transitions Measure, range=0-100, high score denotes better transition

‡indicates history of MI, heart failure, hypertension, coronary heart disease, or angina

Table IV.3. Caregiver Characteristics by Level of Agreement on Reports of Initiation of Lifestyle Changes

	Level of Congruence			p*
	Low (n=17)	Moderate (n=18)	Perfect (n=37)	
Age, mean(SD)	61 (16)	51 (13)	57 (13)	.32
Age ≥65, n(%)	4 (50)	8 (30)	11 (31)	.99
Male gender, n(%)	4 (24)	3 (17)	5 (14)	>.99
White race, n(%)	17 (100)	18 (100)	34 (94)	>.99
College education, n(%)	7 (41)	5 (28)	9 (26)	.95
Health Literacy†, median(IQR)	1 (1-3)	1 (1-2)	1 (1-2)	.62
Health Numeracy, median(IQR)	2 (2-2)	1 (1-2)	2 (2-2)	.96
Married, n(%)	14 (88)	16 (89)	30 (83)	.99
Cardiac morbidity‡, n(%)	6 (38)	8 (44)	12 (33)	.98
Depressive symptoms, n(%)	0 (0)	3 (17)	3 (8)	>.99
Anxiety symptoms, n(%)	7 (47)	4 (22)	6 (17)	.67
High stress, n(%)	8 (53)	10 (56)	16 (44)	.99
High caregiver burden, n(%)	1 (8)	2 (11)	2 (6)	.94
Transitional Quality†, mean(SD)	71 (15)	81 (17)	81 (16)	.053
Spouse or partner of patient, n(%)	15 (88)	16 (89)	29 (78)	.83
Length of Relationship, mean(SD)	34 (16)	31 (15)	33 (16)	.97
Cohabitation with patient in years, n(%)	15 (88)	17 (94)	28 (85)	>.99
Frequency of contact, daily, n(%)	14 (88)	17 (100)	33 (89)	>.99
Caregiver is sole caregiver, n(%)	10 (63)	11 (61)	30 (83)	.83
Relationship closeness†, mean(SD)	18 (4)	20 (3)	21 (3)	.012

*p-values are from tests for linear trends across groups of congruence

† health literacy and numeracy scores range=1-5, lower score denotes better literacy/numeracy; transitional quality measured with Care Transitions Measure, range=0-100, high score denotes better transition; relationship closeness measured with Relationship Closeness Scale, range=0-24, higher score denotes closer relationship

‡ indicates history of MI, heart failure, hypertension, coronary heart disease, or angina

Table IV.4. Agreement of Patient and Caregiver Reports of Initiation of Individual Lifestyle Changes

Lifestyle Change	n*	Congruent Dyads, n(%)	McNemar's χ^2 (p-value)	PPA†	PNA‡	Kappa κ (95% CI)
Change the way you eat	45	39 (87)	0.7 (.69)	0.93	0.25	0.18 (-0.23-0.60)
Exercise more/be more active	37	25 (68)	3.0 (.15)	0.78	0.40	0.20 (-0.11-0.52)
Quit smoking	17	13 (77)	1.0 (.63)	0.86	0.33	0.21 (-0.31-0.73)
Reduce/manage stress	29	18 (62)	7.3 (.012)	0.72	0.42	0.22 (-0.05-0.50)
Attend cardiac rehab program	50	39 (78)	0.82 (.55)	0.82	0.72	0.54 (0.30-0.78)

*number of patients who reported receiving a recommendation for lifestyle change and thus were eligible to report initiation

†PPA=proportion of positive agreement

‡PNA=proportion of negative agreement

Table IV.5. Multivariable-adjusted Risk Ratios (RR) for Patient-Caregiver Congruence on Reports of Lifestyle Changes per 1-point Decrease in TICS score

