# Projected Cost-effectiveness of Smoking Cessation Interventions in Patients Hospitalized With Myocardial Infarction

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**Background:** As many as 70% of smokers with acute myocardial infarction (AMI) continue to smoke after hospital discharge despite high rates of inpatient smoking cessation counseling. Supportive contact after discharge improves quit rates but is rarely used.

**Methods:** Using data from a meta-analysis of randomized trials of smoking cessation interventions and other published sources, we developed a Monte Carlo model to project health and economic outcomes for a hypothetical US cohort of 327 600 smokers hospitalized with AMI. We compared routine care, consisting of advice to quit smoking, with counseling with supportive follow-up, consisting of routine care and follow-up telephone calls from a nurse after discharge. Primary outcomes were number of smokers, AMIs, and deaths averted; health care and productivity costs; cost per quitter; and cost per quality-adjusted life-year.

**Results:** Implementation of smoking cessation counseling with follow-up contact for the 2010 cohort of hospitalized smokers would create 50 230 new quitters, cost $27.3 million in nurse wages and materials, and prevent 1380 nonfatal AMIs and 7860 deaths. During a 10-year period, it would save $22.1 million in reduced hospitalizations but increase health care costs by $166.4 million, primarily through increased longevity. Productivity costs from premature death would fall by $1.99 billion and nonmedical expenditures would increase by $928 million, for a net positive value to society of $894 million. The program would cost $540 per quitter considering only intervention costs. Cost-effectiveness would be $5050 per quality-adjusted life-year. Results were sensitive to the utility and incidence of nonfatal AMI and the potential effect of pharmacotherapies.

**Conclusion:** Smoking cessation counseling with supportive contact after discharge is potentially cost-effective and may reduce the incidence of smoking and its associated adverse health events and social costs.

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CORONARY HEART DISEASE (CHD) is responsible for more than 440 000 deaths each year in the United States, and smoking is the foremost preventable risk factor in its development.[1] Although notably associated with angina and heart failure, the role of smoking in acute myocardial infarction (AMI) is particularly noteworthy. Researchers have estimated its attributable risk to be 36%—more than that of obesity, hypertension, diabetes mellitus, or a sedentary lifestyle.[2]

*See Invited Commentary on page 53*

In recognition of these health risks and the role physicians play in their mitigation, the Agency for Healthcare Research and Quality and Centers for Medicare and Medicaid Services proposed quality measures in the care of hospitalized patients with AMI that include the provision of smoking cessation counseling.[3,4] The rates of adherence to this quality measure have increased steadily, rising from as low as 41% in 1995 to 94% in 2008.[4,5] This increase has been concurrent with growing support for pay-for-performance models in Medicare's payment structure and greater transparency in the reporting of hospital quality measures, which are now readily available to the community online.[4,6]

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Despite these high adherence rates, as many as 60% to 70% of smokers with AMI will continue to smoke after hospital discharge.[7,8] These individuals are at increased risk of recurrent AMI, stroke, and death.[9-11] Randomized controlled trials have demonstrated that the addition of supportive contact in the form of follow-up telephone calls for at least 1 month after discharge significantly improves quit rates, but this rarely occurs in clinical practice. As a consequence, thousands of patients continue smoking who

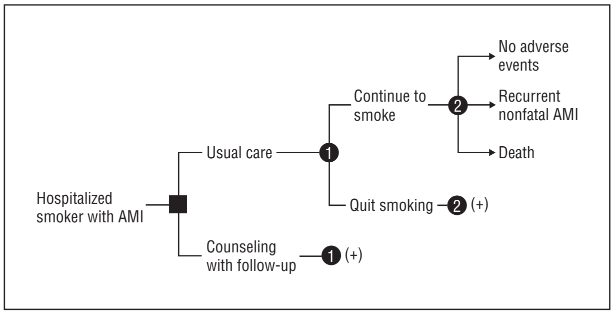


**Figure 1.** Hospitalized smokers with acute myocardial infarction (AMI) receive usual care or smoking cessation counseling with supportive follow-up and experience health events whose likelihoods depend on their smoking status. 1 and 2 represent probability nodes and the plus sign, clones of these nodes such that patients in the different treatment arms who continue to smoke or quit smoking face varying health risks.

would have, with supportive contact, quit. As a health care program, counseling and supportive contact for smokers after discharge is inexpensive and potentially cost-effective, particularly when compared with other high-technology treatments used in CHD.[12-15] In the setting of ongoing debate about rising health care costs and funding priorities, this intervention requires further economic and clinical exploration. We sought to help inform the current policy environment by performing an up-to-date economic appraisal of smoking cessation counseling with follow-up supportive contact in patients hospitalized with AMI.

