

Articles

Reducing Need and Demand for Medical Services in High-risk Persons

A Health Education Approach

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We undertook this study to identify persons with high medical use to target them for health promotion and self-management interventions specific to their problems. We compared the reductions in cost and health risk of a health education program aimed at high-risk persons with a similar program addressed to all risk levels. We compared health risk and use in 2,586 high-risk persons with those of employee (N = 50,576) and senior (N = 39,076) groups and contrasted results in specific high-risk disease or behavior categories (modules)—arthritis, back pain, high blood pressure, diabetes mellitus, heart disease, smoking, and obesity—against each other, using validated self-report measures, over a 6-month period. Interventions were a standard generic health education program and a similar program directed at high risk individuals (Healthtrac). Health risk scores improved by 11% in the overall high-risk group compared with 9% in the employee group and 6% in the senior group. Physician use decreased by 0.8 visits per 6 months in the high-risk group compared with 0.05 and 0.15 visits, respectively, per 6 months in the employee and senior groups. Hospital stays decreased by 0.2 days per 6 months in the high-risk group compared with 0.05 days in the comparison groups. The duration of illness or confinement to home decreased by 0.9 days per 6 months in the high-risk group and 0.15 and 0.25, respectively, in the employee and senior groups. Using imputed costs of \$130 per physician visit, \$1,000 per hospital day, and \$200 per sick day, previous year costs were \$1,138 in direct costs for the high-risk groups compared with \$352 and \$995 in the employee and senior groups, respectively. At 6 months, direct costs were reduced by \$304 in the high-risk group compared with \$57 and \$70 in the comparison groups. Total costs were reduced \$484 in the high-risk groups compared with \$87 in the employee group and \$120 in the senior group. The return on investment was about 6:1 in the high-risk group compared with 4:1 in the comparison groups. Effective health education programs can result in larger changes in use and costs in high-risk persons than in unscreened persons, justifying more intensive educational interventions in high-risk groups.

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The ability of well-designed health education, health promotion, and self-management programs to improve health, reduce health risks, and decrease medical care costs has now been extensively documented.^{1–17} Several reviews describe recent progress with the use of these programs.^{18–20} Cost savings in the first year of effective programs appear to be due largely to an increased use of self-management techniques and increased personal self-efficacy. Subsequently, a reduction in illness burden due to the postponement or

prevention of costly, chronic illness can lead to further cost savings.¹

Theoretically, the effectiveness and cost savings of such programs might be greatest if they were targeted at persons at high risk of illness or who have high medical use. If these persons can be identified, more intensive interventions could be channeled toward the specific problems of persons who are in greatest need. The identification of groups of persons who will have substantially greater use in the following year than the average

person has become possible.^{20–22} On the other hand, persons with established chronic illness or with the worst health habits may not be as amenable to improvement through health education programs as those without these conditions or may be most intractable to making behavior changes. Few studies have been done that explore these issues.

The programs studied (Healthtrac, Inc., Menlo Park, California) have been documented to improve health habits, decrease health risks, and reduce costs in many randomized controlled and observational studies for as long as 30 months.^{11–20} These studies have included the study of specific high-risk categories. Effectiveness and cost reduction has thus been documented by randomized trial in chronic disease programs such as those aimed at arthritis^{15,17} and Parkinson's disease.¹⁶

In this study, we compare the results of programs directed at specific high-risk groups—including the arthritis program previously documented by randomized trial^{15,17}—against each other and against comparison groups receiving the standard Healthtrac program, previously proved effective by randomized control trial. We compared effectiveness and cost savings in high-risk persons with standard Healthtrac programs directed at unscreened persons and also results in specific high-risk “modules”—programs targeted at arthritis, back pain, high blood pressure, combined risk, diabetes mellitus, heart problems, smoking, and weight loss—against each other.

