**Association of Smoking Status With Angina and Health-Related Quality of Life After Acute Myocardial Infarction**

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**Background**—Smoking cessation after acute myocardial infarction (AMI) decreases the risk of recurrent AMI and mortality by 30% to 50%, but many patients continue to smoke. The association of smoking with angina and health-related quality of life (HRQOL) after AMI is unclear.

**Methods and Results**—Patients in 2 US multicenter AMI registries (n=4003) were assessed for smoking and HRQOL at admission and 1, 6, and 12 months after AMI. Angina and HRQOL were measured with the Seattle Angina Questionnaire and Short Form-12 Physical and Mental Component Scales. At admission, 29% never had smoked, 34% were former smokers (quit before AMI), and 37% were active smokers, of whom 46% quit by 1 year (recent quitters). In hierarchical, multivariable, regression models that adjusted for sociodemographic, clinical and treatment factors, never and former smokers had similar and the best HRQOL in all domains. Recent quitters had intermediate HRQOL levels, with angina and Short Form-12 Mental Component Scale scores similar to never smokers. Persistent smokers had worse HRQOL in all domains compared with never smokers and worse Short Form-12 Mental Component Scale scores than recent quitters.

**Conclusions**—Smoking after AMI is associated with more angina and worse HRQOL in all domains, whereas smokers who quit after AMI have similar angina levels and mental health as never smokers. These observations may help encourage patients to stop smoking after AMI. (**Circ Cardiovasc Qual Outcomes.** 2015;8:00-00. DOI: 10.1161/CIRCOUXTONES.114.001545.)

Key Words: angina pectoris ■ myocardial infarction ■ quality of life ■ smoking ■ smoking cessation

Smoking is common among patients presenting with acute myocardial infarction (AMI) and represents an important modifiable risk factor for recurrent events. Smoking cessation after AMI decreases the risk of recurrent MI and mortality by 30% to 50%. Although efforts to improve smoking cessation after AMI have become important performance measures for both hospitals and outpatient clinics, a large percentage of smokers do not quit after their AMI. Although current educational strategies focus on the risks of continued smoking, patients may be concerned that smoking cessation will lead to worse quality of life (eg, increased negative affect). Such concerns may lower patients’ motivation and success with quitting.

Patients recovering from an AMI currently have no information about how smoking cessation might alter their health status (their symptoms, function, and quality of life). Although it is well established that smoking after AMI is associated with a significantly greater risk of recurrent MI and mortality, there are few studies describing how smoking relates to health-related quality of life (HRQOL) in cardiac patients, despite HRQOL often being equally or more important to patients than longevity. Better illuminating the health status impact of continued smoking after AMI might support improved counseling of patients to quit.

To address this current gap in knowledge, we sought to describe the association between smoking status and patient HRQOL in a cohort of 4003 post-AMI subjects using data from 2 large, prospective, observational registries. Understanding the association of smoking cessation with HRQOL could have important implications for smoking prevention and the treatment of patients who are actively smoking at the time of AMI.

**Methods**

**Study Population and Protocol**

Our analytic cohort was derived from 2 consecutive multicenter, prospective cohort studies of patients hospitalized with AMI in the United States The Prospective Registry Evaluating Myocardial Infarction: Events and Recovery (PREMIER) study enrolled 2498 patients with AMI from 19 US hospitals between January 2003 and June 2004. Similarly, 4340 patients with AMI from 24 US hospitals were enrolled into the Translational Research Investigating Underlying disparities in acute Myocardial infarction Patients’ Health Status (TRIUMPH)
WHAT IS KNOWN

- Smoking is common among patients presenting with acute myocardial infarction (AMI) and many patients continue to smoke after their AMI.
- Although it has been well established that smoking cessation after AMI decreases the risk of recurrent MI and mortality, the association of smoking with angina and health-related quality of life after AMI is unclear.

WHAT THE STUDY ADDS

- There is a gradation of more angina and worse disease specific and generic health-related quality of life across smoking status groups from never smokers having the best health status and persistent smokers the worst.
- Those who quit smoking before their AMI were similar to those who had never smoked in all health-related quality of life domains.
- Within only 1 year, those who quit smoking after their AMI had less angina and improved general mental health, similar to levels of those who had never smoked.