## METHODS

### MODEL FRAMEWORK

We built a cost-effectiveness model to compare 2 major options for managing smokers admitted with AMI (**Figure 1**). Under the usual care option, hospitalized smokers receive standard smoking cessation consultation, including advice to quit smoking and provision of printed materials on smoking cessation, such as a copy of the *How Can I Quit Smoking?* pamphlet from the American Heart Association.[16] These steps meet Agency for Healthcare Research and Quality's and Centers for Medicare and Medicaid Services' requirements and are similar to those typically taken in hospitals.[5,17] Under the counseling and supportive follow-up option, patients receive usual care and an evidence-based smoking cessation regimen consisting of a behavioral counseling session before discharge, the American Heart Association's *Active Partnership for the Health of Your Heart* workbook and DVD, and follow-up telephone calls 2 days, 1 week, 3 weeks, 4 weeks, and 3 months after discharge.[18] The structure of these interventions closely models a framework used in randomized controlled trials of counseling for patients hospitalized with AMI performed at the University of California, San Francisco, and Stanford University, Palo Alto, California, leading institutions for smoking cessation research in this population.[19,20] Our model accounted for the health events after discharge, including nonfatal AMI and death. Patients accrued costs related to their baseline medical care, CHD medications, and hospitalizations for recurrent AMI.

We conducted our analysis from the societal perspective, including all major cost and health outcomes. We projected disease outcomes for a hypothetical US cohort of 327 600 smokers hospitalized with AMI and used a 10-year follow-up period, based on the time for which data on health outcomes were available.[9] Data on mortality and nonfatal AMIs were primarily attained between the late 1970s and the 1990s.[9] We determined the cohort size by finding the product of 1.26 million, the number of patients with new or recurrent AMI each year, and 26%, the prevalence of smoking among patients with AMI in the US in 1999.[21,22] Although evaluating outcomes throughout a lifetime period would be ideal, we decided to limit the time to a range for which there was less uncertainty. The model used a Monte Carlo microsimulation framework and was programmed with TreeAge Pro 2009 (TreeAge Software Inc, Williamstown, Massachusetts) and analyzed with Microsoft Excel (Microsoft Inc, Redmond, Washington) and Intercooled Stata 9.2 (College Station, Texas).

**Table 1. Smoking Cessation Counseling and Follow-up and CHD Health Event Probabilities**

| Variable | Base Case Estimate | Sensitivity Analysis | Source |
|---|---|---|---|
| Proportion of patients who quit smoking | | | |
| Usual care | 0.30 | . . . | 7 |
| Counseling with follow-up | 0.45 | . . . | 7 |
| NRT[a] | . . . | 0.61 | 39 |
| Bupropion[a] | . . . | 0.63 | 39 |
| Varenicline[a] | . . . | 0.66 | 39 |
| Annual nonfatal AMI risk[b] | | | |
| Continue to smoke | 0.022 | 0.02-0.04 | 9[e] |
| Quit smoking | 0.016 | . . . | 9[e] |
| Annual mortality risk[b] | | | |
| Continue to smoke | 0.057 | 0.04-0.08 | 9 |
| Quit smoking | 0.034 | . . . | 9 |
| Quality of life | | | |
| Utility at baseline | 0.859 | . . . | 23, 24 |
| Utility after recurrent AMI | 0.834 | 0.700 | 24, 25 |
| Nonsmoking AMI population life expectancy[c] | | | |
| Life-years | 7.39 | . . . | 9 |
| QALYs[d] | 6.35 | . . . | 9, 23, 24 |

Abbreviations: AMI, acute myocardial infarction; CHD, coronary heart disease; NRT, nicotine replacement therapy; QALYs, quality-adjusted life-years. Ellipses represent values that were not included in the base case analysis or were not varied in the sensitivity analysis.
[a] Derived by applying odds ratio of quitting to probability of quitting under usual care; pharmacotherapy is used in conjunction with counseling and follow-up.
[b] Derived from exponential survival model using mean follow-up period and unadjusted data from Critchley and Capewell.
[c] Derived using life expectancy during a 10-year time horizon in patients with AMI who stop smoking after hospitalization. Values are discounted by 3% and adjusted with a half-cycle correction.
[d] QALYs weighted by baseline utility in CHD population.
[e] Written communication with J. Critchley, PhD, November 2009.