Methods and Subjects

Methods

High-risk persons were identified by using the Healthtrac health assessment questionnaire with a multiple regression-based algorithm designed to predict medical care costs over the following 12 months based on age, sex, prior use, health risk score, smoking behavior, patients' self-reported health status, and the presence of chronic illness. The algorithm has been shown to predict both self-reported costs and claims costs over the following 12 months.²³

The algorithm was developed by using a data bank of 24,626 subjects in the Healthtrac and Senior Healthtrac programs. Subjects were divided into learning and test data sets by random assignment. Univariate correlates between variables in the first study year and costs in the second year were examined in the learning data set. Stepwise multiple regression with the most promising variables was used to create a model for prediction and tested against the test data set. Predicted costs were compared with self-reported costs for the second year and with claims experience from Blue Shield of California, San Francisco. Claims costs in the highest decile were 12 times greater than claims costs in the lowest decile. Analysis of the program in high-risk subjects, performed by MEDSTAT Inc., Ann Arbor, Michigan, showed a return-on-investment quotient of 6.7:1 (R. Goetzel, M.D., R. Canto, J. Murnane: “A Return-on-Investment

Analysis of the Citibank Health Management Program,” unpublished manuscript).

Participants identified as high risk were allocated to a specific high-risk educational module by a second computer algorithm based on a ranking of the relative seriousness of particular chronic illnesses and health habits and the “most serious medical problem,” as reported by the participant. Twelve such high-risk module programs were used: arthritis, back pain, high blood pressure, diabetes mellitus, heart problems, smoking, obesity, stroke, chronic obstructive pulmonary disease, alcohol intake, and a final group in which a combination of risks and disease factors established a risk for high use. We report the results of the entire high-risk group and of eight high-risk modules for which data on 100 or more participants were available.

Healthtrac programs use two-page health assessment questionnaires, either general health-oriented questionnaires or ones tailored to specific problem areas. Questionnaires have been repeatedly validated^{12–14,24–27} and widely used. Participants receive a letter (signed by a physician) identifying their most problematic areas with specific recommendations for behavior change and self-management. Participants also receive a graphic summary of their individual health risk problems; subsequent progress; and books, audiotapes, and videotapes specific to these identified risks.^{11–17} The program proceeds in cycles of six months in the standard programs and three months in the high-risk program modules. During each cycle, each participant receives a questionnaire, a letter, a report, and health education material. More than 40 separate sets of materials are used.

The programs are designed to increase self-efficacy (health confidence) and to effect specific behavioral changes. In addition, each module has specific goals. For example, the diabetes module is designed to improve risk factor profiles for cardiovascular disease, minimize complications, and reduce the frequency of hospital admissions for diabetic ketoacidosis and of leg ulcers and amputations by regular self-care.^{28,29} Programs are not presented as “high risk” to the participant but as individually titled modules—that is, “Accent on Arthritis” or “Accent on Diabetes.” The costs per participant are about \$30 per year for the standard program and about \$100 per year and \$50 per six months for the high-risk programs.

A parallel study design was used in which the standard Healthtrac program is compared with the high-risk program, and individual high-risk modules are compared with each other. Data were gathered by a self-reported health assessment questionnaire at baseline and at six months. Many validation studies have been performed for these techniques.^{11–16,24–27} Identical techniques and outcome measures were used for all groups. Primary dependent variables³⁰ were the overall health risk score, self-reported medical use (the number of physician visits and number of hospital days), and indirect costs as represented by “days sick or confined to home.” Cost data are obtained for the previous six months and have been annualized in the tables for convenience in interpretation. The overall health risk score is computed from individual

