**Background:** Case management (CM) is a systematic approach to supplement physician-centered efforts to prevent cardiovascular disease (CVD). Research is limited on its implementation and efficacy in low-income, ethnic minority populations.

**Methods:** We conducted a randomized clinical trial to evaluate a nurse- and dietitian-led CM program for reducing major CVD risk factors in low-income, primarily ethnic minority patients in a county health care system, 63.0% of whom had type 2 diabetes mellitus. The primary outcome was the Framingham risk score (FRS).

**Results:** A total of 419 patients at elevated risk of CVD events were randomized and followed up for a mean of 16 months (81.4% retention). The mean FRS was significantly lower for the CM vs usual care group at follow-up (7.80 [95% confidence interval, 7.21-8.38] vs 8.93 [8.36-9.49]; *P* = .001) after adjusting for baseline FRS. This is equivalent to 5 fewer heart disease events per 1000 individuals per year attributable to the intervention or to 200 individuals receiving the intervention to prevent 1 event per year. The pattern of group differences in the FRS was similar in subgroups defined a priori by sex and ethnicity. The main driver of these differences was lowering the mean (SD) systolic (−4.2 [18.5] vs 2.6 [22.7] mm Hg; *P* = .003) and diastolic (−6.0 [11.6] vs −3.0 [11.7] mm Hg; *P* = .02) blood pressures for the CM vs usual care group.

**Conclusion:** Nurse and dietitian CM targeting multifactor risk reduction can lead to modest improvements in CVD risk factors among high-risk patients in low-income, ethnic minority populations receiving care in county health clinics.

**Trial Registration:** clinicaltrials.gov Identifier: NCT00128687


**CARDIOVASCULAR DISEASE (CVD) affects 80.7 million Americans, with estimated national costs of $448.5 billion in 2008.** Age, sex, high blood pressure (BP), smoking, dyslipidemia, obesity, and diabetes mellitus are widely recognized as major risk factors, frequently clustering and interacting multiplicatively in predicting the risk for coronary and other atherosclerotic vascular diseases. Although CVD and its major risk factors affect every racial/ethnic group and social class, they disproportionately burden ethnic minorities and low-income communities. These population subgroups also are more likely to receive inadequate cardiac care compared with white and higher-income individuals. Innovative approaches are needed to supplement traditional care models that emphasize episodic, acute delivery of physician services. Case management (CM) is a comprehensive, longitudinal approach involving multidisciplinary teams of physicians and other clinicians who cooperate to identify, manage, and coordinate care of patients with costly, high-risk conditions. Evidence supports the efficacy of intensive CM, particularly in diabetes and prevention of subsequent events for patients with existing CVD. Experience with CM among low-income, ethnic minority patients is limited, although some studies show favorable results. Translation of proven interventions into community practice is a strategic imperative for eliminating health disparities.

Chronic disease management in low-income, ethnic minorities is a unique challenge for local health care systems, in particular county systems that serve the most disadvantaged populations. Such systems are often underresourced to cope with a complex clinical load and use a primary care delivery model ill-suited to provide comprehensive disease management with...
continued follow-up support. The Stanford and San Mateo Heart to Heart (HTH) project was a 2-arm randomized controlled trial to evaluate the feasibility and clinical utility of a CM model of multifactor CVD risk reduction for low-income, ethnically diverse patients served by the county health care system in San Mateo County, California. We hypothesized that compared with usual care (UC), CM participants would experience greater improvements in Framingham risk scores (FRSs) and in individual modifiable risk factors.

**METHODS**

A complete description of the research design and methods of the HTH project is available elsewhere. We therefore provide a condensed description.

**RECRUITMENT**

The San Mateo Medical Center (SMMC), a branch of the San Mateo County government, serves the county’s sizable low-income population, most of whom have Medicaid or a county-sponsored indigent care plan. Patients were recruited between October 1, 2003, and April 30, 2005, from 4 SMMC outpatient clinics. These clinics were chosen for their accommodating clinic environment, patient volume, patient demographics, and established adult primary care services. All data acquisition and CM visits occurred within the clinics where the patients received primary care services.

