Cost-Effectiveness of a Peer and Practice Staff Support Intervention

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Objectives: We examined the cost-effectiveness of an intervention to reduce coronary heart disease (CHD) risk and blood pressure in African Americans.

Study Design: Stochastic cost-effectiveness analysis alongside a clinical trial, augmented by a Markov model of lifetime cost-effectiveness.

Methods: In 2 urban academic primary care practices, we randomized African American patients with uncontrolled hypertension to a 6-month intervention of office practice and peer coach behavioral support (N = 136) or informational brochures about CHD risk factors (N = 144). Costs were estimated from the perspective of the provider. Outcomes included estimated CHD events avoided over 6 months and reduction in systolic blood pressure (SBP) (mm Hg). Subgroup analysis was performed for compliers who received an "effective" dose of the peer coach and office staff visits. Long-term cost-effectiveness was estimated by applying the clinical trial cost and effectiveness into a Markov model of CHD risk.

Results: The average cost for the behavioral support intervention group was $435.36 compared with $74.39 for the brochure control group. The incremental cost-effectiveness ratio (ICER) was $47 per mm Hg reduction in SBP and $453,419 per CHD event avoided in 6 months. Modeled over a 10-year horizon, the intervention had an ICER only as high as $3998 per incremental quality-adjusted life-year.

Conclusions: A community-primary care practice behavioral intervention to reduce hypertension in African Americans with sustained uncontrolled hypertension does not appear to be cost-effective in the first 6 months. If intervention results are sustained over the long term, the program may be cost-effective over the patient's lifetime.

Am J Manag Care. 2014;20(3):253-260

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Innovative models of primary care offer the potential to reduce disparities in health outcomes for vulnerable populations with chronic diseases.[1] Cost-effectiveness studies have reported that future healthcare utilization and costs can be reduced by implementing a diabetes patient registry along with clinical meetings.[2] Supplementing a registry with education for patients with diabetes about self-management and improving professional quality of care also meets standard guidelines of increasing quality-adjusted life-years (QALYs).[3] However, few cost analyses have been conducted of interventions based on Wagner's chronic care model that focus on reducing coronary heart disease (CHD) risk and improving blood pressure (BP) in those from racial/ethnic minority backgrounds.

We report a cost-effectiveness analysis of a randomized, controlled trial of a 6-month community- and staff-based intervention of behavioral support and education for African Americans with sustained, uncontrolled hypertension based on a practice-based registry. All subjects received educational brochures and usual physician care while intervention subjects received 3 community support phone calls from trained peers from the same practices alternating with personal counseling by trained mid-level staff at 2 practice visits on alternate months. The study outcomes were 6-month changes in systolic blood pressure (SBP) and CHD risk. These results add to evidence of the potential cost-effectiveness from a provider standpoint of adopting features of the chronic care model to empower patients to reduce CHD risk due to poorly controlled risk factors.

METHODS

Study Participants

Study subjects were recruited from July 2007 through November 2009 in 2 urban academic general internal medicine practices largely serving low-income patients. Subjects were identified from a registry of all 9135 African American patients aged 40 to 75 years receiving longitudinal care (2+ visits in 2 years). We identified those patients with treated but uncontrolled hypertension per the 7th Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) targets (ie, SBP 130 mm Hg or higher, or diastolic blood

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Take-Away Points

A community and primary care practice behavioral intervention may be cost-effective to reduce hypertension in African Americans with sustained uncontrolled hypertension. From the payer perspective, the intervention appears to be:

- Not likely to be cost-effective in reducing coronary heart disease in the first 6 months.
- Likely to be cost-effective in lowering blood pressure in the first 6 months.
- Cost-effective in terms of incremental cost per quality-adjusted life-year over the lifetime of the patient if the intervention results are sustained.

pressure [DBP] 80 mm Hg or higher, if chronic kidney disease or diabetes; otherwise, SBP 140 mm Hg or higher, or DBP 90 mm Hg or higher) and at least 1 value 10 mm Hg above goal.[4] Of 1057 subjects with uncontrolled hypertension, recent lipid levels, and at least moderate adherence to keeping primary care visits, 810 were randomly selected to ask approval from the provider for the trial; 574 were approved and sent a recruitment letter. Of 440 patients who were contacted, 280 subjects were randomized.