TABLE 1.—Baseline Characteristics of Participant Groups*

Variable	All High Risk	Comparison Employee	Comparison Senior	Arthritis	High Blood Back Pain	Combined Pressure	Diabetes Risk	Heart Mellitus	Cigarette Problems	Smoking	Weight Loss
No.	2,586	50,576	39,076	297	472	378	576	146	160	200	314
Age, yr	49.7	41.2	73.3	65.9	46.3	54.3	41.5	55.5	55.5	39.7	40.7
Blood pressure, mm of mercury											
Systolic	130	120	135	132	125	139	123	132	130	121	128
Diastolic	78	76	77	77	76	85	77	77	74	76	79
Cholesterol level, mmol/liter (mg/dl) .	5.30 (205)	5.07 (196)	5.56 (215)	5.40 (209)	5.04 (195)	5.33 (206)	5.61 (217)	5.17 (200)	5.30 (205)	5.25 (203)	5.15 (199)
Kg (lb) over ideal weight	10.9 (24)	5.0 (11)	4.5 (10)	7.2 (16)	6.8 (15)	10.0 (22)	6.4 (14)	10.9 (24)	5.4 (12)	10.0 (22)	33.1 (73)
Body mass index . . . . .	.27	24	25	26.1	25.2	27.3	25.0	28.2	25.5	26.1	36.4
Seat-belt use, % . . . . .	.85	90	89	92	88	89	76	83	94	78	85
Fiber servings/day	2.5	2.8	3.2	3.0	2.5	2.6	1.9	3.1	3.1	1.8	2.5
Dietary fat, % calories . . . . .	.36	25	30	29	35	28	44	35	25	42	39
Saturated fat, % calories . . . . .	.14	13	11	11	13	11	15	14	9	16	15
Smokers, % . . . . .	.14	11	8	8	11	6	3	10	4.4	100	4.0
Packs/day	1.1	0.9	0.9	1.0	1.0	1.0	0.5	1.0	1.2	1.2	0.5
Alcohol, % . . . . .	.28	37	38	32	34	32	24	15	40	31	13
Oz/day	1.3	1.3	1.6	1.3	1.1	1.4	1.4	1.4	1.4	1.5	1.2
Exercise, % . . . . .	.82	86	83	91	88	89	71	84	85	81	78
Minutes/wk	120	174	159	144	136	135	64	122	159	122	114
Stress, % . . . . .	.34	30	6	18	33	26	51	22	15	41	40
Global health	41.2	27.6	29.8	39.9	36.9	36.6	40.1	44.2	45.3	44.4	47.1
Health risk score	23.5	18.2	17.4	18.1	18.8	19.7	25.1	21.8	16.3	42.5	26.8

*The data are given as the mean for each group.

health risks—smoking, saturated fat intake, lack of exercise—using algorithms based on the Framingham and other established risk factor models.^{31–33} Cost imputations used charges of \$130 for a physician visit (which includes the costs of the visit and associated laboratory tests, x-ray tests, and drugs), \$1,000 per hospital day, and \$200 per day sick or confined to home. The costs for physician visits and hospital days were estimated from claims data for similar groups of patients for 1994.^{12–14}

Subjects

The study group comprised 2,586 consecutive subjects participating in the high-risk program and completing questionnaires at zero, three, and six months. Most of these subjects were members of employee groups, were principally white-collar workers, had private health insurance, and had a mean age of 49.7 years. We developed two large comparison groups as convenience samples. To approximate the age distribution, we selected an employee comparison group, aged a mean of 41.2 years, from consecutive participants enrolled in the standard Healthtrac program during the same time period—also principally white-collar workers, employed, and with private health insurance—who completed questionnaires at zero and six months. Similarly, a group of con-

secutive participants in the senior Healthtrac program, aged a mean of 73.3 years, was selected; senior status itself may be considered a high-risk characteristic.

Results

Characteristics of the participant groups are listed in Table 1. Specific high-risk patients have ages ranging from means of 65.9 years for patients with arthritis to about 40 years for patients with stroke or morbid obesity. The group with obesity weighed a mean of 33 kg (73 lb) above ideal, with a mean body mass index (weight [kg]/[height (meter)]²) of 36.4. The blood pressure in the patients with hypertension was apparently well controlled with medication at study entry. The highest fat intake was seen in the combined-risk group and in patients reporting strokes. The highest saturated fat intake was reported in patients with stroke, those with obesity, and patients in the combined-risk group. Most persons reported at least some exercise; the combined-risk group, which includes the “worried well,” had the lowest exercise levels. Stress scores were highest in the combined-risk and smoking groups.

