

Appendix C.1

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Evaluation of Lifestyle Modification and Cardiac Rehabilitation in Medicare Beneficiaries*

The Economics of Cardiac Rehabilitation: A Review of Literature

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Introduction and Statement of Purpose

The goal of this review is to identify, review and rate all available credible evidence on the costs and cost effectiveness of cardiac lifestyle modification and related modalities, reflecting information as reported on all such modalities in the scientific literature. Unfortunately, the available literature in this area is both extraordinarily thin and highly variable in research integrity. While we felt obliged to be comprehensive in our review of this limited literature, we nevertheless thought it important to highlight the variable quality of this literature and explicitly acknowledge our lesser confidence in the findings from some studies. Heterogeneity of study methods precluded formal meta-analysis.

Review of Relevant Literature

One truly excellent literature review (Oldridge 1997) provided an invaluable point of departure and foundation for this report. In further searching the literature, we used MEDLINE and NLM Gateway to identify published articles with various subsets of keywords, including "heart," "cardiac" "rehabilitation," "diet," "exercise," "lifestyle," "cost" and "cost-effectiveness." We considered only those studies published in English, and reporting original empirical findings focused on cardiac rehabilitation (CR)-type programs and related interventions. Based on the abstracts, case-control and other very small-scale comparisons were eliminated, as were studies that reported only pre-post comparisons with no control group. We then obtained full text documents for studies remaining and eliminated those with manifest methodological flaws (e.g., using only a demographically-matched control group). Additional, generally older studies were identified from the literature reviews and bibliographies included in newer studies. Cost-related studies identified by the authors of other chapters were also referred to our attention. No meta-analyses were found. The studies described below are loosely organized in order of usefulness and quality. Their key findings, strengths and weaknesses are summarized in **Table 4.1**.

Table 4.1. Summary of Study Findings, Strengths and Weaknesses

Study	Key Finding	Strength(s)	Weakness(es)
Cost Analysis of a Five-Year Non-Randomized Trial of Exercise-Only Cardiac Rehabilitation (Levin et al. 1991)	Savings in health treatment expense nearly five times as large as the cost of this exercise-only program.	Five-year followup; well-matched comparison group.	Comparatively small sample sizes (about 150 each); program conducted more than 25 years ago; exercise only program.
Differences in Rehospitalization Charges for Self-Selected Cardiac Rehabilitation Patients (Ades et al. 1992)	Short-term savings in rehospitalization charges amounts to two-thirds of cost for traditional cardiac rehabilitation program.	Modern cardiac rehabilitation program; supporting analysis of covariance.	Entry into cardiac rehabilitation self-selected; physician charges not monitored; charges rather than cost; only 21-month followup.
A Meta-Analysis Based Cost-Effectiveness Estimate (Ades et al. 1997)	Incremental life expectancy of 0.202 years for cardiac rehabilitation participants; net cost (in 2003 dollars) of a cardiac rehabilitation program amounts to approximately \$6,000 per life-year saved.	Meta-analysis of 22 randomized trials of cardiac rehabilitation; involving total of 2,200 patients.	Meta-analysis data reflect experience of mostly male, non-elderly populations who underwent rehabilitation prior to availability of thrombolytic therapy and lipid-lowering drugs; health care cost savings estimate based on single study (Ades et al. 1992).

Study	Key Finding	Strength(s)	Weakness(es)
The Costs of Hospital vs. Home-Based Rehabilitation (Marchionni et al. 2003)	Home-based program costing less than a fifth of hospital-based program; notably lower health care costs in the home-based program.	Randomized trial with three groups: hospital-based, home-based and control; 12-month followup; supporting evidence from total work capacity and health-related quality of life measurements.	Small sample sizes (90 each); statistical significance of cost differences not reported (but evidently not significant).
Economic Evaluation of a Randomized Trial (Oldridge et al. 1993)	Estimated cost per quality-adjusted life-year gained of nearly \$12,000 in 2003 dollars.	Randomized trial; 12-month followup; modern cardiac rehabilitation program.	Small sample sizes (about 100 each); includes only AMI patients with anxiety or depression; reflects only three-year survival difference.
Exercise vs. Stress Management Training (Blumenthal et al. 2002)	Compared to exercise-only program, significantly lower cardiac rehospitalization costs for participants in stress management-only program.	Randomized assignment to two treatment arms; five-year followup.	Very small sample sizes (ranging from 26 to 37); non-equivalent control group; primitive and incomplete costing methodology.
Effects on Health Care Utilization in Patients Aged 65 and Older (Bondestam et al. 1995)	Rehospitalization and emergency visit rates significantly lower in aged AMI patients receiving two home visits by a specially trained nurse and encouraged to exercise.	12-month followup.	Modest treatment; small sample sizes (less than 100 each); questionable control group.