Lifestyle Change	Change in Likelihood Congruence per 1-point decrease in TICS score RR (95% CI)	
	Unadjusted	Multivariable-adjusted*
Change diet	0.96 (0.90-1.03)	0.98 (0.92-1.05) ^a
Increase physical activity	0.87 (0.77-0.99)	0.83 (0.70-0.98)^b
Quit smoking	0.97 (0.86-1.10)	0.87 (0.72-1.05) ^c
Reduce or manage stress	0.98 (0.84-1.14)	0.99 (0.85-1.14) ^d
Attend cardiac rehab program	0.97 (0.91-1.03)	0.97 (0.91-1.03) ^e
Overall congruence [†]	0.83 (0.69-0.99)	0.77 (0.60-0.98)^f

*regression models contain all variables significant (p<.10) with congruence variables

† 3-level variable- defined dyads with low, moderate, and perfect congruence, result is OR derived from ordinal regression, rather than RR derived from Poisson regression

a- Adjusted for ACS severity and caregiver-reported transitional quality

b- Adjusted for ACS severity, caregiver's education, sole caregiving, relationship closeness

c- Adjusted for ACS type, caregiver burden, and relationship closeness

d- Adjusted for health numeracy and sole caregiver status

e- Adjusted for numeracy

f- Adjusted for patient's age, ACS severity, patient's anxiety, patient's stress, caregiver's age, caregiver's transitional quality, relationship closeness

Appendix Table IV.1- Multivariable-adjusted Risk Ratios (RR) for Association of Covariates with Patient-Caregiver Congruence on Reports of Lifestyle Changes

Model Covariates	Association with Patient and Caregiver Congruence in Reporting Initiation of SPBs RR (95%CI)					
	Overall Congruence‡	Change Diet	Increase Physical Activity	Quit Smoking	Reduce or Manage Stress	Attend Cardiac Rehab
Patient Characteristics						
Baseline TICS score*	0.77 (0.60-0.98)	0.98 (0.92-1.05)	0.83 (0.70-0.98)	0.87 (0.72-1.05)	0.99 (0.85-1.14)	0.97 (0.91-1.03)
age	1.02 (0.94-1.11)					
ACS category STEMI (ref) NSTEMI UA				-- 2.06 (0.68-6.24) 1.97 (0.64-6.07)		
GRACE	1.01 (0.98-1.04)	1.00 (0.99-1.00)	1.00 (0.99-1.01)			
Numeracy						0.81 (0.62-1.05)
Cardiac Comorbidities					1.96 (0.64-5.99)	
Anxiety	0.73 (0.20-2.74)					
Above average stress	0.72 (0.22-2.37)					
Caregiver Characteristics						
Age group>65	0.52 (0.13-2.02)					
College education			0.51 (0.27-0.98)	*		
High caregiver burden				1.22 (0.21-7.07)		
Transitional quality	1.01 (0.98-1.05)	1.01 (1.00-1.01)				
Caregiver is sole caregiver			2.86 (1.21-6.73)		4.61(0.70-30.24)	
Caregiver-patient relationship closeness	1.19 (1.01-1.40)		1.08 (1.00-1.16)	1.14 (1.00-1.31)		

*could not be examined due to perfect prediction of congruence

‡ 3-level variable- defined dyads as incongruent, partially congruent, or perfectly congruent, result is OR derived from ordinal regression

Chapter V
Discussion and Conclusion

V.1 Summary of Findings

The purpose of this dissertation was to address several important research questions that may help to inform the management of patients with comorbid acute coronary syndrome and cognitive impairment. Cognitive impairment is associated with increased morbidity and mortality after ACS, but the mechanisms by which cognitive status influences outcomes in ACS are not well understood. We hypothesized that cognitive status may impact outcomes following ACS by influencing a patient's ability to make lifestyle changes, such as improving diet, exercising more, quitting smoking, reducing stress, and attending cardiac rehabilitation. The specific aims of this dissertation were to examine ACS patients' cognitive status during hospitalization as a predictor of lifestyle changes at one-month post-discharge, to examine whether caregiver support moderated this association, and to assess the reliability of self-reported lifestyle changes in cognitively impaired patients through comparison with reports from their caregivers. These goals were accomplished by secondary analysis of data from the TRACE-CORE and TRACE-CARE studies, two prospective longitudinal studies of patients hospitalized for acute coronary syndrome. The rich data from TRACE-CORE and TRACE-CARE provided a unique opportunity to examine several aspects of the relationship between cognitive status and lifestyle change after ACS.