Smoking Status
Smoking was assessed at baseline and each follow-up time point using the following options: (1) I have never smoked, not even a puff, (2) I have smoked in the past but <100 cigarettes in total, (3) I stopped smoking >1 year ago, (4) I stopped smoking between 1 month and 1 year ago, and (5) I have smoked (even a puff) in the past 30 days. At baseline, responses (1) and (2) were categorized as never smokers. Responses (3) and (4) were categorized as former smokers, and response (5) was categorized as current smokers. Those who were current smokers at baseline were then reclassified based on their 1-year follow-up interview responses. At 1 year, those who responded that they had quit in the past year were designated as recent quitters, whereas those who continued to smoke were designated as persistent smokers. Patients with inconsistent answers at baseline and 1 year (eg, reported being a former smoker at baseline and never smoker at 1 year) and patients who started smoking during the year (eg, reported being a former smoker at baseline and a current smoker at 1 year) were excluded from the analyses.

Health-Related Quality of Life
Disease specific and generic HRQOL were measured using the Seattle Angina Questionnaire (SAQ) and the Medical Outcomes Study 12-item Short Form (SF-12). The SAQ is a reliable, responsive, and valid 19-item questionnaire that assesses the symptoms, function, and quality of life (QOL) of patients with coronary artery disease and has been shown to be associated with mortality, admission for acute coronary syndrome, and healthcare costs. For this study, we focused on the SAQ angina frequency and QOL domains. Scores range from 0 to 100, with higher scores indicating less disease burden. On the basis of previous work, SAQ angina frequency was categorized into the clinically interpretable framework of no (score 100) versus any (score <100) angina. The SF-12 is a reliable and valid measure of generic health status that provides summary component scales for overall physical (PCS) and mental (MCS) health. Scores are standardized using norm-based methods to a mean of 50 and a SD of 10 with higher scores indicating better health status.

Statistical Analysis
The purpose of these analyses was to describe the association between smoking status and patient HRQOL 1 year after AMI. Baseline characteristics and post-AMI treatment of the 4 smoking groups (defined at the 12-month time point as never smokers, former smokers, recent quitters, and persistent smokers) were compared using the χ2 test for categorical variables and 1-way ANOVA for continuous variables. To describe the HRQOL profile during the course of 1 year after MI, we conducted a multivariable regression model to assess the independent association of 1-year smoking status with HRQOL at 1 year after AMI. All models were hierarchical with site entered as a random effect to account for clustering of patients within sites. Models were logistic (SAQ angina) or linear (SAQ QOL and SF-12), as appropriate. For all models, never smokers were used as the reference group and then recent quitters were also compared with persistent smokers. Because smoking might be associated with several factors that may also affect HRQOL, we performed sequential multivariable adjustment to better examine the effect of adjustment on the independent association between smoking and HRQOL.

We tested for factors in the order of basic demographics (age, sex, and race), clinical comorbidities (hypertension, diabetes mellitus, previous MI, previous angioplasty, previous bypass graft surgery, heart failure, ST elevations at presentation, LV systolic dysfunction [ejection fraction <40%], lung disease, hypercholesterolemia, and history of renal failure), treatment during the index hospitalization (angioplasty, bypass graft surgery, and % of quality of care measures received [eg, timely reperfusion for ST elevations, β-blocker at discharge, etc.]), post-MI treatment during the year after the index hospitalization (revascularization within 1 year; whether the patient was prescribed antiplatelet, β-blocker, statin, or angiotensin-converting enzyme inhibitor or angiotensin II receptor blocker therapy and whether the patient reported taking these medications at follow-up; and patient report of participation in cardiovascular rehabilitation), sociodemographic characteristics (marital status, education, insurance status, self-reported monthly financial reserve, and self-reported avoiding medication due to costs), and psychosocial characteristics of social support (assessed with the Enhancing Recovery in Coronary Heart Disease [ENRICHD] Social Support Inventory) and symptoms of depression (assessed with the 9-item Patient Health Questionnaire).

Baseline data were fairly complete, with only 22% missing 1 year of follow-up data. All statistical analyses were conducted using SAS Version 9.3 (SAS Institute, Cary, NC), IVEware (University of Michigan, MI), and R Version 2.11.1 (Free Software Foundation, Boston, MA). All tests for statistical significance were 2-tailed and were evaluated at a significance level of 0.05.
Results

Patient Population
Among the 6838 patients included in TRIUMPH and PREMIER, baseline smoking status was obtained on 6780. We excluded 148 patients who were not discharged alive to home and 422 patients who did not survive to the 1-year interview. In addition, we excluded 1585 (23%) patients who did not participate in the 1-year interview, 167 patients who participated in the interview but did not report 1-year smoking status or HRQOL, and 455 patients who gave inconsistent smoking status answers (n=393; eg, reported being a former smoker at baseline but at 1 year reported having never smoked) or who started smoking during the year after AMI (n=62). As such, the final analytic cohort was comprised 4003 patients (Figure 1).