Intervention

The Healthy Heart trial randomly assigned subjects to 1 telephone-based peer counseling session and office-based visits with trained mid-level providers over 6 time frames, or to a control condition of usual physician care. Practice providers nominated 20 patients to serve as peer coaches from lists of African Americans with well-controlled hypertension aged 50 to 75 years, because they were perceived to be "good communicators." Of these, 11 completed training and 5 continued to the end of the study while 3 replacements were recruited and trained to assist with peer support. Training involved viewing and discussing illustrated slide shows created by the study team about CHD in the community and risks and barriers to control. Peer coaches were taught elements of motivational interviewing and practiced phone calls before being assigned patients. Peer coaches contacted intervention patients every other month for 6 months (minimum of 3 calls).

For practice-based counseling visits, we trained 3 African American staff members (eg, medical assistants) with the same slide shows used to train peers, and also trained them to use a personalized, computer-based, 4-year CHD risk calculator as a teaching tool. On alternate months from peer calls, patients made two 15- to 30-minute visits with trained practice staff to review personal CHD risk factors. All study subjects received culturally appropriate educational brochures and healthy recipes from the American Heart Association. Participants received $50 in gift certificates for participation ($20 at enrollment and $30 at end point visit). Peer coaches received $20 per completed phone call and followed a mean of 8 patients at once (other costs in Table 1). The protocol and procedures were reviewed and approved by the University of Pennsylvania Institutional Review Board.

Costs

Direct intervention costs were estimated from the perspective of the provider/health system and measured in 2010 US dollars. Because the trial was based on outcomes monitored over 6 months, we did not apply any discounting. Specific resources used for the intervention included cost of training peer coaches, labor cost of peer coach telephone calls, cost of training office-based health educators, cost of clinic visits and laboratory tests, incentives for patients, cost of brochures, and cost of materials such as transportation, postage, and office supplies (Table 1). We also included costs for the overall administration of the trial, but not solely research-related costs. For the brochure control group, resources included the cost of clinic and laboratory visits and the cost of the brochures. Patients in the intervention group incurred all of these costs. Costs that were not relevant to the provider perspective, such as indirect costs for patients, were not considered.

Effectiveness

We studied 2 measures of effectiveness for the within-trial stochastic cost-effectiveness analysis: predicted 6-month CHD risk avoided and 6-month improvements in SBP (per mm Hg). The 6-month CHD risk measure was derived from D'Agostino's risk equations for primary events and secondary events in Framingham data (eg, myocardial infarction, angina), using original (rather than the calibrated) versions of these equations.[5] Separate risk equations were used for men and women. Our primary CHD event end point combined predicted 6-month risk of primary and secondary CHD events for patients. All outcomes were based on an intention-to-treat approach. In the long-term cost-effectiveness analysis, we studied 2 measures of effectiveness: years of life saved (YLS) and QALYs, both over a 10-year lifetime horizon.

Cost-Effectiveness Analysis

Two cost-effectiveness analyses were performed: a within-trial stochastic cost-effectiveness analysis that focused on cost-effectiveness during the 6-month trial period, and long-term cost-effectiveness based on a Markov model that modeled the longer-term benefits of BP reduction.[6,7]

For the within-trial stochastic cost-effectiveness analysis, we estimated 2 incremental cost-effectiveness ratios (ICERs): incremental cost per predicted CHD event avoided within