Study	Key Finding	Strength(s)	Weakness(es)
Traditional vs. Modified Cardiac Rehabilitation (Carlson et al. 2000)	Compared to traditional cardiac rehabilitation, cost of "modified protocol" program emphasizing off-site exercise about a third less.	Examined a less expensive version of cardiac rehabilitation.	Very small sample sizes (about 40); only six-month observational interval; questionable cost measures.
A Limited Trial of Lifestyle Interventions in General Practice (Salkeld et al. 1997)	General practice-based educational interventions (videos and self-help booklets) directed at "high risk" males costing about \$40,000 (2003 dollars) per life-year saved, based on associated cardiovascular risk factor improvements.	Randomized design.	Modest interventions; extraordinary patient attrition (36 percent); insignificant risk factor differences; authors concede insufficient evidence.
The Estimated Costs and Savings of Medical Nutrition Therapy (Sheils et al. 1999)	Providing medical nutrition therapy to aged cardiac patients associated with significant reduction in hospital use and physician visits.	Large sample of HMO claims data.	Apparent reductions in health care use and expense improbably large for an ill-defined, brief intervention; questionable control for "regression to the mean" after expensive inpatient episode; concerned that results reflecting non-causal correlation.

Cost Analysis of a Five-Year Non-Randomized Trial of Exercise-Only Cardiac Rehabilitation

In Sweden, Levin et al. (1991) monitored the direct and indirect costs of CR following acute myocardial infarction (AMI), comparing the five-year experience of 147 post-AMI patients under age 65 (124 males, 23 females) who received CR to the experience of 158 similar patients (134 males, 24 females) who received standard care. Between August 1977 and December 1980, all these eligible AMI patients discharged from a district hospital in Sweden were invited to participate in a medically supervised, hospital-based physical training program. Beginning six weeks after AMI, patients were to exercise (cycling, jogging and calisthenics) twice weekly at the hospital for three months. After this initial training interval, hospital-based training was phased out over a two-year interval, and patients were encouraged to continue with home-based training. The control group includes all similarly eligible patients discharged from a neighboring district hospital between 1978 and 1980. These patients received standard care, consisting of one post-AMI visit to the hospital clinic, followed by referral to primary health care.

The two hospitals offered comparable treatment for AMI patients, with similar lengths of stay. The two geographically defined catchment areas are similar, and the baseline demographic and clinical characteristics of the two study cohorts are remarkably similar.

Some 82 of the 147 patients included in the treatment group (56%) completed the first three months of physical training, and 72 patients (49%) continued training after two years. Reflecting the perspective of intention to treat, the cost analysis includes all treatment group patients—not only those who participated in the training program, but also those who chose not to participate.

The mean training cost per patient was Swedish Kroner (SEK) 1,530 (\$805 in 2003 US dollars). Although treatment group patients visited the clinic more often—14.0 visits vs. 10.9 visits for the control group—they were hospitalized less frequently for cardiovascular diseases over the five-year interval—1.6 admissions vs. 2.2 admissions for the control group—and the lengths of stay for cardiac admissions were shorter—10.7 days vs. 16.1 days for the control group. The two groups did not differ with respect to frequency or length of stay for non-cardiac admissions. Over the five-year interval of follow-up, the mean treatment cost of intervention patients was SEK 7,370 (\$3,876 in 2003 US dollars) less than the mean treatment cost of control patients—SEK 36,030 for the intervention group and SEK 43,000 for the control group (\$18,949 and \$22,824 in 2003 US dollars, respectively). Taking account only of this difference in health care treatment expense, we calculate a benefit-cost ratio for this exercise-only CR program of 4.8 to 1 for health costs alone.