Patients who were excluded because of missing or inconsistent smoking status data (n=2207), when compared with those included in the analysis (n=4003), were more likely to be younger, non-white, have poorer socioeconomic status, have cardiac and noncardiac comorbidities, undergo less revascularization, and take less cardiac medications (Table I in the Data Supplement). However, there was no difference in baseline smoking status between those with and without missing/inconsistent data (P=0.116).

Description of Smoking Groups
At the time of admission for AMI, 29% of patients reported that they were life-long nonsmokers, 34% were former smokers (ie, quit previous AMI), and 37% had smoked within 30 days of the AMI. Of those currently smoking at the time of their AMI, 46% quit smoking during the year after their AMI and were classified as recent quitters, whereas 54% were persistent smokers 1 year after their AMI. The baseline characteristics and post-AMI treatment of never smokers, former smokers, recent quitters, and persistent smokers are presented in Table. There were numerous differences among the 4 smoking status groups. For example, those who were smoking at the time of their MI, compared with those who were not, tended to be about 10 years younger, unmarried, less educated, of lower socioeconomic status, have higher depression scores, and have less comorbidities. They were also more likely to present with an ST-segment–elevation MI and be treated with percutaneous coronary intervention during their index hospitalization, but less likely to participate in cardiac rehabilitation after their AMI.

Unadjusted Analyses at Baseline, 1, 6, and 12 Months
Overall, all groups showed improvement from baseline to 1 year in SAQ angina, SAQ QOL, and SF-12 MCS, but little or no improvement in SF-12 PCS. In unadjusted comparisons, there were statistically significant differences (P<0.001) across the 4 smoking status groups for each HRQOL domain at baseline and 1, 6, and 12 months after AMI. At each separate time point, there was a gradation of more angina and worse disease-specific and generic HRQOL across the 4 smoking status groups from never smokers having the best health status and persistent smokers the worst (Table II and Figure I in the Data Supplement).

Multivariable Analyses of 1-Year Smoking Status and 1-Year HRQOL Domains
The associations between smoking status and each domain of 1-year HRQOL were somewhat attenuated at each step of sequential adjustment, but no particular step drastically changed the step-wise associations between smoking status and 1-year HRQOL, indicating that no particular factor category accounted for a greater portion of variance in the sequential analysis than other categories (Figure II in the Data Supplement). Thus, the final fully adjusted models are shown as the primary results (Figure 2A–2D). In the fully adjusted models with never smokers as the reference group, former smokers were statistically similar to never smokers for all HRQOL domains. Recent quitters varied in the degree they were similar to and different from never smokers, depending on the HRQOL domain. There were no statistically significant differences between recent quitters and never smokers in the odds of having angina at 1 year (Figure 2A) and in SF-12 MCS scores (Figure 2D). Recent quitters had worse SAQ QOL and SF-12 PCS scores compared with never smokers, having a 2.7 points lower score on the SAQ QOL scale (95% confidence interval [CI], −4.5 to −0.9; P=0.003) and a 2.3 points lower score on the SF-12 PCS (95% CI, −3.4 to −1.2; P<0.001; Figures 2B and 2C). Persistent smokers had worse HRQOL than never smokers for all domains. Persistent smokers had a 1.5-fold increased odds of having angina at 1 year when compared with never smokers (95% CI, 1.1–1.9; P=0.003), 3.5 points lower scores on the SAQ QOL scale (95% CI, −5.2 to −1.7; P<0.001), 1.6 points less on the SF-12 PCS (95% CI, −2.7 to −0.5; P=0.003), and 2.3 points less on the SF-12 MCS (95% CI, −3.3 to −1.4; P<0.001; Figures 2A–2D).

In fully adjusted models comparing recent quitters with persistent smokers, recent quitters were statistically
similar to persistent smokers for angina (P=0.298), SAQ QOL (P=0.411), and SF-12 PCS (P=0.220; Figures 2A–2C).

However, recent quitters had better SF-12 MCS scores compared with persistent smokers (P<0.0001; Figure 2D).