Table 1. Costs and Resource Utilization Measures

Item	Units	Total Costs	Costs per Patient
Healthcare visits			
Clinic	$10.00 per visit	$2750.00	$20.22
Lab	$19.19 per visit	$1669.53	$12.28
Peer coaches	16		
Training	$100-$200	$10,040.00	$73.82
Phone calls	$20 per call	$7440.00	$54.71
Health educators	3		
Training	4 hours	$233.16	$1.71
Sessions	188 sessions	$3665.92	$26.96
Program coordinator	80% effort	$19,665.13	$144.60
Materials			
Postage	—	$648.81	$4.77
Transportation	—	$539.19	$3.96
Office supplies	—	$229.34	$1.69
Copy charges	—	$2.60	$0.02
Miscellaneous supplies	—	$285.15	$2.10
Conference calls with peer coaches	—	$30.00	$0.22
Incentives: gift cards, lunches	—	$9004.00	$66.21
Brochures	$1.13 per set of 2	—	$1.13

6 months, and incremental cost per mm Hg in SBP reduced. To characterize the uncertainty of the within-trial cost-effectiveness results, we used bootstrapping to estimate a 95% confidence ellipse around the ICER.[8,9] The bootstrap method resampled the data 10,000 times with replacement, and computed the ICER for each replicate. From the bootstrap samples, we estimated the probability that one treatment was cost-effective compared with the other for a given willingness to pay (WTP). In addition, we computed the cost-effectiveness acceptability curve (CEAC) and plotted the probability that the behavioral health intervention was cost-effective over a reasonable range of levels of WTP.[10]

We performed a subgroup analysis for patients who were compliant with the intervention. We defined an effective "dose" as at least 2 peer coach calls and 1 practice visit. We then estimated the ICER for the intervention in this intervention subgroup relative to the control group. All stochastic cost-effectiveness analyses were performed using R statistical software (version 2.10.1, http://www.r-project.org).

Long Term Cost-Effectiveness

To estimate the long-term costs and benefits of BP reduction observed in the trial, data on costs and effectiveness from the clinical trial were entered into a Markov model of CHD risk in order to extrapolate trial results to a 10-year lifetime horizon. The Markov model was designed to study the impact of antihypertensive medications and was adapted to this setting. The model has a 10-year time horizon with yearly cycles. All costs begin in year 2010 US dollars and were discounted at a rate of 3%. Utility values for health states were drawn from Sullivan et al and Currie et al.[13,14] As effectiveness measures, the model estimates YLS and QALYs. Additional details of the model are provided in Baker et al.[11]

Because the trial only lasted 6 months, it was necessary to make assumptions about how the intervention would be provided over the 10-year time horizon of the Markov model. We assumed that yearly reinforcements of the intervention would be required in order to sustain improvements.

RESULTS

The 280 intervention (N = 136) and control (N = 144) subjects were well balanced on demographics and clinical conditions (Table 2). Complete data to estimate CHD risk were available for 212 (94 intervention and 118 control)

Table 2. Baseline Characteristics of Intervention and Control Groups of African American Primary Care Patients with Uncontrolled Hypertension

Characteristics	Total Study Population (N = 280)	Intervention Group (N = 136)	Brochure/Cookbook Control Group (N = 144)
Age (years), mean (SD)	61.9 (8.83)	61.2 (9.29)	62.6 (8.34)
Gender, N (%)			
Female	183 (65.4%)	95 (69.9%)	88 (61.1%)
Male	97 (34.6%)	41 (30.1%)	56 (38.9%)
Clinical conditions, N (%)			
Diabetes mellitus	151 (53.9%)	76 (55.9%)	75 (52.1%)
Coronary artery disease or equivalent	50 (17.9%)	20 (14.7%)	30 (20.8%)
Depressive symptoms	117 (41.8%)	55 (40.4%)	62 (43.1%)
Current smoker	52 (18.6%)	27 (19.9%)	25 (17.4%)
Baseline lipid levels, mg/dl (SD)			
LDL cholesterol	114.8 (29.35)	116.2 (29.46)	113.4 (29.29)
HDL cholesterol	55.7 (15.37)	57.5 (15.4)	54 (15.21)
Triglycerides	143.8 (85.07)	138.1 (74.6)	149.1 (93.84)
Total cholesterol	198.2 (33.73)	200.5 (33.63)	196.1 (33.79)
Blood pressure			
Systolic	140.5 (9.08)	140.5 (9.34)	140.5 (8.86)
Diastolic	81.2 (7.26)	81.4 (7.84)	81.0 (6.69)