At the end of five years, 52% of treatment group patients were actively employed, compared to just 27% of control group patients. Over the five-year follow up, the authors project an average savings on sick

leave cost of SEK 70,610. Adding this productivity-type gain to the savings on treatment expense, the review authors calculate a total benefit-cost ratio of 51 to 1. That is, their results indicate that the benefits are 51 times as large as the costs.

Differences in Rehospitalization Charges for Self-Selected Cardiac Rehabilitation

Patients

Ades et al. (1992) compare the rehospitalization experience of 230 post-coronary event patients who enter a traditional CR program to the experience of 350 patients who did not enter the program. All patients who survived AMI or coronary artery bypass graft (CABG) at the Medical Center Hospital of Vermont from October 1983 to January 1987 and lived within a one-hour drive of the medical center were included in the study. Entry into CR was self-selected. Baseline left ventricular ejection fraction was virtually identical in the two groups.

Patients began CR four to eight weeks after the cardiac event. They exercised three hours per week for 12 weeks, and attended a weekly one-hour educational class. This risk factor teaching component included five sessions on stress management, two sessions on diet, three sessions on specific cardiac risk factors, and one session each on cardiac symptoms and cardiac medications. On completion of the program, patients underwent repeat stress testing on the treadmill and were encouraged to continue exercising. Some 179 of the 230 program entrants completed the entire program.

Following cardiac readmissions for an average of 21 months, program entrants were significantly less likely to be rehospitalized and their per-admission charges when hospitalized were significantly less. On average, the cardiac rehospitalization charges of program entrants were \$739 (\$1,739 in 2003 US dollars) lower. Because physician charges were not available, the total charge differential is understated. During the study interval, the per-participant cost of the cardiac program was \$32 (\$75 in 2003 US dollars) per session, or a total \$1,142 (\$2,688 in 2003 US dollars) per patient for those attending all 36 sessions.

Analysis of covariance was used to adjust for differences between the two groups at baseline, and rehospitalization costs remained significantly higher in the group that did not enter CR. However, no estimate of the adjusted hospital charge differential is provided.

A Meta-Analysis Based Cost-Effectiveness Estimate

Using meta-analytic findings drawn from 22 randomized trials of CR involving 2,200 patients in each group, Ades et al. (1997) estimate that participants have an incremental life expectancy of 0.202 years

over the 15-year interval following program completion. Based on survey reports from 626 CR programs, the authors estimate that CR programs cost an average of \$1,280 per patient in the mid-1980s (\$3,671 in 2003 US dollars). Adding a 15% increment for physician services to their estimate that CR saves \$739 (\$2,120 in 2003 US dollars) in hospital charges, they consider that CR saves an average of \$850 (\$2,438 in 2003 US dollars) per patient on medical expense. On this assumption, the net cost of a CR program in the mid-1980s is calculated to be \$430 (\$1,233 in 2003 US dollars), and the authors find that it costs just \$2,130 (\$6,109 in 2003 US dollars) per year of life saved. The authors conclude that, "Compared with other post-AMI treatment interventions, CR is more cost-effective than thrombolytic therapy, coronary bypass surgery, and cholesterol lowering drugs, though less cost-effective than smoking cessation programs." (Ades et al. 1997). Sensitivity analysis provides additional support for this statement. The authors, caution, however, that, "Limitations of this study include the use of primary mortality data obtained in a mostly male, non-elderly population who underwent rehabilitation before the introduction of valuable interventions that are now commonplace, such as thrombolytic therapy and lipid-lowering drugs." (Ades et al. 1997).