In the first aim we explored the association between cognitive status, collected via a validated and objective instrument, with patient-reported receipt of recommendations from providers to initiate lifestyle changes and initiation of these recommended lifestyle changes in 881 patients from the Massachusetts TRACE-CORE

sites. We found that 10% of the sample was cognitively impaired during hospitalization and that cognitive impairment was associated with lower patient-reported receipt of recommendation for and attendance at a cardiac rehabilitation program. This finding has important implications for the health of ACS patients with CI. Cardiac rehabilitation programs offer comprehensive information and support concerning disease management (e.g., managing medications, monitoring blood pressure) and lifestyle changes (e.g., dietary consultation, smoking cessation support) and is consistently associated with decreased mortality¹³² and improved cognition⁸⁷ in patients experiencing an acute coronary event. Since cognitive impairment during hospitalization may prevent patients from comprehending and remembering disease management education provided during discharge, these programs may be most beneficial to cognitively impaired patients by reinforcing lifestyle change goals and providing education about how to initiate these lifestyle changes. Lack of participation in cardiac rehabilitation by ACS patients with CI may contribute to their increased risk for poor outcomes.

In aim 1 we also found that cognitively impaired patients were not less likely to report receiving recommendations for and initiating changes to diet, physical activity, smoking status, or stress reduction than non-impaired patients. We proposed that cognitively impaired patients may not accurately report initiation of lifestyle changes. Misreporting by these patients may be due to memory problems or more furtive causes, such as social desirability or fear of discovery of cognitive impairment by caregivers, providers, and perhaps even research staff. Indeed, cognitively impaired patients with

heart failure have reported lying about or hiding concerns about their ability to perform self-care from family members and providers due to embarrassment, fear of discovery, or fear of loss of independence¹³³. Limited evidence also suggests that patients with cognitive impairment may be more susceptible to social desirability bias in reporting their ability to perform everyday tasks than patients with intact cognition. We also provided preliminary evidence that, even when they do initiate lifestyle changes, cognitively impaired patients may be less successful in making these changes than non-impaired patients, suggesting that they may benefit from more intensive and cognitively appropriate education¹³⁴ about how to initiate lifestyle changes to meaningfully improve their cardiovascular risk. Lastly, we proposed that our finding of a lack of differences in rates of initiation of lifestyle changes according to patients' cognitive status may be explained by cognitively impaired patients' receipt of caregiver support in making lifestyle changes.

To explore potential a potential reason for the generally null findings of aim 1, in aim 2 we used data from TRACE-CORE to investigate caregiver support as a moderator of the association of cognitive status with initiation of lifestyle changes. We hypothesized that cognitively impaired patients without caregiver support would report lower rates of lifestyle change than cognitively impaired patients with caregiver support. As expected, we found that caregiver support was independently associated with improved initiation of some lifestyle changes, but that this association was evident only in patients with intact cognition, not patients with CI. Patient-reported rates of lifestyle change did not differ between cognitively impaired patients with and without caregiver

support. Beyond the limited power to detect association in the modest size sample of cognitively impaired patients, we proposed several potential explanations for these apparently paradoxical results. First, cognitively intact patients may benefit more from help from caregivers in making lifestyle changes due to competing demands of their time and energy from work or family. Second, caregivers of cognitively impaired patients may be burdened with other caregiving duties, such as coordinating patient care or managing medications, and may not have the time or energy to help with initiation of lifestyle changes. Finally, as in aim 1, we proposed that our results may have been influenced by cognitively impaired patients' inaccurate reporting of initiation of lifestyle changes.