Physicians at study clinics were asked to refer patients according to simplified, partial eligibility criteria. Referred patients then underwent formal screening by study staff for interest in the HTH project and eligibility based on self-completed questionnaires and clinical measurements. Of 1005 patients referred, 257 were unreachable and 142 declined participation (Figure 1). Through screenings by telephone or at baseline visits, 187 additional patients were excluded for medical, psychosocial, or personal reasons that would prevent them from providing informed consent or complying with study protocols. A total of 419 patients (40.7%) were eligible and provided informed consent to participate. Participants were men and women aged 35 to 85 years who had moderately to severely elevated levels of major modifiable CVD risk factors with or without a history of atherosclerotic CVD or diabetes mellitus. The study was approved by institutional review boards at Stanford University and SMMC.

**RANDOMIZATION**

Participants were equally randomized to the CM or the UC group, using the permuted block method (block size = 6) stratified by sex and ethnicity (Hispanic vs non-Hispanic) within each clinic. Concealment of treatment allocation was achieved by having study staff who were not involved in the recruitment, intervention, and assessment generate the sequence of treatment allocations and prepare randomization letters. The letters were sealed in sequentially numbered opaque envelopes and opened firsthand by patients at randomization, after completion of the baseline assessment.

**INTERVENTION**

Participants in the UC and CM groups were instructed to continue routine medical care with their primary care physician. In addition, CM participants received a one-on-one nurse- and dietitian-led CM intervention previously demonstrated to reduce multiple major risk factors in patients with or at risk for CVD, including medically underserved patients. As in our previous studies, case managers emphasized behavior change and medical management strategies. The HTH program differed by focusing on high-risk patients served by public health primary care clinics. Unlike previous interventions, all patients had primary care physicians who integrated their care with the case managers’ semiautonomous, protocol-based approach to risk factor management.

Nurse and dietitian case managers were trained and supervised by a senior nurse practitioner (K.B.) and the principal investigator (R.S.S.). Principal CM strategies included (1) intensive, individualized care; (2) continuity of care and coordination with primary and specialty care; (3) self-management support; (4) implementation of evidence-based treatment guidelines for primary and secondary CVD prevention; and (5) behavioral counseling to improve physical activity, nutrition, weight management, stress reduction, and medication adherence. The theoretical underpinning of behavior change protocols was derived from social cognitive theory and the trans-theoretical model of behavior change. Guided by intervention protocols, the intensity of CM and the treatment goals were individualized on the basis of the patient’s clinical and risk factor status, personal preferences, and available resources (home, work, community, and health care access). The CM intervention was delivered in Spanish or English during face-to-face clinic visits supplemented by telephone consultations, as needed. For non–English- and non–Spanish-speaking patients, CM visits were translated by an accompanying adult family member or a friend. Protocol-designated visits had scheduled durations of

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**Figure 1.** Patient flowchart. CM indicates case management; CVD, cardiovascular disease; FRS, Framingham risk score; UC, usual care.
30 to 60 minutes and occurred at 4- to 6-week intervals during the initial 6 months and every 2 to 3 months thereafter, with a per-patient target of 8 to 10 visits during 15 months. Each visit began with a brief physical examination and a review of the patient’s risk reduction plan, progress, and problems. Counseling was then provided and referrals made as needed.

**BASELINE AND FOLLOW-UP ASSESSMENTS**

Participants completed assessments at baseline and at 15 months. Follow-up assessments were completed by research staff other than the case managers who had been directly responsible for the patient’s care, and medical records with the baseline visit data were not available to the study staff at the follow-up visit. A fasting blood sample was obtained by the fingerstick method for analysis of levels of blood glucose, total cholesterol, triglycerides, and high- and low-density lipoprotein cholesterol (LDL Analyzer, Cholestech Corporation, Hayward, California). Plasma hemoglobin A1c levels were also measured (GDX Analyzer; Cholestech Corporation). Height (baseline only), weight, and waist circumference were measured, and body mass index was calculated as the weight in kilograms divided by height in meters squared. Resting BP was measured in the seated position in both upper arms using well-maintained equipment and properly sized cuffs, and the average of the 2 readings was used.