The Costs of Hospital vs. Home-Based Rehabilitation

Marchionni et al. (2003) report a randomized, controlled trial conducted in Florence, Italy around the year 2000. Post-AMI patients were randomized into three treatment arms of 90 each—(1) hospital-based CR (2) home-based CR and (3) a no-CR control group. Each treatment arm was stratified into three age groups of 30 "middle-aged" (45 to 65 years old), "old" (66 to 75 years old) and "very old" (>75 years old) patients.

The hospital-based CR program consisted of 40 exercise sessions, 24 sessions (three per week) of endurance training plus 16 sessions (two per week) of stretching and flexibility exercises. Patients received cardiovascular risk factor management counseling twice per week and were invited to join a monthly support group together with family members. The home-based patients first participated in four to eight hospital-based exercise sessions. They also received risk factor counseling at these sessions and were similarly invited to join a monthly support group. After this instructional phase, the home-based patients received an exercise prescription and were loaned a cycle ergometer for the two-month training program. A physical therapist made home visits every other week to collect data and adjust the prescription as needed. Patients randomized to the no-CR group attended a single educational session on risk-factor management and were referred back to their family physician.

Within each age group, total work capacity (TWC)—as measured by a symptom-limited cycle ergometer test at the conclusion of the training program—improved significantly in both CR groups but was unchanged in the control group. The improvements were similar in the two younger-aged cohorts, while improvement in the oldest cohort was smaller, yet still significant. At the 12-month follow-up, TWC

remained significantly higher than baseline for all age cohorts within the home-based CR group. By comparison, TWC had returned to baseline for the two older-aged cohorts in the hospital-based rehabilitation group. Health-related quality-of-life (HRQL), a scale based on self-reported activities and social interactions, improved significantly over the study interval for "very old" patients in both rehabilitation groups, and it did not improve for those in the control group. In the two younger-aged cohorts, HRQL improved consistently over the study interval, independent of treatment assignment.

The per-patient cost of the hospital-based program was about five times the cost of the home-based program—\$10,170 vs. \$1,898 in 2003 US dollars. Although the home-based rehabilitation group also had notably lower healthcare utilization costs than either the hospital-based rehabilitation group or the control group over the 12-month follow-up interval (due to fewer medical visits and lower rehospitalization rates), the differences do not appear to be statistically significant.

Economic Evaluation of a Randomized Trial

Oldridge et al. (1993) report a 1987 randomized, controlled trial conducted in Hamilton, Ontario hospitals. Patients with AMI and mild to moderate anxiety or depression while still hospitalized (about 70 % of AMI patients screened) were randomized into either an eight-week rehabilitation intervention (n=99) or usual care (n=102). The rehabilitation program consisted of twice-weekly, low-level supervised exercise, as well as group behavioral and risk factor management counseling focused on coping strategies, and individual counseling as needed. Data were collected at baseline, upon completion of the intervention, and at four, eight and 12 months from hospital discharge.

In 1991 US dollars, Oldridge et al. (1993) estimate that the gross cost of the intervention program averaged \$790 (\$1,365 in 2003 US dollars) per patient. However, since "usual care" control patients utilized \$310 (in 1991 US dollars) more services in community-based rehabilitation programs, the net cost of the program is only \$480 (\$829 in 2003 US dollars) per patient.

Using time-tradeoff preference scores to measure HRQL differences during the 12-month follow-up interval, the authors found that, compared to control patients, the intervention patients gained an average of 0.052 quality-adjusted life-years (QALY). Initially, assuming no difference in survival rates, the authors calculated that the program cost \$9,200 (\$15,896 in 2003 US dollars) per QALY gained during the first year.

Although the quality-of-life differences in subsequent years are not monitored, the authors used meta-analysis findings to estimate that intervention group patients also gain 0.022 life-years over three years.

Taking account of this projected survival difference, the estimated cost per QALY gained falls to \$6,800 (\$11,749 in 2003 US dollars).

The paper also includes a variety of sensitivity analyses. In particular, the authors also report that a 95% confidence interval for the number of QALYs gained ranges from 0.100 to 0.007. Using these upper and lower bound estimates, they calculate that the program cost per QALY gained ranges from \$4,800 to \$68,600 in 1991 US dollars (\$8,293 and \$118,527, respectively, in 2003 US dollars).