### PROBABILITIES OF SMOKING CESSATION AND HEALTH OUTCOMES

We derived the probabilities of events in the model from published studies, national databases, and personal communication with study authors (**Table 1**). We used data that were most appropriate for our population and minimized assumptions whenever possible. The likelihood of successfully quitting smoking with usual care or counseling with supportive contact was derived from a meta-analysis of smoking cessation interventions in hospitalized patients.[7] This study included mixed populations with CHD or lung disease, but we used estimates on the CHD population from a subgroup analysis. Approximately 90% of these patients were men and most were between 50 and 60 years old. Additional demographic characteristics were not provided in the meta-analysis. We used smoking status at the longest follow-up point (typically 12 months) to categorize patients as smokers or quitters. We derived probabilities of death and nonfatal AMI from a meta-analysis of observational studies enrolling patients with CHD, most of whom were hospitalized for AMI, who were followed up for at least 2 years after discharge.[9] We were unable to include nonfatal stroke rates in our analysis because this outcome was rarely reported by the studies included in the meta-analysis and, as stated by Julia Critchley, PhD (University of Newcastle, United Kingdom), in a written communication in November 2009, was not synthesized by the authors. The initial age of patients in our cohort was 55 years, the same mean age as that in the meta-analysis. We used life expectancy in patients with AMI who quit smoking after hospitalization as a reference point with which to compare life-year losses in our cohort.

## HEALTH-RELATED QUALITY OF LIFE

We derived utility weights for health states using EuroQoL-5D utilities from a nationally representative sample in the United States.[23,24] Patients with a recurrent AMI experienced a further decline in their utility.[25] This utility decrement was based on a standard gamble and time trade-off model, but there is evidence that changes in utility are frequently comparable across different models.[24] We combined utility and longevity to calculate quality-adjusted life-years (QALYs).

## COSTS

The medical cost of smoking cessation counseling and follow-up contact was derived by modeling the intervention on similar studies performed at the University of California, San Francisco, and Stanford University and applying appropriate unit costs (**Table 2**).[19] We used the mean national wage for nurses to value the time spent on counseling and telephone calls by a trained cessation counselor, and we obtained bulk purchase prices for the American Heart Association's *Active Partnership for the Health of Your Heart* workbook and DVD.[18,26,27] We did not include an incremental cost for the American Heart Association's *How Can I Quit Smoking?* pamphlet used in the usual care option because this was considered to be a baseline expenditure and therefore part of hospitalization costs.[16] We also did not include the cost of pharmacotherapies for smoking cessation in the base case because they have not been shown to increase quit rates in this population.[7] Their potential impact and associated costs were assessed in a sensitivity analysis.

We estimated the cost of nonfatal AMIs in patients who had recurrent infarctions using published data on AMI costs from the Healthcare Cost and Utilization Project Nationwide Inpatient Sample (Table 2).[28] The Nationwide Inpatient Sample is an all-payer inpatient database with nationally representative data on clinical and economic outcomes and includes data from 1044 hospitals across 40 states in 2007, its most recent release. We derived costs of baseline health care (a function of sex and age) and CHD-related care using the hierarchical condition categories model used by Centers for Medicare and Medicaid Services to risk-adjust Medicare capitation payments to private health plans.[29] Because the hierarchical condition categories predict costs for the following year using the current year's health status, some double counting occurs when a patient experiences an AMI. We derived age- and sex-specific baseline costs using the mean age (55 years) and sex distribution (90% were men) in the meta-analysis of mortality risk and adjusted these figures as patients aged in the model.[9] We also tracked the cost of CHD-related medications using a typical regimen of aspirin, metoprolol succinate (β-adrenergic blocker), simvastatin (hydroxymethylglutaryl-CoA reductase inhibitor), and lisinopril (angiotensin-converting enzyme inhibitor), based on prices from a major online pharmacy.[30,31] The cost of 1 year of clopidogrel hydrogen sulfate therapy after an episode of AMI was also included.[32]

We estimated productivity losses as a result of premature death using the present value of expected future earnings dur-