SD indicates standard deviation.
Entries are mean (SD) and count (proportion) for continuous and categorical outcomes, respectively. No differences between intervention and control group are statistically significant.

Table 3. Average Costs, Outcomes, and Incremental Cost-Effectiveness Ratio During 6-Month Trial for Patients, Without Missing Data

Measure	Cases	Controls	Difference	ICER
All patients	(N = 94)	(N = 118)	—	—
Cost	$435.36	$74.39	$360.97	—
SBP (change)	–7.15	–0.77	–6.38	–55.47
6-month CHD risk (change)	–0.05%	0.03%	–0.08%	–453,419
Patients who completed effective dose	(N = 79)	(N = 118)	—	—
Cost	$441.66	$74.39	$367.27	—
SBP (change)	–8.45	–0.77	–7.68	–47.80
6-month CHD risk (change)	–0.07%	0.03%	–0.10%	–350,134

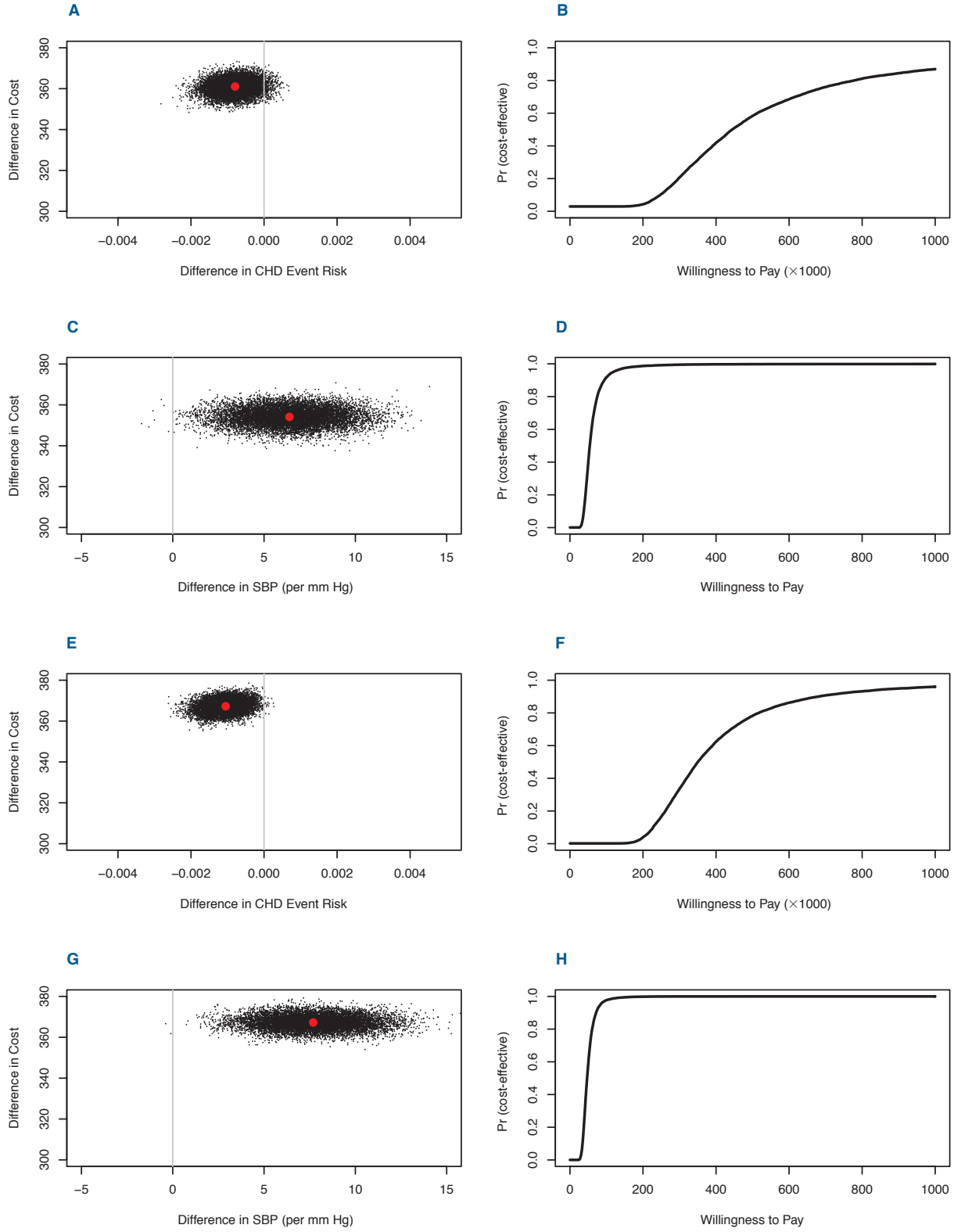
CHD indicates coronary heart disease; ICER, incremental cost-effectiveness ratio; SBP, systolic blood pressure.