**PRIMARY OUTCOME**

The prespecified primary outcome variable was the global CVD risk score, according to the 1998 sex-specific Framingham point score algorithms of Wilson et al. Although those algorithms were developed for prediction of absolute coronary risk among patients without clinical manifestations of coronary heart disease, they combine the following major risk factors recognized for coronary and other atherosclerotic CVD: age, sex, high BP, smoking, dyslipidemia, and diabetes status. We used risk scores as a composite measure of change in modifiable major risk factors, rather than as a predictor of risk, for patients without clinical manifestations of coronary heart disease.2 Sensitivity analyses were performed to assess the robustness of analytical results. First, we evaluated intervention effect on the primary outcome, FRS, was examined at 15 months on an intention-to-treat basis using a mixed-effects regression model adjusted for baseline FRS. The model also took into account random effects associated with physicians and clinics in a hierarchical structure. The magnitudes and patterns of missing data were examined by randomized group, and no significant differences were detected. Missing outcomes at the 15-month follow-up were imputed using the method of the baseline observation carried forward. The same mixed-effects model was used for protocol-specific subgroup analyses defined by sex and ethnicity. Sensitivity analyses were performed to assess the robustness of analytical results. First, we evaluated intervention effects using alternate risk models. We repeated the primary analyses with alternative global cardiovascular risk scores and stroke risk scores available from the Framingham Study and others.23-25 Although limited by sample size, we also analyzed subgroups using coronary risk functions specific to patients with type 2 diabetes mellitus (United Kingdom Prospective Diabetes Study)26 (63.0% of the study sample) and those with existing CVD (18.9%). Second, we evaluated the sensitivity of study results to missing outcomes by replacing missing data with values from a multiple regression imputation model.29 Third, we performed a complete-case analysis on the subset of patients who attended a 15-month follow-up visit to estimate efficacy. Results from these sensitivity analyses were consistent with those from primary analyses; we report the latter only. In addition to between-group differences, mean (95% confidence interval [CI]) changes from baseline to 15 months by group are reported. All analyses of individual risk factors were performed on the subset of patients with complete follow-up data and were compared using t tests. All reported P values and 95% CIs are 2 sided. Statistical significance was set at P < .05. All analyses were performed using commercially available software (SAS, version 9.1; SAS Institute Inc, Cary, North Carolina).

This trial was designed to enroll 400 patients equally to the CM or UC group. This sample size was powered to detect a group difference in the FRS at 15 months of half of a standard deviation at an α level of .01 and a power of 87% after accounting for a 25% loss to follow-up.

**RESULTS**

**BASELINE CHARACTERISTICS**

We exceeded our target sample size and enrolled 419 ethnically diverse patients of low socioeconomic status to CM (n = 212) and UC (n = 207). Baseline demographic and clinical characteristics were similar between the CM and UC groups (Table 1). Patients in the CM group, however, were less likely to have completed eighth grade (P = .02). The rate of retention was 81.4% for a mean follow-up of 16 (range, 7-25) months and did not vary by randomized group (P = .89).

**PRIMARY OUTCOME: FRS**

Compared with baseline, the mean FRS decreased in the CM group (−0.92; 95% CI, −1.28 to −0.57), whereas it remained unchanged in the UC group (−0.19; −0.56 to 0.18) (Table 2). Among patients randomly assigned to receive CM, the amount of change in the FRS was inversely associated with the number of face-to-face visits (r = −0.22; P = .001; Figure 2). The mean (SD) number of CM visits was 8.0 (5.3), equivalent to 11.2 (6.8) hours of face-to-face contact time.

Compared with the UC group, the FRS of the CM group was significantly lower at 15 months (difference between groups, −1.13; 95% CI, −1.94 to −0.32; P = .001) after adjusting for the baseline FRS and the effects of clinic and physician (Table 2). This is equivalent to 5 fewer heart disease events per 1000 individuals per year attributable to the intervention or to 200 individuals receiving the intervention to prevent 1 event per year. Variations in the intervention effect did not differ significantly among physicians or clinics. In addition, the mean FRS at 15 months was consistently lower for CM vs UC across tertiles of baseline FRS (data not shown).
The pattern of results was similar in subgroups defined by sex and ethnicity, although the results were not quite significant for women and Hispanic patients. Compared with the UC group, the CM group decreased the FRS by a mean of 1.45 points ($P = .002$) in men (equivalent to 5 fewer heart disease events per 1000 individuals per year), 0.89 points ($P = .06$) in women (4 fewer events), 0.82 points ($P = .07$) in Hispanic patients (3 fewer events), and 1.66 points ($P = .004$) in non-Hispanic patients (6 fewer events) (Table 2).