### Discussion
In a large, multicenter cohort of patients with AMI, we found a gradation in the association of smoking status with angina and HRQOL. Those who had never smoked had the least angina and the best disease-specific and general HRQOL. On the basis of adjusted analyses, those who quit before their AMI (former smokers) were similar to those who had never smoked in all HRQOL domains. In contrast, those who continued to smoke after their AMI (persistent smokers) were significantly worse than those who had never smoked in all HRQOL domains. Those who quit smoking after their AMI (recent quitters) had intermediate levels of HRQOL, with their experience of angina and mental health status being similar

### Table. Comparison of Baseline Characteristics and Post-AMI Treatment by 1-Year Smoking Status

<table>
<thead>
<tr>
<th>Smoking Status</th>
<th>Never Smoked, n=1145</th>
<th>Former Smokers, n=1374</th>
<th>Recent Quitters, n=683</th>
<th>Persistent Smokers, n=801</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic Demographics</strong></td>
<td></td>
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</tr>
<tr>
<td>Age</td>
<td>62.8±13.3</td>
<td>64.1±10.7</td>
<td>54.6±9.8</td>
<td>54.6±9.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Men</td>
<td>55.4%</td>
<td>74.9%</td>
<td>71.2%</td>
<td>66.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>White</td>
<td>75.7%</td>
<td>84.0%</td>
<td>72.7%</td>
<td>69.8%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Sociodemographics</strong></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Marriage</td>
<td>63.1%</td>
<td>69.5%</td>
<td>59.7%</td>
<td>45.9%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;High-school education</td>
<td>41.3%</td>
<td>44.9%</td>
<td>50.4%</td>
<td>57.5%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Insurance coverage for medications</td>
<td>81.0%</td>
<td>82.8%</td>
<td>72.6%</td>
<td>66.5%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Monthly financial situation not enough to make ends meet</td>
<td>12.6%</td>
<td>10.3%</td>
<td>18.6%</td>
<td>27.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Avoided healthcare because of cost</td>
<td>14.7%</td>
<td>13.8%</td>
<td>25.7%</td>
<td>34.6%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Psychosocial factors</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENRICHD Social Support Score</td>
<td>22.7±3.7</td>
<td>22.7±3.7</td>
<td>22.1±4.1</td>
<td>21.2±5.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PHQ Depression Score</td>
<td>4.5±4.9</td>
<td>4.7±4.9</td>
<td>5.2±5.3</td>
<td>6.4±5.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Clinical comorbidities</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>65.5%</td>
<td>68.2%</td>
<td>52.4%</td>
<td>58.8%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>30.9%</td>
<td>30.9%</td>
<td>20.5%</td>
<td>20.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Previous MI</td>
<td>17.4%</td>
<td>22.6%</td>
<td>12.3%</td>
<td>10.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Previous PCI</td>
<td>15.5%</td>
<td>23.3%</td>
<td>11.7%</td>
<td>7.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>12.1%</td>
<td>17.8%</td>
<td>5.4%</td>
<td>6.9%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>7.8%</td>
<td>8.9%</td>
<td>2.9%</td>
<td>6.5%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>STEMI</td>
<td>41.5%</td>
<td>42.3%</td>
<td>58.7%</td>
<td>49.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LV systolic dysfunction</td>
<td>18.8%</td>
<td>20.4%</td>
<td>20.1%</td>
<td>17.8%</td>
<td>0.425</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>51.9%</td>
<td>67.0%</td>
<td>41.0%</td>
<td>44.6%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic renal failure</td>
<td>7.7%</td>
<td>8.2%</td>
<td>2.5%</td>
<td>4.1%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic lung disease</td>
<td>6.7%</td>
<td>10.1%</td>
<td>7.0%</td>
<td>10.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Treatment during index hospitalization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>In-hospital PCI</td>
<td>63.2%</td>
<td>66.7%</td>
<td>75.8%</td>
<td>72.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>In-hospital CABG</td>
<td>10.7%</td>
<td>13.0%</td>
<td>12.2%</td>
<td>6.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;100% of Quality of care measures received</td>
<td>27.3%</td>
<td>29.3%</td>
<td>41.3%</td>
<td>40.1%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Post-MI treatment within 1 y of index hospitalization</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Revascularization</td>
<td>7.2%</td>
<td>8.2%</td>
<td>7.9%</td>
<td>6.4%</td>
<td>0.459</td>
</tr>
<tr>
<td>Antiplatelet use</td>
<td>83.1%</td>
<td>87.8%</td>
<td>90.7%</td>
<td>85.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>β-blocker use</td>
<td>71.0%</td>
<td>73.8%</td>
<td>75.4%</td>
<td>68.8%</td>
<td>0.022</td>
</tr>
<tr>
<td>Statin use</td>
<td>64.8%</td>
<td>69.0%</td>
<td>71.5%</td>
<td>63.7%</td>
<td>0.003</td>
</tr>
<tr>
<td>ACE/ARB use</td>
<td>50.5%</td>
<td>51.0%</td>
<td>56.7%</td>
<td>53.1%</td>
<td>0.061</td>
</tr>
<tr>
<td>Cardiac rehabilitation</td>
<td>54.3%</td>
<td>54.2%</td>
<td>50.8%</td>
<td>35.0%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Continuous variables were compared using 1-way ANOVA. Categorical variables were compared using χ² or Fisher exact test.