A more recent study similarly uses time-tradeoff preference scores to measure health-related quality of life differences. Yu et al. (2004) report that an eight-week CR program in Hong Kong yields a benefit of 0.6 QALYs per patient and estimate that the program actually saves \$640 in 2003 US dollars per QALY gained. However, we are concerned that the time-tradeoff benefit used in this calculation is not significant. The estimated benefit is obtained as the average of three measurements, only one of which is reported to be significant ($p < 0.05$). Most importantly, the time-tradeoff measurement obtained at the end of the two-year program is not statistically significant. Although the intervention evidently yielded a cost savings, the magnitude of the savings is not reported; nor do we know if the cost difference is significant.

Exercise vs. Stress Management Training

Blumenthal et al. (2002) examined the effects of exercise and stress management training on clinical outcomes and hospital costs over a five-year follow-up interval in 94 male patients with coronary artery disease and evidence of stress-induced myocardial ischemia. Patients who lived near Duke University Medical Center were randomly assigned to either (1) an exercise program ($n=26$) or (2) stress management training program ($n=31$), and patients who lived too far from Duke to participate in either intervention formed a third usual care comparison group ($n=37$).

The exercise program included three sessions per week of aerobic exercise for 16 weeks. The stress management program consisted of 16 one-and-a-half hour sessions conducted in a group setting with eight patients per group. While the initial stress management group sessions were largely educational, most sessions involved instruction in specific skills to reduce stress. Patients in the "usual care" group maintained their normal medical regimens and visited their local cardiologists as needed. The patients were followed for five years.

At the end of the first and second years, stress management patients had significantly lower per-patient cardiac rehospitalization costs (including inpatient physicians' services) than patients in either the exercise or usual care groups. At the end of five years, the stress management group still had significantly lower cumulative costs than the usual care group. The even larger cost advantage that the

usual care group had over the exercise group, however, was not quite significant. While this latter finding is not explained, it may arise due to the exercise group's lower sample size (26 for the exercise group, compared to 37 for the usual care group).

While this study is undeniably provocative, we have several reservations about it. The comparison group includes only patients "who were geographically unable to attend...." This selection presents two problems. For one, the geographically remote patients referred to Duke University Medical Center for a cardiac procedure might have had more serious cardiac disease. It seems plausible that the less acute patients would be treated locally. Second, the geographically remote patients came from different, more rural physician communities, and the clinical thresholds for cardiac rehospitalization (e.g., cardiac catheterization and PTCA) could have differed in those communities than the ones at Duke University Medical Center.

The sample sizes in this study are also much too small to permit strong inference. While statistically significant, study results still reflect comparatively few clinical events. Moreover, the study's hospital costing methodology is primitive, e.g., assuming the same cost structure for all hospitals and not adjusting for length of stay. The absence of office visit and drug cost information is also unfortunate.

Effects on Health Care Utilization in Patients Aged 65 and Older

Bondestam et al. (1995) report another non-randomized trial conducted in Sweden. The aged (65+) AMI patients from one primary health district in Goteberg were assigned to a rehabilitation program (n=91), while similar patients in a neighboring district constituted the control group (n=99). The treatment itself was really quite modest. Soon after hospital discharge, a specially trained nurse made two home visits to educate and counsel the patient and patient's family. During a subsequent visit at the local health center, patients were encouraged to join a low-intensity exercise group, one hour per week for four to eight weeks. Only 21 rehabilitation group patients joined the exercise group. Both patient groups were followed for 12 months.

At three months and 12 months, the authors report that the rehospitalization and emergency department visit rates were significantly lower in the intervention group. They thereupon conclude that, "...an uncomplicated rehabilitation model characterized by very early intervention and performed within the primary health care system can significantly reduce the consumption of health care one year after myocardial infarction in patients >65 years old" (Bondestam et al. 1995).