subjects and complete end point data were available for 247 (116 intervention and 131 control) subjects. Sixty-eight percent of intervention subjects (N = 79) were compliant with an effective "dose" intervention (ie, at least 2 peer coach calls and 1 practice visit) and included in the compliance subgroup analysis.

Baseline cost-effectiveness results (Table 3) show that the average cost over 6 months of the intervention was $435 for intervention subjects and $74 for control subjects. The intervention was successful in reducing both SBP and CHD risk. SBP fell by 7.2 mm Hg among intervention subjects, compared with only 0.77 mm Hg for control subjects (P = .0011). The average difference in CHD risk among intervention subjects fell by 0.046% but rose by 0.034% among control subjects (P = .07). The ICERs were $453,419 per predicted CHD event avoided over 6 months and $55 per mm Hg reduced in 6 months.

The uncertainty analysis for these ICERs (Figures 1A and 1B) shows a high probability that the intervention would re-

■ **Figure 1.** Plots of 10,000 Bootstrap Replicates of the Incremental Cost-Effectiveness Ratio (left panels) and Their Cost-Effectiveness Acceptability Curves (right panels) for Patients Without Missing Data (panels A-D) and Subset of Patients Who Received an Effective Dose (at least 2 peer coach calls plus at least 1 practice visit, panels E-H)



CHD indicates coronary heart disease; Pr, probability; SBP, systolic blood pressure.

Table 4. Long Run Cost-Effectiveness Results Extrapolating Trial Results Using 10-Year Markov Model

Measure	Cases	Controls	Incremental	ICER
Costs				
CHD and CVD events	$3020	$3651	–631	—
Follow-up costs	$1564	$1682	–118	—
Program costs	$2740	$251	2490	—
Total	$7324	$5584	1741	—
Effectiveness				
YLS	8.0	7.8	0.1	$12,373
QALY	6.3	6.2	0.2	$10,866

CHD indicates coronary heart disease; CVD, cardiovascular disease; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life year; YLS, years of life saved.

sult in a reduction in systolic blood pressure. The probability that the intervention is cost-effective is 25%, 50%, and 75% if the decision maker is willing to pay $45.20, $55.40, and $70.80, respectively, to reduce SBP by 1 mm Hg for at least 6 months (Figure 1B). For CHD risk, the CEAC suggests that the probability that the intervention is cost-effective for reducing CHD risk is 25%, 50%, and 75% if the decision maker is willing to pay $324,000, $449,000, and $674,000, respectively, to avoid 1 CHD event over 6 months (**Figures 1C** and **1D**).