**Table 2. Smoking Cessation Counseling and Follow-up and CHD Health Event Costs**

| Variable | Base Case Estimate | Sensitivity Analysis | Source |
|---|---|---|---|
| Smoking cessation counseling and follow-up | | | |
| Counseling time, h[a] | 1 | . . . | 19 |
| AHA's *Active Partnership for the Health of Your Heart* workbook and DVD, $ | 12.96 | . . . | 27 |
| Follow-up telephone calls[a,b] | 5 | . . . | 19 |
| Time per call, min[a] | 15 | . . . | 19 |
| Nurse wages, $ | 31.31 | . . . | 26 |
| Total cost of intervention, $ | 83.41 | 0-500 | . . . |
| Medical social worker wages, $ | . . . | 22.87 | 26 |
| Total cost of intervention with social workers, $ | . . . | 64.42 | |
| Smoking cessation pharmacotherapies, $ | | | |
| NRT[c] | 263 | . . . | 31 |
| Bupropion[d] | 246 | . . . | 31 |
| Varenicline[e] | 361 | . . . | 31 |
| Medical care, $ | | | |
| Age, baseline care, y[f] | | | |
| 55-59 | 2038 | . . . | 29 |
| 60-64 | 2567 | . . . | 29 |
| CHD-related care | | | |
| No AMI last year | 1739 | . . . | 29 |
| AMI last year | 2631 | . . . | 29 |
| CHD-related medications[g] | | | |
| No AMI last year | 821 | . . . | 32 |
| AMI last year | 2580 | . . . | 32 |
| AMI hospitalization | 18 211 | . . . | 28 |
| Productivity, $[h] | | | |
| Annual productivity, 55-59 y | 64 705 | . . . | 33 |
| Annual productivity, 60-64 y | 47 778 | . . . | 33 |
| Present value of productivity, over 10 y[h] | 414 592 | . . . | 33 |
| Nonmedical expenditures, $ | | | |
| Annual nonmedical expenditures, 55-64 y | 24 266 | . . . | 36 |
| Present value of expenditures, over 10 y[h] | 173 246 | . . . | 36 |

Abbreviations: AHA, American Heart Association; AMI, acute myocardial infarction; CHD, coronary heart disease; NRT, nicotine replacement therapy. Ellipses represent values that were not included in the base case analysis or were not varied in the sensitivity analysis.

[a] Includes time for medical chart review and other preparatory activities. Actual counseling time is approximately 30 to 45 minutes.

[b] Telephone calls placed at 2 days, 1 week, 3 weeks, 4 weeks, and 3 months.

[c] Based on 21 mg/d for 6 weeks, then 14 mg/d for 2 weeks, then 7 mg/d for 2 weeks.

[d] Based on 12 weeks of therapy with 300 mg/d in 2 divided doses to minimize adverse effects.

[e] Based on 3 months of treatment; begins with 0.5-mg tablet daily for 3 days, then 0.5-mg tablet twice daily for 4 days, then 1-mg tablet twice daily starting on day 7 and continued for 3 months.

[f] Linear interpolation was used to estimate costs between ages.

[g] Based on daily regimen of aspirin, 81 mg; metoprolol succinate, 50 mg; simvastatin, 80 mg; and lisinopril, 10 mg. Includes clopidogrel, 75 mg/d, for 1 year after AMI.

[h] Derived using life expectancy during a 10-year time horizon in patients with AMI who stop smoking after hospitalization. Values are discounted by 3% and adjusted with a half-cycle correction.

**Table 3. Projected Health Outcomes With Smoking Cessation Counseling and Follow-up Compared With Usual Care in the 2010 Cohort of Hospitalized Smokers With AMI**

| Health Outcome[a] | Usual Care | Counseling With Follow-up | Outcomes Prevented by Intervention |
|---|---|---|---|
| Patients who continue to smoke | 230 400 | 180 200 | 50 230 |
| Nonfatal AMI episodes | 50 060 | 48 680 | 1380 |
| All-cause deaths | 131 300 | 123 500 | 7860 |
| Life-years lost[b] | 174 700 | 136 500 | 38 250 |
| QALYs lost[b] | 154 700 | 121 700 | 32 950 |