The last study in this dissertation aimed to answer a question brought forth by the findings of aims 1 and 2- can cognitively impaired patients accurately report on their initiation of lifestyle changes? In aim 3, we used data from 78 dyads from the novel TRACE-CARE pilot caregiver study to examine the reliability of cognitively impaired patients' self-reported initiation of lifestyle changes by comparing them with their caregivers' reports of the patients' initiation of lifestyle changes. In addition to finding that patients and caregivers displayed moderate to good congruence on reports of lifestyle change, we reported that patients' cognitive function was positively associated with patient-caregiver congruence, meaning that that congruence of patient-caregiver reports was lower among dyads in which the patient had lower cognitive function. Cognitively impaired patients tended to over-report initiation of lifestyle changes compared to their caregivers. These findings support our hypothesis generated in aims

1 and 2 of this dissertation that cognitively impaired patients may inaccurately report lifestyle changes after ACS.

V.2 Clinical Implications

The findings from this dissertation have a number of important clinical implications that could impact providers' management of ACS patients. First, based on evidence that cognitive impairment is prevalent in ACS and that cognitively impaired patients are at increased risk for poor outcomes and suboptimal participation in cardiac rehabilitation, providers should consider incorporating cognitive screening into standard care for ACS patients during hospitalization. Several brief, validated, and easy to administer diagnostic tools that are sensitive to cognitive changes commonly found in patients with vascular disease are available to clinicians¹³⁵.

Second, providers should be aware that patients with CI may be less likely to participate in cardiac rehabilitation than their non-impaired counterparts, which may put this vulnerable patient population at risk for poor outcomes. Providers should work with impaired patients (and their caregivers, if available) to identify and overcome barriers to participation. Provision of detailed, personalized, and cognitively-sensitive¹³⁴ information regarding lifestyle changes in patient discharge instructions¹³⁶ and more intensive post-discharge follow-up and education may improve rates of attendance at cardiac rehabilitation among patients with CI.

Third, providers should acknowledge the important role that caregiver support plays in initiation of lifestyle changes in patients with ACS. Detailed patient discharge

instructions or involvement of caregivers in patient-provider discussions about lifestyle changes may enable caregivers to be better informed about what lifestyle changes are indicated and how they can best help the patient to initiate these changes. However, since caregiver support appeared to benefit only cognitively intact patients in making lifestyle changes, more research is needed before concrete recommendations for involvement of caregivers in lifestyle changes of patients with ACS can be made.

Finally, providers should be aware that cognitively impaired patients may inaccurately report initiation of lifestyle changes, which may lead to an incorrect assessment of a patient's risk for recurrent events and other poor outcomes. Inaccurate reporting by cognitively impaired patients may even extend to other areas of disease management such as symptom recognition or medication adherence. Use of objective measures (e.g., physical activity measured via actigraphy) or proxy reports from family members and friends may be helpful to confirm cognitively impaired patients' reports of lifestyle behaviors after ACS.

V.3 Research Implications

In addition to the several clinical implications presented above, this dissertation identifies several opportunities for future research. Given the substantial prevalence of cognitive impairment in ACS (even in the TRACE-CORE sample which excluded demented patients by design) and its influence on outcomes, future studies examining predictors of outcomes in ACS should collect information on patients' cognitive status. Also, more research on the influence of caregiver support on lifestyle changes and

outcomes in patients with ACS is warranted. Support from caregivers is likely to become more prevalent and perhaps more impactful as the ACS population ages, but the existing literature on caregiver support in ACS is limited and somewhat conflicting. Future research that includes more detailed measures of caregiver support, including the amount and types of support received, and investigates these more finely characterized measures of caregiver support in the context of patients' cognitive status, will enable a deeper understanding of the influence of caregiver support in ACS, particularly in patients with cognitive impairment.

The unexpected and somewhat paradoxical findings of aims 1 and 2, along with the discovery of poorer patient-caregiver congruence in reports of lifestyle change in patients with lower cognitive function, points to a need to more closely examine the validity of self-reported lifestyle changes among cognitively compromised research subjects. The assurance of accurate reporting by cognitively impaired research subjects is especially salient in this time of increasing interest in patient-reported outcomes in cardiovascular research¹³⁷. Validation may be accomplished by comparing subjects' reports of lifestyle change with more objective measures of behaviors, such as physical activity measured with an accelerometer or smoking status assessed via serum cotinine levels. Although previous research has reported that memory impairment may not affect the validity of self-report until the impairment reaches a moderate or severe level¹³⁸, our results suggest otherwise. Patients with mild cognitive impairment may inaccurately report initiation of lifestyle changes for reasons other than memory impairment, such as having an inaccurate understanding of what successful initiation of

lifestyle change is or being heavily influenced by social desirability. Future studies should examine associations of cognitive status with conceptualization of successful lifestyle changes and social desirability bias. If reports of lifestyle changes by cognitively impaired patients are found to be invalid, the use of more objective measures or proxy reports may be indicated.