Similar results were observed for the subgroup of patients who were compliant with the intervention (Table 3). The average cost of the intervention over 6 months was $442 for compliant intervention subjects and $74 for control subjects. SBP fell 8.5 mm Hg among intervention subjects, compared with only 0.77 mm Hg for control subjects. The average difference in CHD risk among compliant subjects decreased by 0.07% and increased by 0.03% among control subjects. The ICERs were $48 per mm Hg reduced in 6 months and $350,134 per predicted CHD event avoided over 6 months. The CEACs for the compliant subgroup, presented in Figure 1 (**G** and **H**), suggest that the probability that the intervention is cost-effective in reducing SBP is 25%, 50%, and 75% if the decision maker is willing to pay $34, $40, and $48, respectively, to reduce SBP by 1 mm Hg for at least 6 months. The probability that the intervention is cost-effective in reducing CHD risk is 25%, 50%, and 75% if the decision maker is willing to pay $274,000, $351,000, and $476,000, respectively, to avoid 1 additional CHD event in 6 months (**Figures 1E** and **1F**).

Long-term cost-effectiveness results are presented in **Table 4**. Assuming that the intervention was given every year over the patient's lifetime (10-year horizon), the intervention was more costly ($7324 vs $5584), but also more effective, both in terms of YLS (8 vs 7) and QALYs (6.3 vs 6.2). This yields ICERs for the intervention of $12,373 per incremental YLS and $10,866 per incremental QALY saved.

DISCUSSION

This study finds that a combined community and office staff behavioral health intervention to reduce hypertension and risk of CHD among African American primary care patients with uncontrolled hypertension and other CHD risks is potentially cost-effective at reducing SBP in the short term, and in terms of cost per YLS and QALY in the long term, but not cost-effective for reducing CHD risk in the short term (6 months). There are 2 explanations for the relatively high within-trial ICER to prevent CHD events. First, substantial costs are expended for the initial training of peer coaches and practice team members. With a more mature program, these may be reduced, yielding lower cost-effectiveness ratios. We conducted qualitative interviews with our peer coaches and identified key characteristics that motivated sustained participation and may be used to find a cohort of committed, long-term peer coaches.[16] Second, the number of predicted CHD events avoided was low, as would be expected for a short (6-month) time frame. Extrapolating for 4 years, we found that predicted CHD risk would be reduced by 12% (0.73% absolute reduction from 6.1% baseline risk). Of course, additional costs would need to be incurred as well.

Another practical concern in regard to the high ICER for preventing 1 CHD event is that our within-trial analysis takes the provider or healthcare system's perspective, so the provider must cover the cost of the additional services to prevent this event. At this point in the United States, peer coaches are not routinely covered by payers and behavioral health visits with mid-level staff would not be reimbursed unless payment for care were changed from fee-for-service to another bundled scheme, such as one under the medical home model. Indeed, providers are not rewarded directly for avoiding CHD events. Only in a setting such as a national healthcare system would this expense be clearly beneficial from the provider perspective. On the other hand, pay-for-performance measures in the United States do evaluate BP control for persons with hypertension, so a $47 expense per mm Hg reduction in BP in persons whose control continues to be inadequate despite treatment might presently be attractive to a provider.