### SECONDARY OUTCOMES

Table 3 gives the changes from baseline in selected clinical and metabolic risk factors by randomized group. The mean (SD) change from baseline in systolic BP was $-4.2$ (18.5) mm Hg in the CM group and 2.6 (22.7) mm Hg in the UC group ($P = .003$). Diastolic BP declined in both groups but the magnitude of reduction was significantly greater for the CM group ($P = .02$). For diabetic patients, those in the CM group demonstrated a significantly greater decrement in fasting blood glucose level than those in the UC group ($-21.0$ vs $-1.4$ mg/dL; $P = .01$). (To convert the glucose level to millimoles per liter, multiply by 0.0555.) For the CM vs UC group, mean changes in low- and high-density lipoprotein cholesterol levels and body mass index were favorable for CM but not statistically significant. Unfavorable but nonsignificant mean changes in triglyceride levels and waist circumference in women were noted for CM.

Patients were divided into 3 categories according to baseline clinical status: nonhypertensive, hypertensive and nondiabetic, and hypertensive and diabetic. Blood pressure control was defined as a systolic BP of less than 140 mm Hg and a diastolic BP of less than 90 mm Hg for non-diabetic patients and as a systolic BP of less than 130 mm Hg and a diastolic BP of less than 80 mm Hg for diabetic patients (no participant had chronic kidney disease). Target BP was achieved at 15 months in 56.5% of CM patients and 38.6% of UC patients overall ($P = .001$; Figure 3). Blood pressure control rates were also higher

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**Table 1. Baseline Characteristics of Participants**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall (N = 419)</th>
<th>CM Group (n = 212)</th>
<th>UC Group (n = 207)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic and social</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>55.1 (9.6)</td>
<td>54.4 (9.5)</td>
<td>55.8 (9.7)</td>
<td>.17</td>
</tr>
<tr>
<td>Female, %</td>
<td>65.6</td>
<td>64.6</td>
<td>66.7</td>
<td>.66</td>
</tr>
<tr>
<td>Hispanic, %</td>
<td>63.0</td>
<td>63.2</td>
<td>62.8</td>
<td>.93</td>
</tr>
<tr>
<td>African American, %</td>
<td>9.6</td>
<td>9.9</td>
<td>9.2</td>
<td>.80</td>
</tr>
<tr>
<td>Asian/Pacific Islander, %</td>
<td>11.9</td>
<td>11.3</td>
<td>12.6</td>
<td>.70</td>
</tr>
<tr>
<td>Education less than eighth grade, %</td>
<td>44.9</td>
<td>50.7</td>
<td>39.0</td>
<td>.02</td>
</tr>
<tr>
<td>Unemployed, disabled, or retired, %</td>
<td>60.5</td>
<td>63.2</td>
<td>57.7</td>
<td>.26</td>
</tr>
<tr>
<td>Unable to speak, read, or understand English, %</td>
<td>49.1</td>
<td>50.5</td>
<td>48.1</td>
<td>.62</td>
</tr>
<tr>
<td><strong>Health status</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-y FRS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>7.2 (2.9)</td>
<td>7.1 (3.1)</td>
<td>7.5 (2.7)</td>
<td>.42</td>
</tr>
<tr>
<td>Women</td>
<td>9.8 (4.3)</td>
<td>9.6 (4.4)</td>
<td>10.0 (4.3)</td>
<td>.51</td>
</tr>
<tr>
<td>TC level, mg/dL</td>
<td>190.2 (41.0)</td>
<td>187.7 (39.7)</td>
<td>192.7 (42.4)</td>
<td>.22</td>
</tr>
<tr>
<td>LDL-C level, mg/dL</td>
<td>104.2 (32.7)</td>
<td>104.2 (33.6)</td>
<td>104.2 (31.8)</td>
<td>.99</td>
</tr>
<tr>
<td>HDL-C level, mg/dL</td>
<td>45.7 (12.1)</td>
<td>45.0 (12.2)</td>
<td>46.3 (12.1)</td>
<td>.27</td>
</tr>
<tr>
<td>TC to HDL-C level ratio</td>
<td>4.5 (1.7)</td>
<td>4.4 (1.4)</td>
<td>4.5 (1.9)</td>
<td>.72</td>
</tr>
<tr>
<td>Triglyceride level, mg/dL</td>
<td>201.0 (105.7)</td>
<td>196.4 (101.1)</td>
<td>205.5 (110.1)</td>
<td>.38</td>
</tr>
<tr>
<td>Systolic BP, mm Hg</td>
<td>133.9 (19.8)</td>
<td>132.7 (19.4)</td>
<td>135.1 (20.2)</td>
<td>.20</td>
</tr>
<tr>
<td>Diastolic BP, mm Hg</td>
<td>79.6 (10.4)</td>
<td>79.6 (10.6)</td>
<td>79.6 (10.1)</td>
<td>.94</td>
</tr>
<tr>
<td>CVD, %</td>
<td>18.9</td>
<td>17.9</td>
<td>19.6</td>
<td>.62</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>63.0</td>
<td>64.2</td>
<td>61.8</td>
<td>.62</td>
</tr>
<tr>
<td>Hemoglobin A1c level, %$^b$</td>
<td>7.6 (1.7)</td>
<td>7.6 (1.7)</td>
<td>7.7 (1.7)</td>
<td>.87</td>
</tr>
<tr>
<td>FBG level, mg/dL$^b$</td>
<td>159.8 (58.3)</td>
<td>161.2 (62.2)</td>
<td>158.2 (54.2)</td>
<td>.68</td>
</tr>
<tr>
<td>Metabolic syndrome, %</td>
<td>59.2</td>
<td>59.0</td>
<td>59.4</td>
<td>.92</td>
</tr>
<tr>
<td>Cigarette smoking, %</td>
<td>16.2</td>
<td>16.0</td>
<td>16.4</td>
<td>.96</td>
</tr>
<tr>
<td>Family history of CAD or stroke, %</td>
<td>45.4</td>
<td>44.3</td>
<td>46.4</td>
<td>.68</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>33.0 (7.6)</td>
<td>33.1 (7.1)</td>
<td>32.9 (8.2)</td>
<td>.87</td>
</tr>
<tr>
<td>Women</td>
<td>35.4 (8.6)</td>
<td>35.2 (7.2)</td>
<td>35.5 (9.9)</td>
<td>.76</td>
</tr>
<tr>
<td><strong>Waist circumference, cm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>104.1 (18.3)</td>
<td>104.6 (16.5)</td>
<td>103.9 (20.3)</td>
<td>.83</td>
</tr>
<tr>
<td>Women</td>
<td>107.2 (15.5)</td>
<td>107.7 (15.5)</td>
<td>106.9 (15.7)</td>
<td>.68</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure; CAD, coronary artery disease; CM, case management; CVD, cardiovascular disease; FBG, fasting blood glucose; FRS, Framingham risk score; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; UC, usual care.