ACE indicates angiotensin-converting enzyme; AMI, acute myocardial infarction; ARB, angiotensin II receptor blocker; CABG, coronary artery bypass grafting; ENRICHD, Enhancing Recovery in Coronary Heart Disease; LV, left ventricle; PCI, percutaneous coronary intervention; PHQ, patient health questionnaire; and STEMI, ST-segment–elevation MI.
to those who never smoked. Furthermore, recent quitters had markedly better general mental health than persistent smokers.

Our findings support and extend previous studies that have reported smoking to be associated with poorer HRQOL\(^9,10,12\); whereas other studies have reported that smoking is not associated with HRQOL\(^13\) and that smoking cessation may, in fact, be associated with poorer HRQOL for some patients.\(^14\) In terms of disease-specific HRQOL, our findings complement those from studies of patients undergoing percutaneous coronary intervention, which demonstrated that never and former smokers have similar levels of angina and angina-related quality of life that are significantly better than that of those who persist in smoking.\(^10,11\) Jang et al.\(^11\) further found that patients who quit smoking within 1 year after percutaneous coronary intervention had less angina than those who continued to smoke. In our study, although recent quitters and persistent smokers still had similar levels of angina, recent quitters did not have more angina compared with never smokers, whereas persistent smokers had more angina than never smokers.

There are several potential mechanisms underlying the association between smoking and angina. Exposure to toxic compounds contained in cigarette smoke causes free radical-mediated oxidative stress and decreased nitric oxide bioavailability resulting in decreased endothelium-dependent vasodilatation.\(^29-32\) Studies have shown that smoking increases mean platelet volume, platelet activation, platelet aggregation and nonresponsiveness to clopidogrel.\(^33-36\) Smoking also causes endothelial damage and activation of inflammation pathways resulting in increased expression of proinflammatory cytokines, adhesion molecules, and other prothrombotic factors.\(^37-39\) Damage to the endothelium allows the subendothelium to be exposed to these factors as well as platelets with increased activity and the overall result can promote thrombus formation. Moreover, in patients with coronary artery disease, smoking has been associated with increased adrenergic tone and increased coronary vasospasm.\(^37,40\)

In terms of general HRQOL, our results are also consistent with those of Stafford et al.\(^15\) who looked at this association in a broad group of patients with coronary artery disease and showed a stronger inverse association between smoking status and general mental health than with general physical health. In our study, even after adjusting for social support and depressive symptoms, the general mental health status of both former and recent quitters was similar to that of never smokers. Furthermore, recent quitters had substantially better general mental health status than persistent smokers. Our findings are also consistent with a recent systematic review and meta-analysis that concluded that smoking cessation is associated
with improved mental health compared with continued smoking in both general and clinical populations.\textsuperscript{41} There are likely to be complex mechanisms underlying the association of smoking and poor mental health that involve biological, behavioral, and environmental factors. For example, there is evidence of shared biological pathways of both smoking and depression with coronary artery disease as smoking has been associated with oxidative stress\textsuperscript{42} and increases in C-reactive protein-induced inflammation,\textsuperscript{43} which have been depicted in the pathophysiology of both depression and cardiovascular disorders.\textsuperscript{44–47}

Similar to the approach of De Smedt et al\textsuperscript{2} and Jang et al,\textsuperscript{11} our study extends the insights from previous studies on smoking status and HRQOL in patients with coronary heart disease by comparing HRQOL across 4 smoking status categories that address the full smoking status spectrum: never smokers, former smokers (quit before AMI), recent quitters (quit after AMI), and persistent smokers (continued to smoke after AMI). However, in contrast to previous studies, our study included only subjects with AMI and is, therefore, directly relevant to post-AMI patients. Furthermore, our study used HRQOL measures specific to coronary artery disease, which greatly strengthens our findings and conclusions because they are specific to patients with AMI who smoke. In fact, our study is the largest known study to examine the disease-specific manifestations of continued smoking after AMI.