Unlike the similarly designed Swedish study reported above from Levin et al. (1991), this study is considerably less robust. In particular, we are concerned that patient acuity was not altogether

comparable in the two groups. At discharge, compared to intervention patients, control patients were significantly ($p < 0.02$) more likely to be taking short-acting nitroglycerin, and they appeared more likely to be discharged to a convalescent home. In the control group, 12 of the 99 patients were discharged to a convalescent home, with stays of two to four weeks. By comparison, only six of the 91 intervention patients were discharged to a convalescent home, and three of these stayed only a week. The p-level indicates that the difference in use of short-acting nitroglycerin is statistically significant. Statistical significance was not evaluated for discharge disposition. While the control group was also somewhat older and contained a greater number of women, these differences were controlled through a matching process in analyzing the data.

The authors also tell us that, "While readmissions and emergency department visits generally were well justified in the intervention group, vague symptoms dominated among the controls" (Bondestam et al. 1995). Thus, cardiac care practice patterns appear to be different in the two districts, and, if so, there we may not have a valid control group.

Traditional vs. Modified Cardiac Rehabilitation

Carlson et al. (2000) tested and compared the "traditional protocol" (TP) standard to a reduced cost "modified protocol" (MP) for CR. Some 80 low- to moderate-risk cardiac patients at a metropolitan hospital in the Midwest were randomized to either TP ($n=42$) or MP ($n=38$) CR, and then followed for six months.

During the initial 12 weeks of the six-month observational interval, TP patients exercised three times per week at the CR facility, with continuous ECG monitoring, and were encouraged to exercise off-site two additional times per week. In addition, TP patients attended a three-session nutritional/risk factor education class, and received dietary and other individual counseling. During months four to six, TP patients were encouraged to attend a phase III maintenance program three times per week.

During the first four weeks, MP patients followed the same regimen as TP patients. The MP program, however, discontinued ECG monitoring at week five, and MP patients were gradually weaned to off-site exercise. In week six, MP patients also began attending weekly education/support meetings.

Compared with TP patients, MP patients had a significantly higher rate of off-site exercise over the entire six-month observational interval, and they had a higher rate of total exercise (on-site plus off-site) over the last three months. Both groups showed comparable improvements in clinical measures.

The authors report that the MP program cost \$738 (\$915 in 2003 US dollars) less than the TP program: \$2,349 (\$2,912 in 2003 US dollars) per patient for the TP program compared to \$1,519 (\$1,883 in 2003 US dollars) for the MP program. This report, however, needs more documentation. Although not well documented, it appears that the authors calculated program costs using only the fee schedule for services reimbursable by insurers, and added the fees paid by patients for the phase III maintenance program. Given the vagaries of insurer reimbursement for CR and complete lack of coverage for an off-site program (e.g., the weekly meetings), the authors submit that the cost measures reported may be incomplete. More telling, in our judgment, the authors also report that the MP program required 30 % less staff time than the TP program (87 vs. 124 staff hours). However, no additional detail is provided to support this finding.

A Limited Trial of Lifestyle Interventions in General Practice

In Australia, Salkeld et al. (1997) conducted an economic evaluation of a randomized controlled trial of two general practice-based lifestyle interventions for patients with risk factors for cardiovascular disease. In one intervention, patients received videos and other educational materials on lifestyle improvement. In the other intervention, patients received a self-help booklet in addition to the videos and educational materials. Randomizing by general practice, the usual care control group (representing "current therapy" for cardiovascular disease) initially included 255 patients, the first intervention "video" group included 269 patients and the second intervention "self help" group included 231 patients. All physicians, including those in the usual care group, were asked to assess their patients' cardiovascular risk factors and provide them with feedback on the results.

All three arms of the trial experienced unusual attrition (36%). Of the 755 patients initially enrolled, only 484 patients completed the trial and provided data for analysis. The authors used the modest changes in risk factors from this trial to estimate various cost-effectiveness ratios, and concluded that a program targeted at "high-risk" males would cost about \$30,000 in Australian dollars (\$40,463 in 2003 US dollars) per QALY. At the same time, they said that, "The lifestyle interventions had no significant effect [emphasis added] on cardiovascular risk factors when compared to routine [usual] patient care. There remains insufficient evidence that lifestyle programs conducted in general practices are effective" (Salkeld et al. 1997). De facto, this means that one can have no confidence in the study's cost-effectiveness results.