SI conversion factors: To convert TC, HDL-C, and LDL-C to millimoles per liter, multiply by 0.0259; FBG to millimoles per liter, multiply by 0.0555; hemoglobin A1c to a proportion of 1, multiply by 0.01; triglycerides to millimoles per liter, multiply by 0.0113.

$^a$Unless otherwise indicated, data are expressed as mean (SD).

$^b$Includes only patients with diagnosed diabetes.
in the CM group compared with the UC group, for hypertensive patients with (41.9% vs 22.7%; P = .007) or without (69.8% vs 38.5%, P = .001) diabetes mellitus. The control rate for BP among patients who were nonhypertensive at baseline did not differ significantly by randomized group. Our search for mediators of the intervention’s effect on systolic BP identified reduction in dietary saturated fats as a mediating variable (P = .03), whereas the number of antihypertensive medications was not.

The use of alternative prediction models indicated substantial agreement with the FRS model. Models that relied heavily on BP (eg, the Framingham stroke score) suggested more dramatic improvements associated with CM than we report, whereas those relying more heavily on other variables (eg, the United Kingdom Prospective Diabetes Study) show favorable but nonsignificant net changes.

The 15-month intervention cost $896 per person in 2008 dollars, including labor, supplies, and office space. In routine practice we expect that the intervention would be slightly less intensive but would extend beyond 15 months. If a registered nurse delivers all care, then we estimate a cost of $371 for year 1 and $337 annually thereafter (2008 dollars). If instead an internist delivers all care, then the estimated cost rises to $686 in year 1 and $647 annually thereafter.

SERIOUS ADVERSE EVENTS

Five patients died during the study, including 4 in the UC group and 1 in the CM group (P = .21). Emergency department visits were equally likely among the CM participants (27.8%) and UC participants (24.6%; P = .46). The SMMC system uses their emergency department for all after-hours urgent and emergency care for patients examined in the primary care clinics. Among the CM participants, 2 episodes of diabetic hypoglycemia occurred, resulting in emergency department visits, and were likely related to the increased intensity of glucose control strategies in the CM group. The rates of hospitalizations were similar between the 2 groups (18 vs 16 hospitalizations per 100 participants in the CM vs UC groups). Hospitalizations for cardiac diagnoses (including chest pain) were more frequent in the CM group than in the UC group (8.0 vs 3.4 hospitalizations per 100 participants; P = .04). The Data and Safety Monitoring Board determined that none of the deaths, CVD events, or other hospitalizations were causally related to study participation. The CM participants, however, likely had more opportunities to receive advice to have cardiac symptoms evaluated.