It is important to interpret our findings through a clinical framework. In our attempt to isolate the effect of smoking with HRQOL, we knowingly adjusted for multiple covariates that are associated with both smoking and HRQOL (eg, depression and socioeconomic status). As such, the small group differences in the multivariable analyses are potentially because of overadjustment and the complex inter-relationships between smoking and other variables, such as depressive symptoms, may underestimate the HRQOL benefits of quitting smoking (eg, patients who quit may also become less depressed). In addition, it should be noted that the HRQOL mean differences are reported at the population level rather than at a patient level. As such, our findings likely indicate that smoking cessation is associated with a large HRQOL improvement in some patients, whereas others may have no benefit. Finally, noting that former smokers were statistically similar to never smokers indicates that there may be a time-dependent effect of smoking on health status. Patients categorized as recent quitters could have quit just over 30 days before their 1-year follow-up interview after their AMI and yet it could be that longer durations of smoking cessation are associated with better HRQOL. Understanding the long-term effect of smoking cessation on HRQOL and the time-dependence of this effect will require longer study. However, even in the absence of large improvements in HRQOL with smoking cessation, we have, at a minimum, shown that smoking cessation is not associated with worse HRQOL. In addition, our results—showing better mental health for those who quit smoking—may provide helpful information for those concerned that smoking cessation may have a detrimental effect on mental health. Our results must be interpreted in light of several study limitations. First, patient self-report was used to determine smoking status and these reports were not accompanied with biochemical measures for confirmation. However, research shows that self-report is a valid indicator of current smoking, especially when there are no strong incentives to deceive.\textsuperscript{48,49} Second, some studies have shown that decreasing intensity (pack-years or number of cigarettes per day) can improve HRQOL.\textsuperscript{1} Because we did not assess intensity of smoking, we cannot comment on whether there were differences in angina and HRQOL within the current smoker group associated with different smoking intensity subgroups. Third, we excluded a large number of subjects because of missing or inconsistent data. This could limit study generalizability and introduce possible selection bias because those excluded for missing/inconsistent data did differ from those included on several baseline characteristics and treatment factors that could be associated with smoking cessation and HRQOL. However, those excluded for missing/inconsistent data did not differ in baseline smoking status when compared with those we included. Finally, although we adjusted for many clinical and sociodemographic factors that may confound the association between HRQOL and smoking, there is always the potential for unmeasured confounding in any observational study.

In conclusion, we observed, in a large multicenter cohort of post-AMI patients, that persistent smoking after the AMI is associated with significantly more angina and worse disease-specific and general HRQOL. Those who quit smoking before their AMI were similar to those who had never smoked in all HRQOL domains. Within 1 year, the odds of having angina and the general mental health status of those who quit smoking after their AMI was also similar to those who had never smoked. Further study of the time-dependent effect of longer-term smoking cessation on HRQOL might determine if those who quit smoking after their AMI might see benefits in additional areas of HRQOL with increased time of abstinence. Our findings provide unique information to post-AMI patients and should provide strong support for counseling patients about how smoking cessation not only reduces the risk of MI and death but is also associated with better health status over time. As such, these observations may offer current smokers increased incentive and motivation for quitting.

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Disclosures
Dr Spertus owns the copyright for the Seattle Angina Questionnaire.