Abbreviations: AMI, acute myocardial infarction; QALYs, quality-adjusted life-years.
[a]Results are rounded and projected for a cohort of 327 600 smokers hospitalized with AMI followed up for 10 years.
[b]Life-years and QALYs were discounted by 3% annually and compared with baseline values for patients with AMI who stop smoking after hospitalization.

ing a 10-year period for the general US population as a reference point (Table 2).[33] We did not include productivity losses related to smoking-related disability or employee absenteeism or the costs associated with secondhand smoke. We accounted for nonmedical expenditures using values reported in the Consumer Expenditure Survey for 2008 for the general 55-year-old US population.[34-36]

## COST-EFFECTIVENESS CALCULATIONS

We performed the base-case analysis from the societal perspective for a hypothetical cohort of 327 600 smokers hospitalized with AMI. In accordance with recommendations of the Panel on Cost-Effectiveness in Health and Medicine, we discounted costs and health benefits by 3% each year.[37] Cost-effectiveness ratios were calculated as the quotient of the difference in costs (excluding productivity losses and nonmedical expenditure gains) and difference in health outcomes between usual care and smoking cessation counseling with follow-up. All costs were converted to 2008 US dollars using the medical care component of the Consumer Price Index.[38]

## SENSITIVITY ANALYSES

We varied key variables over plausible ranges to explore their effect on our results (Tables 1 and 2). Sensitivity analyses included (1) the incidence of nonfatal AMI, varied from 3% to 5%; (2)the annual risk of mortality, varied from 4% to 8%; (3) the cost of counseling, varied to reflect the mean wage of a medical social worker (lower costs) or increased time or material requirements for a nurse performing counseling and follow-up (higher costs); (4) the utility after a recurrent AMI, reduced to 0.70; and (5) the probability of quitting smoking, varied using the odds ratio of success in patients who received treatment with nicotine replacement therapy, bupropion hydrochloride, or varenicline.[6] Costs due to lost productivity and averted expenditures from premature death were included.[39,40] We used a meta-analysis performed by Eisenberg et al[39] to estimate the effect of pharmacotherapy on the likelihood of quitting because those authors preferentially selected 12-month smoking cessation rates. A meta-analysis performed by Fiore et al[41] found that 6-month and 12-month cessation rates were similar but primarily reported the 6-month rates. However, their estimates of the effect of pharmacotherapy were similar to those provided by Eisenberg et al.

**Table 4. Projected Cost Outcomes With Smoking Cessation Counseling and Follow-up Compared With Usual Care in the 2010 Cohort of Hospitalized Smokers With AMI**

| Cost[a] | Usual Care | Counseling With Follow-up | Costs (Savings) From Intervention |
|---|---|---|---|
| Counseling/pharmacotherapy | | 27.3 | 27.3 |
| Medical care | | | |
| Baseline medical care[b] | 677 | 743 | 66.5 |
| CHD-related care[c] | 4089 | 4155 | 65.4 |
| Nonfatal AMI | 3744 | 3722 | (22.1) |
| CHD medications[d] | 2206 | 2235 | 29.3 |
| Total medical care | 10 720 | 10 880 | 166.4 |
| Productivity losses[e] | 4332 | 2342 | (1990) |
| Nonmedical expenditures | 54 500 | 55 430 | 928 |
| Total costs[f] | 69 550 | 68 650 | (894) |

Abbreviations: AMI, acute myocardial infarction; CHD, coronary heart disease.
[a]Results are rounded, projected for a cohort of 327 600 smokers hospitalized with AMI followed up for 10 years, reported in millions of dollars, discounted by 3% annually, and in 2008 US dollars.
[b]Based on age and sex only.
[c]Attributable cost of CHD; excludes the cost of recurrent AMI.
[d]Include aspirin, metoprolol succinate, simvastatin, lisinopril, and clopidogrel.
[e]Based on premature death and lost earnings.
[f]Total costs reflect sum of medical care, productivity losses, and nonmedical expenditures.

# RESULTS

Projected health outcomes and costs are displayed in **Table 3** and **Table 4**. Implementation of evidence-based smoking cessation counseling with follow-up supportive contact for the 2010 cohort of smokers hospitalized with AMI would cost $27.3 million in nurse wages and educational materials, generate 50 230 new quitters, and prevent 1380 nonfatal AMIs and 7860 all-cause deaths. The corresponding gains in life-years and QALYs during a 10-year follow-up period are 38 250 years and 32 950 QALYs. The counseling and follow-up intervention would save $22.1 million in reduced hospitalizations for nonfatal AMI but increase total health care costs by $166.4 million, primarily because of increased longevity and greater costs of ongoing care. Productivity costs associated with premature death would be reduced by $1.99 billion, however, and nonmedical expenditures would increase by $928 million. The intervention would have a net positive economic value to society of $894 million (Table 4).