COMMENT

We tested a CM intervention targeting multifactor cardiovascular risk reduction for persons at elevated risk of CVD events in a low-income, predominantly ethnic minority, largely diabetic population in a county health care system. The CM intervention significantly lowered the global CVD risk score compared with UC. The intervention effect on global risk score was similar for all subgroups by sex and ethnicity. Although not always statis-
changes in biological risk factors.8-11 minority patients and achieving clinically meaningful recruitment approaches also have demonstrated success in UC. Other studies evaluating multifactor CVD risk reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD risk.7-9 Levels of low-density lipoprotein and reduction interventions among patients at varying levels of CVD 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ers to medications, focus on survival issues without a long-term perspective, and limited resources to facilitate lifestyle changes. However, such populations might particularly benefit from multifactor CVD risk management: most current care focuses on acute care needs, and baseline prevention services may be particularly lacking. Furthermore, gaps between the guideline and actual risk factor measures are wider in these populations despite their adverse CVD risk factor profiles, representing the so-called inverse care law whereby medical care is most lacking for patients with the greatest need.30

Research also shows that, to maximize benefits of multifactor CVD risk management for low-income, ethnic minority patients, strategies that address known social, cultural, and financial barriers to optimal health care for disadvantaged populations are needed.8 Clinical prevention services, including clinical CM, will fall short of their promise if provided in isolation from a patient’s living environment.31 It may be unrealistic to expect patients to implement advice given in medical settings without a complementary strategy focused on their home and neighborhood environments.32 In the HTH project, case managers coordinated access to community resources (eg, smoking cessation programs and pharmacy support programs), but all direct CM services were provided within health centers. Previous research has shown that outreach by community health workers can improve CVD prevention.8

Our recruitment process yielded participants who were a high-risk subset of the SMMC population. As a population requiring more intensive outpatient services, they form an important group in which to assess the effectiveness of CM. Although the use of point-of-care laboratory testing provided immediate feedback, this strategy introduced additional measurement variation and may have hampered detection of outcome differences. The Framingham risk functions13 integrate the risk factors that account for most of the CVD burden.2 Consistent findings when other risk functions (including those specific to patients with diabetes and existing CVD)23,26–28 were applied suggests robustness for our results. We acknowledge that these models were not developed for persons with established CVD,13,23 who accounted for 18.9% of our sample. In addition, application of any risk function developed in a single cohort to populations with differing background risk can be associated with misclassifications and might ideally require recalibration or consideration of other risk factors to improve prediction.22 These concerns are mitigated by using the FRS as a composite measure of change in modifiable risk factors, not as a predictor of risk.

Our CM approach to multifactor cardiovascular risk reduction was efficacious. These findings suggest that a multifactor risk reduction approach can foster improved cardiovascular care and outcomes for high-risk patients in low-income, ethnic minority populations.

Accepted for Publication: August 8, 2009.

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Author Contributions: Drs Ma, Xiao, and Stafford had access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Ma, Berra, Haskell, Smith, and Stafford. Acquisition of data: Berra, Klieman, Hyde, and Stafford. Analysis and interpretation of data: Ma, Berra, Haskell, Smith, Xiao, and Stafford. Drafting of the manuscript: Ma, Xiao, and Stafford. Critical revision of the manuscript for important intellectual content: Ma, Berra, Haskell, Klieman, Hyde, Smith, and Stafford. Statistical analysis: Ma, Smith, Xiao, and Stafford. Obtained funding: Berra and Stafford. Administrative, technical, and material support: Berra, Haskell, and Stafford. Study supervision: Ma, Berra, Klieman, Hyde, and Stafford.

Financial Disclosure: Dr Stanford reports having been a consultant to Bayer Corporation and has had grants or contracts with Procter & Gamble, GlaxoSmithKline, Toyo Shinyaku, and Wako.

Funding/Support: This study was primarily supported by research award R01 HL070781 from the National Heart, Lung, and Blood Institute. It was also supported with resources and the use of facilities at the Veterans Affairs Palo Alto Health Care System. Additional resources were received from the SMMC, which provided guidance on the design, implementation, and reporting of the project.

Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the US government. The funding organizations played no role in the design, implementation, or reporting of the study.

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