References


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Donna M. Buchanan, Suzanne V. Arnold, Kensey L. Gosch, Philip G. Jones, Lance S. Longmore, John A. Spertus and Sharon Cresci

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http://circoutcomes.ahajournals.org/content/suppl/2015/08/25/CIRCOUTCOMES.114.001545.DC1

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SUPPLEMENTAL MATERIAL
## Supplemental Table 1. Comparison of Baseline Characteristics and Treatment for Those Included vs. Excluded due to Missing or Inconsistent 1-year Smoking Status Data

<table>
<thead>
<tr>
<th></th>
<th>Included n = 4003</th>
<th>Excluded n = 2207</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Smoking Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never Smoked</td>
<td>28.6%</td>
<td>28.1%</td>
<td>0.116</td>
</tr>
<tr>
<td>Former Smoker</td>
<td>34.3%</td>
<td>32.3%</td>
<td></td>
</tr>
<tr>
<td>Current Smoker</td>
<td>37.1%</td>
<td>39.6%</td>
<td></td>
</tr>
<tr>
<td><strong>Basic Demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>60.2 ± 12.0</td>
<td>57.3 ± 13.0</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Male</td>
<td>67.0%</td>
<td>68.1%</td>
<td>0.386</td>
</tr>
<tr>
<td>Caucasian</td>
<td>76.9%</td>
<td>60.4%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td><strong>Sociodemographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marriage</td>
<td>61.3%</td>
<td>47.5%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Less than high school education</td>
<td>47.3%</td>
<td>55.9%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Insurance coverage for medications</td>
<td>77.3%</td>
<td>67.0%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Monthly financial situation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not enough to make ends meet</td>
<td>15.9%</td>
<td>23.7%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Avoided health care due to cost</td>
<td>20.2%</td>
<td>28.2%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td><strong>Psychosocial factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENRICHD Social Support Score</td>
<td>22.3 ± 4.1</td>
<td>21.4 ± 5.0</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>PHQ Depression Score</td>
<td>5.1 ± 5.2</td>
<td>5.6 ± 5.6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td><strong>Clinical Co-morbidities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>62.9%</td>
<td>66.6%</td>
<td>0.003</td>
</tr>
<tr>
<td>Diabetes</td>
<td>27.0%</td>
<td>31.0%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Prior MI</td>
<td>18.9%</td>
<td>21.8%</td>
<td>0.006</td>
</tr>
<tr>
<td>Prior PCI</td>
<td>17.9%</td>
<td>19.8%</td>
<td>0.067</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>11.9%</td>
<td>10.1%</td>
<td>0.041</td>
</tr>
<tr>
<td>Congestive Heart Failure</td>
<td>7.1%</td>
<td>10.3%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>STEMI</td>
<td>46.3%</td>
<td>41.8%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>LV systolic dysfunction</td>
<td>19.4%</td>
<td>21.2%</td>
<td>0.093</td>
</tr>
<tr>
<td>Health Condition</td>
<td>Site A</td>
<td>Site B</td>
<td>p-value</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>50.3%</td>
<td>45.7%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Chronic Renal Failure</td>
<td>6.2%</td>
<td>8.2%</td>
<td>0.005</td>
</tr>
<tr>
<td>Chronic Lung Disease</td>
<td>8.4%</td>
<td>9.0%</td>
<td>0.383</td>
</tr>
</tbody>
</table>

### Treatment during index hospitalization

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Site A</th>
<th>Site B</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital PCI</td>
<td>68.4%</td>
<td>62.0%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>In-hospital CABG</td>
<td>10.8%</td>
<td>9.1%</td>
<td>0.027</td>
</tr>
<tr>
<td>&lt;100% of Quality of Care Measures</td>
<td>32.9%</td>
<td>36.2%</td>
<td>0.009</td>
</tr>
</tbody>
</table>

### Post-MI treatment within 1 year of index hospitalization

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Site A</th>
<th>Site B</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revascularization</td>
<td>7.5%</td>
<td>3.6%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Antiplatelet use</td>
<td>86.5%</td>
<td>66.4%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Beta blocker use</td>
<td>72.3%</td>
<td>45.2%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Statin use</td>
<td>67.2%</td>
<td>43.4%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>ACE/ARB use</td>
<td>52.3%</td>
<td>26.9%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Cardiac Rehabilitation</td>
<td>50.1%</td>
<td>46.8%</td>
<td>0.066</td>
</tr>
</tbody>
</table>

Continuous variables compared using Students’ T-test.
Categorical variables compared using chi-square or Fisher's exact test.
Supplemental Table 2. Angina and HRQOL of Entire Cohort and by 1-Year Smoking Status