## COST-EFFECTIVENESS RATIOS

The cost-effectiveness of evidence-based smoking cessation counseling with follow-up supportive contact, at varying costs of the intervention, is shown in **Figure 2**. The program would cost $540 per quitter and $19 800 per AMI avoided (considering only intervention costs), and the cost-effectiveness would be $4350 per life-year and $5050 per QALY (considering all health care costs).

## SENSITIVITY ANALYSES

The results were sensitive to the incidence of nonfatal AMI. If the risk in smokers increased from 2.2% to 4.0%, the number of AMIs avoided during the follow-up period grew from 1380 to 7580 and the cost-effectiveness fell from $5050 to $1700 per QALY because of lower costs of care for AMI. The change in AMI incidence was marked because the large cohort size magnified the effects of small changes in probability. We also varied the cost of counseling and follow-up over a wide range (Figure 2). When the intervention was performed by medical social workers instead of nurses, its cost fell to $64 and the cost per patient who quit smoking fell to $420. Results were also sensitive to the utility associated with recurrent nonfatal AMI. When the utility fell from 0.83 to 0.70, there were an additional 1550 QALYs gained compared with the base case, and the cost-effectiveness ratio fell to $4940 per QALY.

We explored the potential effect of pharmacotherapy by modeling the counseling and supportive contact intervention using odds ratios for quitting from patients also using nicotine replacement therapy, bupropion, or varenicline (Table 1). The actual effect of pharmacotherapy combined with counseling and follow-up on quit rates in the AMI population has not been well studied, to our knowledge. We found that nicotine replacement therapy, bupropion, and varenicline would increase the number of smokers who quit by 104 000, 109 000, and 120 000 compared with usual care; reduce AMIs by 2800, 2900, and 3200; and reduce deaths by 16 000, 17 000, and 19 000, respectively. The net savings to society would be $1.8 billion, $1.9 billion, and $2.1 billion, with corresponding cost-effectiveness ratios of $11 400, $11 600, and $13 700 per QALY. The savings were driven by reductions in premature death and lost productivity, as were the higher cost-effectiveness ratios driven by higher costs of ongoing care.

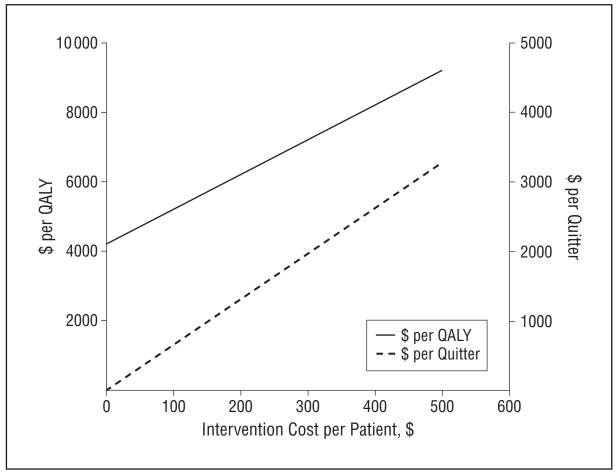


**Figure 2.** Cost per quality-adjusted life year (QALY) and per quitter under the smoking cessation counseling with follow-up policy option, varying cost of intervention.

## COMMENT

### MAIN FINDINGS

Evidence-based smoking cessation counseling coupled with follow-up supportive contact in smokers hospitalized with AMI is potentially cost-effective and could create 50 230 new quitters in its year of implementation. It would prevent 1380 nonfatal AMIs and 7860 deaths and save society money overall, with a net benefit of $894 million for the 2010 cohort of smokers. Its cost-effectiveness is $540 per patient who quits in program costs, $4350 per life-year saved, and $5050 per QALY saved when all health care costs are considered. In a study of nurse-led smoking cessation interventions in hospitalized patients with AMI, smoking cessation was found to cost $220 per life-year saved in 1991 US dollars.[13] However, those authors estimated that the intervention would reduce smoking by an absolute rate of 26%, almost twice as large as our estimate. Nonetheless, our cost-effectiveness ratio falls well within the range of what is considered high value.