Global health scores were drawn from a horizontal analogue scale that ranged from 0, indicating excellent health, to 100, indicating very poor health. Global health

TABLE 2.—Baseline Costs

Variable	All High Risk	Comparison Employee	Comparison Senior	Arthritis	Back Pain	High Blood Pressure	Combined Risk	Diabetes Mellitus	Heart Problems	Cigarette Smoking	Weight Loss
Physician visits/6 mo	3.75	1.55	2.65	4.1	4.4	2.7	3.35	4.1	4.45	3.75	4.0
Cost of physician visits, \$, at \$130 . . . . .	.488	202	345	533	572	351	436	533	579	488	520
Hospital days/6 mo	0.65	0.15	0.65	0.60	0.45	0.40	0.45	1.40	2.10	0.5	0.55
Cost of hospital days, \$, at \$1,000 . . . . .	.650	150	650	600	450	400	450	1,400	2,100	500	550
Sick days/6 mo	3.85	1.60	2.05	2.95	5.00	1.55	4.05	4.15	4.80	5.10	3.65
Cost of sick days, \$, at \$200 . . . . .	.770	320	410	590	1,000	310	810	830	960	1,020	730
Direct costs, imputed, \$	1,138	352	995	1,133	1,022	751	886	1,933	2,679	988	1,070
Total costs, imputed, \$	1,908	672	1,405	1,723	2,022	1,061	1,696	2,763	3,639	2,008	1,800

scores were worse in the groups with obesity, heart problems, and diabetes mellitus and in smokers. Health risk scores were worst in the smoking group, in large part as a result of high scores in various categories beyond the smoking behavior itself.

Table 2 lists six-month medical use and imputed costs for the different groups at baseline. The high-risk group had previous six-month direct medical costs of \$1,138 compared with \$352 in the employee comparison group and \$995 in the senior comparison group. Thus, the algorithms were effective in identifying high-risk persons. Total direct and indirect costs were \$1,908 in the high-risk group, \$672 in the employee comparison group, and \$1,405 in the senior comparison group. Of individual modules, the highest previous six-month costs were in

patients with heart problems, with a total of \$3,639 in direct and indirect costs, followed by patients with diabetes mellitus at \$2,763. Persons with back pain and cigarette smokers had the next highest total costs, at slightly more than \$2,000 per six months for each. Absenteeism was greatest in smokers, followed by patients with heart problems and those with back pain. In contrast, smokers had relatively low direct costs in the previous six months.

Table 3 shows health risk and health risk component change scores at six months. For convenience in interpretation, scores have been reversed in Table 3 for seat-belt use, number of fiber servings per day, exercise percentage, and minutes of exercising per week so that in all cases a minus sign indicates improvement. Change scores are percentage changes from baseline, except for cigarette

TABLE 3.—Health Risk Change Scores at 6 Months

Variable	All High Risk	Comparison Employee	Comparison Senior	Arthritis	Back Pain	High Blood Pressure	Combined Risk	Diabetes Mellitus	Heart Problems	Cigarette Smoking	Weight Loss
No.	2,586	50,576	39,076	297	472	378	576	146	160	200	314
Cholesterol*†	+0.3	-0.5	-0.8	+0.2	+2.2	+0.6	-1.9	-0.2	-1.9	+1.9	+2.8
Body mass index	0.0	+0.1	-0.1	-0.1	0.0	-0.1	+0.2	0.0	0.0	+0.3	-0.3
Seat-belt use, %	-6.2	-2.3	-1.2	-2.6	-2.9	-5.5	-14.0	-5.3	-0.1	-5.1	-7.5
Fiber servings/day‡	-0.2	0.0	0.0	-0.2	-0.3	-0.2	-0.4	0.0	-0.2	-0.3	-0.2
Dietary fat, % calories	-9	-16	-13	-2	-6	-5	-17	-3	-12	-5	-7
Saturated fat, % calories	-6	-15	-14	+3	-2	-6	-14	+2	-7	-6	-3
Smoking, %	-6	-8	-9	-19	+6	+8	+2	+2	-14	-8	+1
Packs/day‡	-0.1	0.0	0.0	+0.1	0.0	-0.1	+0.1	+0.1	-0.2	0.0	+0.2
Alcohol intake, %	+1.4	-2.0	-4.0	+3.0	-3.0	+1.0	+4.0	+6.0	-14.0	0.0	+3.0
Oz/day	-0.1	0.0	-0.1	0.0	0.0	-0.1	-0.3	-0.3	-0.1	-0.3	+0.1
Exercise, %†	-6.0	-5.0	-1.0	-2.0	-0.7	-4.0	-23.0	-3.0	-4.0	+3.0	28
Minutes/wk †‡	-25	-9	-5	-17	-17	-20	-47	-44	-24	-19	-18
Stress, %	-17	-26	0	-19	-3	-25	-25	-19	-24	-8	-12
Global health	-2.0	-2.5	-3.0	-7.5	-3.1	-6.3	+5.5	-6.1	-12.4	+2.3	+3.4
Health risk score	-11.0	-8.8	-5.7	-7.7	-7.8	-10.7	-17.9	-6.0	-9.2	-7.3	-7.8