<table>
<thead>
<tr>
<th>% with Angina</th>
<th>Total Analytic Cohort n = 4003</th>
<th>1-Year Smoking Status</th>
<th>P-Value Across Smoking Status Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never Smoked n = 1145</td>
<td>Former Smokers n = 1374</td>
<td>Recent Quitters n = 683</td>
</tr>
<tr>
<td>Baseline</td>
<td>47.8%</td>
<td>42.4%</td>
<td>50.3%</td>
</tr>
<tr>
<td>1-month</td>
<td>27.0%</td>
<td>22.2%</td>
<td>24.1%</td>
</tr>
<tr>
<td>6-month</td>
<td>24.1%</td>
<td>20.9%</td>
<td>21.0%</td>
</tr>
<tr>
<td>12-month</td>
<td>21.1%</td>
<td>17.3%</td>
<td>18.4%</td>
</tr>
</tbody>
</table>

**SAQ Angina Frequency***

| Baseline | 85.9 ± 20.2 | 87.9 ± 19.1 | 84.2 ± 21.8 | 87.7 ± 18.1 | 84.2 ± 20.3 | < 0.001 |
| 1-month   | 92.2 ± 16.0 | 93.5 ± 15.5 | 93.1 ± 15.3 | 91.8 ± 15.9 | 88.9 ± 17.5 | < 0.001 |
| 6-month   | 92.4 ± 16.8 | 93.2 ± 16.7 | 93.6 ± 15.4 | 92.5 ± 16.1 | 88.8 ± 19.3 | < 0.001 |
| 12-month  | 93.5 ± 15.5 | 94.4 ± 15.4 | 94.4 ± 14.8 | 92.8 ± 15.3 | 91.5 ± 16.7 | < 0.001 |

**SAQ Quality of Life***

| Baseline | 64.2 ± 22.9 | 65.9 ± 22.0 | 64.5 ± 22.8 | 64.2 ± 23.6 | 61.1 ± 23.5 | < 0.001 |
| 1-month   | 77.9 ± 21.7 | 80.1 ± 20.2 | 81.0 ± 19.5 | 74.7 ± 23.4 | 71.9 ± 24.5 | < 0.001 |
| 6-month   | 82.1 ± 20.5 | 84.6 ± 18.3 | 85.7 ± 17.2 | 78.7 ± 22.2 | 74.3 ± 24.9 | < 0.001 |
| 12-month  | 83.1 ± 19.6 | 85.8 ± 17.0 | 86.2 ± 16.9 | 79.7 ± 21.4 | 76.9 ± 23.6 | < 0.001 |

**SF-12 Physical Component***

<p>| Baseline | 43.6 ± 12.2 | 44.3 ± 12.3 | 43.2 ± 12.3 | 45.2 ± 11.2 | 42.0 ± 12.4 | &lt; 0.001 |
| 1-month   | 40.9 ± 11.4 | 41.3 ± 11.4 | 40.9 ± 11.5 | 41.6 ± 10.9 | 39.7 ± 11.4 | 0.020 |
| 6-month   | 44.5 ± 11.9 | 45.3 ± 12.2 | 44.8 ± 11.7 | 44.9 ± 11.8 | 42.3 ± 11.9 | &lt; 0.001 |</p>
<table>
<thead>
<tr>
<th>Time Point</th>
<th>SAQ</th>
<th>SF-12 Mental Component*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>50.3 ± 11.2 51.2 ± 10.7 51.8 ± 10.6 49.2 ± 11.2 47.3 ± 12.3</td>
</tr>
<tr>
<td></td>
<td>1-month</td>
<td>52.4 ± 10.1 53.5 ± 9.2 53.6 ± 9.1 51.4 ± 10.3 49.3 ± 11.8</td>
</tr>
<tr>
<td></td>
<td>6-month</td>
<td>52.5 ± 10.0 54.1 ± 8.6 54.2 ± 8.8 51.1 ± 10.4 48.1 ± 12.0</td>
</tr>
<tr>
<td></td>
<td>12-month</td>
<td>52.6 ± 9.9  54.1 ± 8.6 54.0 ± 8.8 51.9 ± 10.4 48.8 ± 11.6</td>
</tr>
</tbody>
</table>

SAQ = Seattle Angina Questionnaire (disease-specific health status); SF-12 = Short-Form 12 (generic health status)
*Scores for the SAQ and SF-12 range from 0-100, with higher scores indicating less disease burden and better health status.
Supplemental Figure 1.

Unadjusted analyses of baseline, 1-, 6-, and 12-month HRQOL domains across the 4 smoking status groups. Differences across the 4 smoking status groups for each HRQOL domain at each time-point were statistically significant (p < 0.001).
Supplemental Figure 2. Multivariable sequential analyses of the association of 1-year smoking status with HRQOL domains at 1 year following AMI.