The Estimated Costs and Savings of Medical Nutrition Therapy

Sheils et al. (1999) seek to measure the potential savings from medical nutrition therapy (MNT) and estimate the net cost to Medicare of covering such services for all Medicare beneficiaries. MNT is defined

as "the assessment of the nutrition status of a client followed by nutrition therapy ranging from diet modification to the administration of enteral and parenteral nutrition" (Sheils et al. 1999). As part of this study, they use data from Group Health Cooperative of Puget Sound (Seattle, Washington) and analyze the health care utilization experience of persons aged 55 years and older with cardiovascular disease (n=10,895).

The authors use multiple regression analysis to estimate the effect of MNT service utilization in the current quarter on hospital, physician and hospital outpatient utilization in subsequent quarters, after controlling for patient age, physician specialty and several (weak) proxy measures of health status. They conclude that MNT is associated with a significant 8.6 % reduction in hospital use and a significant 16.9 % reduction in physician visits compared to usual care for Medicare beneficiaries. MNT is not found to have a significant relation to hospital outpatient utilization.

Prima facie, we have concerns about the validity of these findings. The apparent reductions in health care utilization and expense are really quite large for an ill-defined, brief intervention. If so, how could such spurious results arise? Suppose (as we believe) that many or most MNT services provided to cardiovascular cohort patients were provided within hospital or soon after hospital discharge (e.g., post-AMI or post-CABG or other procedure). If so, one should expect that hospital and physician use would fall in the next quarter, as health care utilization "regresses to the mean" after an expensive inpatient episode. If so, MNT utilization is correlated with a reduction in health care use, but it does not cause it.

The authors report that just 19 % of cardiovascular cohort patients ever used MNT services. Cardiac hospitalization was one of the criteria used to identify Group Health members with cardiovascular disease and select them into the study cohort.

Discussion and Application to Practice

Given the paucity and inconclusiveness of available evidence, it is impossible to draw strong inferences about the costs or cost-effectiveness of CR and other cardiac lifestyle modification programs. We have found regrettably few methodologically sound studies, and even the best of them have limitations. The strongest findings come from studies conducted in the early 1990's or before, when modern lipid-lowering drugs were either not available or not widely used. Also, most of the studies were conducted in other countries, with different cultures and different health care systems than found in the U.S.

Thus, for a variety of reasons, it is difficult to say with any authority how these findings should be applied in appraising contemporary cardiac lifestyle modification programs. Clearly, there is a continuing and

urgent need to more comprehensively investigate and update the available evidence on the economics of cardiac lifestyle modification.

Summary and Conclusions

Despite misgivings about this literature, we, nevertheless, cautiously conclude that the preponderance of evidence would support a finding that a traditional, exercise-based CR program is economically advantageous. When earlier return to work was factored in, a Swedish study by Levin et al. (1991) found a highly favorable benefit cost ratio of 51 to 1. It appears that CR not only saves on rehospitalization expense, but also that the net cost per QALY is really quite moderate (if not zero). A cost-effectiveness analysis based on a meta-analysis by Ades et al. (1997) found that savings in hospital charges offset about two thirds of the cost of CR (\$3,671 in 2003 US dollars), giving a favorable cost per year of life saved of only \$6,109 (in 2003 US dollars). Analysis of a Canadian trial by Oldridge et al. (1993) found a cost per year of life saved of \$11,749 in 2003 US dollars. In addition, the literature provides intriguing, albeit inconclusive evidence that home-based CR alternatives are not only less costly, but also similarly effective as hospital-based programs.

This literature provides no evidence whatsoever on the economics (i.e., benefits and costs) of specific dietary modifications or more intensive, multi-modality approaches to cardiac lifestyle modification. Moreover, there have been no economic studies of more intensive and arguably more costly lifestyle modification programs, such as Dr. Dean Ornish's well known Lifestyle Modification Program (Ornish 1996) and the Mind/Body Medical Institute's Cardiac Wellness Program (Casey and Benson 2004). There is clearly a need for more economic research examining CR programs of all types.

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