*Percentage change score is based on cholesterol level in milligrams per deciliter, rather than millimolar per liter. †The sign has been reversed so that a negative value represents a favorable change for all variables. ‡Absolute change. Other values are percentage changes from baseline.

TABLE 4.—Cost Changes per Participant at 6 Months

Variable	All High Risk	Comparison Employee	Comparison Senior	Arthritis	Back Pain	High Blood Pressure	Combined Risk	Diabetes Mellitus	Heart Problems	Cigarette Smoking	Weight Loss
No.	2,586	50,576	39,076	297	472	378	576	146	160	200	314
Baseline	3.75	1.55	2.65	4.1	4.4	2.7	3.35	4.1	4.45	3.75	4.0
6 Months	2.95	1.5	2.5	3.45	3.45	2.35	2.35	3.8	3.35	2.65	2.9
Change	-0.8	-0.05	-0.15	-0.65	-0.95	-0.35	-1.0	-0.3	-1.1	-1.1	-1.1
Dollar Change ...	-104	-7	-20	-85	-124	-46	-130	-39	-143	-143	-143
Hospital Days											
Baseline	0.65	0.15	0.65	0.6	0.45	0.4	0.45	1.4	2.1	0.5	0.55
6 Months	0.45	0.1	0.6	0.45	0.35	0.15	0.35	1.4	0.6	0.75	0.15
Change	-0.2	-0.05	-0.05	-0.15	-0.1	-0.25	-0.1	0.0	-1.5	+0.25	-0.4
Dollar Change ...	-200	-50	-50	-150	-100	-250	-100	0.0	-1500	+250	-400
Sick Days											
Baseline	3.85	1.6	2.05	2.95	5.00	1.55	4.05	4.15	4.8	5.1	3.65
6 Months	2.95	1.45	1.8	2.65	4.35	1.8	2.45	3.7	1.85	3.85	2.6
Change	-0.8	-0.15	-0.25	-0.3	-0.65	+0.25	-1.6	-0.45	-2.95	-1.25	-1.05
Dollar Change ...	-180	-30	-50	-60	-130	+50	-320	-90	-540	-250	-210
Direct Costs											
Baseline	1138	352	995	1133	21022	1751	886	1933	2679	988	1070
6 Months	834	295	925	899	799	456	656	1894	1036	1095	527
Change	-304	-57	-70	-235	-224	-296	-230	-39	-1643	+107	-543
% Change	-27	-16	-7	-21	-22	-39	-26	-2	-61	+11	-51
Total Costs											
Baseline	1906	672	1405	1723	2022	1061	1696	2763	3634	2008	1800
6 Months	1424	585	1285	1429	1664	816	1146	2634	1466	1865	1047
Change	-484	-87	-120	-295	-354	-246	-550	-129	-2233	-143	-753
% Change	-25	-13	-9	-17	-17	-23	-32	-5	-61	-7	-42

packs per day, ounces of alcohol per day, and exercise minutes per week where absolute changes are noted. Change scores for the cholesterol levels are based on conventional units, rather than Systeme International units.

Overall health risk scores improved by 11% over six months in the high-risk groups compared with 9% in the employee comparison group and about 6% in the senior comparison group, consistent with previous studies.¹¹⁻¹⁷ Although improvement was seen in most variables and in all specific modules, few changes were seen in reported cholesterol levels, body mass index, or dietary fiber intake.

Table 4 presents cost changes per participant at six months, showing baseline values, values at six months, the absolute change, and the imputed change in dollars. Direct costs are the sum of costs for physician visits and for hospital days. Total costs also include costs for sick days. Favorable changes were noted in nearly all categories and in essentially all modules.