Our within-trial cost-effectiveness results regarding the role of lay counselors in CHD risk reduction are much higher than those from other countries. Barton et al studied the cost-effectiveness of lay health trainers in a randomized trial conducted in Liverpool, where the intervention involved offering information, advice, and support aimed at changing beliefs and behaviors in order to reduce risk of cardiovascular disease.[18] The intervention had an estimated ICER of £14,480 (approximately $22,709 per QALY) over 6 months. However, there was only a 39.5% chance that it would be cost-effective at a WTP threshold of £20,000, and at no WTP threshold was it cost-effective with a probability greater than 50%. A cost-effectiveness analysis of an Australian cluster-randomized trial of telephone counseling addressing diet and physician activity in 434 adult participants with type 2 diabetes mellitus or hypertension reported that the cost per QALY gained in 2008 Australian dollars was $29,375.[19] Although these studies use different metrics for cost-effectiveness assessment, collectively they paint a much more favorable picture for the use of lay counselors to reduce cardiovascular risk than our within-trial analysis. Extrapolating the trial results using the Markov model suggested that our intervention was cost-effective, even under the conservative assumption that the intervention would have to be repeated every year.

This study targeted a highly vulnerable population—African Americans—who have a greatly increased CHD risk in the United States.[21] CHD risk factor screening and counseling interventions that target low-income older persons in the community who are uninsured, such as the WISEWOMAN study, have found that, in the best-case analysis, it costs US $4400 per discounted life-year gained, but a sensitivity analysis revealed substantial uncertainty around this estimate.[22] Nonetheless, these data suggest that patients in healthcare delivery settings and persons in the community with poor access to care may benefit from interventions to reduce CHD risks that exact a great toll on minority populations. Of course, the financial resources required for these interventions may not be insignificant.

Limitations

There are several limitations to this study. CHD risk is based on predicted score, and we did not measure actual events. This is a common limitation of any trial to prevent CHD events, since few events can be expected over the short term. We used a CHD risk measure developed by D'Agostino and colleagues that is less commonly employed but offers the advantage of allowing us to assess risk of either a primary or a secondary CHD event.[5] Also, as noted in the results from the clinical end points, the difference in CHD risk was not statistically significant. This is less of a concern for the cost-effectiveness analysis since we are able to model the uncertainty in both the outcome and costs. In addition, because we did not directly measure utilities, we could not evaluate QALYs—a standard benchmark for cost-effectiveness—in the short term. This has 2 implications. First, it means that the within-trial results cannot be compared with other cost-utility analyses. And second, the usual thresholds for declaring an intervention cost-effective in terms of cost per QALY are in the range of $50,000 to $100,000. Since we do not report cost per QALY, decision makers must come to their own conclusions as to whether the intervention is cost-effective in the first 6 months, given the ICER. Finally, as noted earlier, the trial lasted only 6 months. But very few CHD events can be expected over such a short time period. We attempted to address these limitations by extrapolating the trial results using a Markov model. This has the advantage of providing QALYs, but is limited in that the results are modeled and not directly observed as they are in the within-trial analysis. The Markov model was also limited by the fact that its risk equations did not differentiate between primary and secondary CHD events for the 50 patients (20 cases and 30 controls) who had been previously diagnosed with coronary artery disease.

The threat of CHD looms large worldwide. A modeling analysis of the benefit of interventions to reduce this threat internationally found that targeting interventions to persons whose 10-year CHD risk is over 35% would avert 63 million disability-adjusted life-years worldwide.[15] In our trial, participants had a 6-month risk of CHD of roughly 0.63%, which would likely be under that very strict threshold. We suggest that developed nations must consider supporting behavioral interventions that complement pharmacotherapy to reduce risk factors for CHD.

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Source of Funding: This study was funded by the Robert Wood Johnson Foundation. In addition, Pfizer contributed supplemental funding for the study. Drs Hollenbeak, Weiner, and Turner received salary support from these funds to complete the work.

Author Disclosures: Dr Hollenbeak reports receiving a grant from the Robert Wood Johnson Foundation, which funded this study. The other authors (MGW, BJT) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (CSH, MGW); acquisition of data (JHN, MGW); analysis and interpretation of data (CSH); drafting of the manuscript (CSH); critical revision of the manuscript for important intellectual content (CSH, MGW); statistical analysis (CSH); administrative, technical, or logistic support (CSH).

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