### COMPARISON WITH OTHER CARDIAC TECHNOLOGIES

Our findings suggest that smokers hospitalized with AMI may benefit significantly from the addition of follow-up supportive contact after discharge. The current quality guidelines issued by the Agency for Healthcare Research and Quality and Centers for Medicare and Medicaid Services require the provision of smoking cessation counseling for these patients; however, the absence of follow-up support likely results in lack of motivation to quit for thousands of patients each year. This follow-up is unlikely to be achieved with similar duration or effectiveness under other circumstances, as the opportunity for secondary prevention is often missed in the outpatient setting and rates of cardiac rehabilitation use are low.[42-44]

As an intervention based primarily on discussion and requiring few material resources, smoking cessation counseling with supportive contact for 2 to 3 months is relatively inexpensive. Its cost-effectiveness compares favorably with that of several other interventions, including β-blocker use after AMI (<$10 000 per QALY), medication for hypertension ($10 000-$60 000 per QALY), statin use ($10 000-$50 000 per QALY), and left ventricular assist devices ($500 000-$1.4 million per QALY).[12] It is also more cost-effective than some new technologies whose reimbursement and application remain at the center of health policy debates, including high-resolution cardiac computed tomography.[15,45]

### LIMITATIONS

Our analysis used conservative assumptions that likely underestimated the potential benefits of smoking cessation counseling with supportive follow-up. For example, smoking cessation not only reduces the risk of death and recurrent AMI, it also decreases the likelihood of stroke, peripheral vascular disease, lung disease, and cancer, not only in smokers but also in those exposed to secondhand smoke.[10] These comorbidities negatively affect both quality of life and longevity, and they are also associated with significant productivity losses and costs related to additional hospitalizations, diagnostic tests, and medications. Incorporating them would likely make our health and cost-effectiveness projections more clinically and economically attractive.

Patients who quit smoking after AMI tend to be sicker than those who continue to smoke.[9] Because our risk estimates were drawn from observational data, this pattern likely also results in underestimation of the harms associated with continuing to smoke. We attempted to address this in a sensitivity analysis in which we increased the risk of recurrent AMI in smokers.

Ninety percent of our study population were men. Because of this predominance, our results may not be generalizable to women. Other sociodemographic characteristics, including ethnicity, educational level, income, and geographic region, may also have important effects on our outcomes. However, these data were not available in the Critchley and Capewell[9] meta-analysis.

We limited the model's follow-up time to 10 years because this was the period for which data on the effect of quitting smoking on survival were available. Although evaluating outcomes for a lifetime period would allow for a more accurate estimation of the present value of clinical and economic consequences, we decided to limit the time to a shorter range for which data existed. Related to this, we did not model dynamic changes in smoking status, nor did we have data on long-term smoking cessation rates. However, these effects may be small: only 2% to 3% of smokers spontaneously quit each year, and smokers who are abstinent for at least 12 months (the median follow-up time for patients in our counseling and follow-up meta-analysis) have a 95% likelihood of continuous abstinence for 20 months.[46-48]

Our costs are also subject to uncertainty. We did not explicitly model nonadherence to medications, nor did we model costs related to adverse medication effects. The former affects both cost and health outcomes related to medication effectiveness. In the sensitivity analysis, we used simple approximations for productivity costs and nonmedical expenditures that reflected age-adjusted population averages but were not specific to our cohort. For example, our estimates for productivity losses underestimated losses by not including the costs of smoking-related disability and employee absenteeism but overestimated losses by not accounting for employers' ability to compensate for worker absence or hire replacements. Our nonmedical expenditure estimates have similar shortcomings in precision. The recent finding of the effectiveness of financial incentives in promoting long-term smoking cessation highlights another potentially important policy option that merits further exploration.[46] Researchers estimate that employers save about $3400 per year when an employee stops smoking, so they should theoretically be willing to invest up to this amount for each smoker who quits.[46]

## CONCLUSIONS

We conclude that smoking cessation counseling with supportive contact after discharge for smokers admitted with AMI has the potential to be cost-effective relative to the standard of care and may lead to significant reductions in the incidence of smoking and its associated adverse health events and social costs. Medicare and other health insurers should explore the inclusion of continued supportive contact with patients hospitalized for AMI who smoke as a quality measure.

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