Overall, the high-risk group had a reduction in imputed direct costs of \$304 compared with \$57 in the employee comparison group ($P < .01$) and \$70 in the senior comparison group ($P < .01$). Percentage changes were also highest in the high-risk group, where an overall 27% reduction in direct costs was seen compared with 16% in the employee comparison group and 7% in the senior group. Total costs (including absenteeism or number of days confined to home) yielded cost savings of \$484 in

the high-risk group compared with \$87 in the employee group and \$120 in the senior group.

In the comparisons across individual high-risk groups, the numbers of subjects are smaller, and the results are more likely to be influenced by a few outliers. A single participant in the smoking group had 120 days of hospitalization and was excluded from the smoking subgroup computations but was included in the overall high-risk computations discussed earlier. Significance values have not been computed for these results because of the issue of multiple comparisons and the instability of hospital costs due to low sample sizes. Nevertheless, the consistency of results across groups is striking. The cigarette smoking group is the only one that did not show an overall direct cost decrease, due to a small increase in the hospital day category; however, reductions in physician visits, absenteeism, and total costs were seen in this group.

Change scores between the overall high-risk group and the comparison groups for the major comparisons of total direct costs and total costs were significantly different ($P < .01$) and were not significantly different between the two comparison groups. Differences in baseline and six-month values for health risk score, direct costs, and total costs were significant ($P < .01$) for all three groups using two-tailed t tests. Savings-to-cost ratios were approximately 4:1 for the standard programs and 6:1 for the high-risk programs.

Discussion

Health education programs directed at persons at high risk can be effective in changing behaviors and reducing use. Cost reductions can be greater in these targeted programs than in programs directed at unscreened populations, in part because the levels of use are greater, and a similar percentage reduction results in a larger decrease in use.

Several caveats apply. These programs were specifically designed to both change behaviors and reduce costs and included targeted objectives for each model; programs using different educational models or techniques might not have similar results. These programs were based on self-efficacy and readiness-to-change models. High-risk modules focus on targeted goals of both self-management and behavioral change. The intervention is tailored to each person's problems.

This study is not a randomized trial, and the usual caveats about observational studies apply. Dependent variables are obtained by self-report. The standard Healthtrac programs and specific high-risk modules, however, have been studied by randomized trials with essentially identical results, providing the support for this study.¹¹⁻¹⁷ These previous studies have included claims data analyses, again with congruent results. That any self-report bias would operate differently in the different participant groups being compared seems unlikely.

This study was for six months and raises the issue of the durability of the response over longer periods. A similar program without further reinforcement in arthritis by our group⁵ showed continued effects after four years, suggesting that learned behaviors may be carried forward. With continued intervention, continued improvement has been noted for as long as 30 months.¹¹ The high-risk program, with continued intervention, remains highly effective after 32 months (R. Goetzel, R. Canto, J. Murhane: "A Return-on-Investment Analysis of the Citibank Health Management Program," unpublished manuscript). Thus, beneficial effects may be seen as early as six months and may increase over time.

The possibility of regression to the mean for the cost data must be considered because subjects were selected in part by their experiences in the previous six months. Opposite biases are also present because costs and use are expected to increase with increased age, and the costs of treating chronic illnesses are expected to rise slowly with the duration of the illness. Thus, any regression to the mean effects should be most important in the risk factor behavior modules (smoking, obesity, and combined risk) and least important in the chronic disease modules (arthritis, diabetes mellitus, hypertension, and heart problems). In contrast, results were generally less impressive in the behavioral modules than in the chronic disease modules. Moreover, this study was congruent with randomized controlled trials of these interventions showing effective behavioral change and cost reduction; such trials are not susceptible to regression to the mean effects.¹²⁻¹⁷

These results support the hypothesis that greater program benefits may accrue to health education programs tar-

geted at high-risk populations. They do not, however, suggest that educational programs should be directed at only high-risk persons. Although baseline costs average three times as much in the 20% of a screened population at high-risk compared with the rest of that population, about half of the total costs reside with the other 80%. Furthermore, for programs based at the worksite or in a managed care population, singling out high-risk persons for intervention might increase concerns about lack of confidentiality or cause those not receiving an intervention to feel undervalued. An increase in the intensity of an intervention for those at high risk seems an appropriate strategy.

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