V.4 Strengths and Limitations

This dissertation is strengthened by the use of the large prospective longitudinal TRACE-CORE dataset which linked comprehensive demographic, clinical, and patient-reported data to psychosocial and clinical predictors of outcomes after ACS. Use of data from the novel TRACE-CARE caregiver pilot study allowed examination of characteristics of caregivers in ACS and comparison of patient and caregiver reports of lifestyle changes. We used a validated and widely used instrument to assess cognitive status during hospitalization, the time in which most patients receive discharge counseling regarding lifestyle changes. We examined patient-reported initiation of five lifestyle behaviors that are known to improve outcomes in ACS but are often neglected in secondary prevention research.

The findings of this dissertation should be interpreted in the context of several potential limitations. At the time of completion of this dissertation, data from participants at the TRACE-CORE Georgia sites were incomplete and thus these participants were not included in analyses. This limited our sample size and likely impacted the prevalence of cognitive impairment in our sample. This also limited the

generalizability of our findings to a primarily white population. Analyses using the full TRACE-CORE dataset will be performed before publication of aims 1 and 2. All reports of recommendation and initiation of lifestyle changes, as well as reports of caregiver support, were collected via self-report and thus may be subject to recall or social desirability bias. However, our findings add new information about potential biases introduced by self-report of cognitively impaired research subjects. Due to the exclusion of demented and delirious patients from TRACE-CORE, our sample of cognitively impaired patients was mostly mildly impaired and we were not able to assess the influence of moderate or severe CI on lifestyle changes. The loss of 21% of the initial sample used in aims 1 and 2 due to incomplete follow-up may have introduced selection bias, as patients with missing data at 1-month had lower cognition than included participants. However, this bias likely underestimated the association between cognitive status and initiation of lifestyle changes. We did not collect information from caregivers regarding providers' recommendation of lifestyle changes so we could not examine patient-caregiver congruence in reports of receipt of recommendation for lifestyle changes. We also did not assess caregivers' cognitive status, which may have affected their ability to accurately report on patients' lifestyle changes. The small number of cognitively impaired smokers (n=18) may have resulted in reduced power to detect significant differences in reported smoking cessation rates according to cognitive status. Finally, due to the observational nature of the study data, we cannot infer causal links between cognitive status and initiation of lifestyle changes, but hope that the research presented here prompts more robust investigations of this relationship.

V.6 Future Directions

In the near future I (A.H.) hope to replicate the findings of this dissertation in a sample of older myocardial infarction patients, where the prevalence of cognitive impairment may be higher and more severe, and their caregivers from a study currently taking place at another Center for Cardiovascular Outcomes Research (CCOR) site. I also hope to evaluate the association of cognitive status with outcomes including rehospitalization and mortality in this sample, examining engagement in secondary preventive behaviors (including lifestyle changes) and caregiver support as mediators or moderators of this association. Down the road, I hope to use a mixed methods approach (i.e., collect and examine quantitative and qualitative data) to elucidate barriers to lifestyle changes and other secondary preventive behaviors among cognitively impaired cardiac patients. Ultimately, I plan to use the results of this dissertation and future studies to inform the development of interventions tailored to the unique needs of cognitively impaired patients to their risk for poor outcomes after ACS.

V.7 Final Conclusions

This dissertation provides new evidence that ACS patients who are cognitively impaired during hospitalization may face challenges initiating certain secondary preventive lifestyle changes after discharge and also offers new insight into the potential challenges faced when examining self-reported outcomes in cognitively compromised populations. This research will be used as a foundation for future studies to elucidate the mechanisms by which cognitive impairment leads to poor outcomes after ACS.

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