ORIGINAL ARTICLE

Cost-effectiveness of an Intervention to Prevent Depression in At-Risk Teens

Frances L. Lynch, PhD, MSPH; Mark Hornbrook, PhD; Gregory N. Clarke, PhD; Nancy Perrin, PhD; Michael R. Polen, PhD; Elizabeth O'Connor, PhD; John Dickerson, MS

Contact: Depression is common in adolescent offspring of depressed parents and can be prevented, but adoption of prevention programs is dependent on the balance of their incremental costs and benefits.

Objective: To examine the incremental cost-effectiveness of a group cognitive behavioral intervention to prevent depression in adolescent offspring of depressed parents.

Design: Cost-effectiveness analysis of a recent randomized controlled trial.

Setting: Kaiser Permanente Northwest, a large health maintenance organization.

Participants: Teens 13 to 18 years old at risk for depression.

Interventions: Usual care (n=49) or usual care plus a 15-session group cognitive therapy prevention program (n=45).

Main Outcome Measures: Clinical outcomes were converted to depression-free days and quality-adjusted life-years. Total health maintenance organization costs, costs of services received in other sectors, and family costs were combined with clinical outcomes in a cost-effectiveness analysis comparing the intervention with usual care for 1 year after the intervention.

Results: Average cost of the intervention was $1632, and total direct and indirect costs increased by $610 in the intervention group. However, the result was not statistically significant, suggesting a possible cost offset. Estimated incremental cost per depression-free day in the base-case analysis was $10 (95% confidence interval, –$13 to $52) or $9275 per quality-adjusted life-year (95% confidence interval, –$12 148 to $45 641).

Conclusions: Societal cost-effectiveness of a brief prevention program to reduce the risk of depression in offspring of depressed parents is comparable to that of accepted depression treatments, and the program is cost-effective compared with other health interventions commonly covered in insurance contracts.

Arch Gen Psychiatry. 2005;62:1241-1248

Author Affiliations: Center for Health Research, Kaiser Permanente Northwest, Portland, Ore (Drs Lynch, Hornbrook, Clarke, Polen, and O'Connor and Mr Dickerson); and School of Nursing, Oregon Health and Science University, Portland (Dr Perrin).

DEPRESSION IS COMMON among adolescents, with a point prevalence between 3% and 8%.[1] By age 18 years, as many as 25% of adolescents have had at least 1 depressive episode.[2] Depressive disorders in children and teens increase the risk of illness, interpersonal problems, and psychosocial difficulties that persist long after the episode,[3] and adolescents who experience depressive episodes have an increased risk of substance abuse and suicidal behavior.[4-6] Adults with depression have increased health care costs,[7] and successful depression treatment may decrease these costs for adults[8] and children.[9]

Recent research[10-14] indicates that some groups are at much higher risk of developing depression, including children and adolescents with a depressed parent and individuals who report significant subsyndromal depressive symptomatology (without meeting full *DSM* criteria). Preventing depression in adolescents could decrease the chance of premature death, increase the quality of life and productivity of teens and their families, and reduce health care costs for these teens.

Evidence is emerging that psychosocial interventions can prevent depression[15-17] in adolescents, and prevention interventions targeted at high-risk groups have recently had favorable results.[16,17] Our group has described a successful group cognitive behavioral intervention to prevent depression episodes in at-risk adolescents.[18] Teens in the study had 2 significant risk factors: (1) they were offspring of depressed parents and (2) they

had significant subsyndromal symptoms and/or a past episode of depression.

Adoption of evidence-based interventions to prevent depression will depend on the balance of the clinical benefits and costs. Yet few studies have examined the economic impact of prevention interventions for any mental health problems, and we are not aware of any cost-effectiveness analyses of depression prevention in adolescents that used randomized clinical trial data. This information could help decision makers assess the relative value of alternative interventions for adolescent depression.

This report presents the cost-effectiveness of a recent prevention trial conducted with the subsyndromal adolescent offspring of parents treated for depression. The randomized controlled trial in a large, group-model health maintenance organization (HMO) examined the ability of the intervention to prevent progression to future episodes of major depression. This article presents an incremental cost-effectiveness analysis of the group cognitive behavioral intervention relative to usual care, from the societal perspective, for 1 year after the intervention.

METHODS

EXPERIMENTAL DESIGN

The randomized clinical trial (RCT) conducted by Clarke et al[18] is described elsewhere. Briefly, the RCT recruited participants from Kaiser Permanente Northwest, an HMO with about 410 000 members. The HMO's Human Subjects Committee approved all study procedures. The RCT used the HMO databases to identify parents of teenagers who had had at least 2 dispensations of an antidepressant medication and/or mental health visits within the past year. Of these cases, medical chart reviews confirmed that 3935 parents also had a depression diagnosis and/or symptoms. Each parent's physician mailed introductory letters to those they judged appropriate for the study (n=2995). Study staff then called parents for a brief screen of study criteria and asked adolescent offspring about participating in the study. Interested families were invited for an intake evaluation at the research center.

Interviews were completed with 481 parents and 551 adolescents. This assessment confirmed the parent's diagnosis of depression and assessed adolescent psychiatric diagnoses, symptoms, and psychosocial functioning. Parents were assessed with the Family Schedule for Affective Disorders and Schizophrenia.[19] Teens were grouped into clinical groups based on their depressive symptoms and determination of *DSM-III-R*[20,21] diagnoses; details on all interviewed subjects are reported elsewhere.[22] This analysis focuses on a medium depression group (n=123 [25.9%]), which was called the *subsyndromal* group.[12] These teens reported a previous depression episode or subdiagnostic levels of depressive symptoms that were insufficient to meet full criteria for a *DSM-III-R* affective diagnosis (Center for Epidemiologic Studies Depression Scale score, ≥24).[16] Teens who met the criteria for the subsyndromal group and agreed to participate were randomized to receive either the prevention intervention program or usual care.

INTERVENTION

The prevention program[23] was an abbreviated version of an adolescent depression treatment program[24] that had been tested previously.[25,26] The intervention consisted of 15 one-hour cognitive behavioral therapy (CBT) sessions for groups of 6 to 10 adolescents. The CBT groups were led by a master's-level therapist trained in the approach and were conducted at the HMO clinic offices. Details of the program are reported elsewhere.[18]

USUAL-CARE CONTROL CONDITION

All teens could initiate or continue any services normally provided by the HMO and/or outside services, including specialty mental health care and antidepressant medication. No additional services were provided to the usual-care control group, but no services usually available were limited in any way.

DATA COLLECTION

Cost and Service Use Measures

We include direct and indirect costs of the intervention.[27] Direct costs include intervention sessions and all usual-care services (both HMO and outside services). Indirect treatment costs include teen and parent time and travel costs for obtaining usual-care and intervention services. All costs are valued in 2000 US dollars. We did not use discounting because the analysis time frame was 1 year after study enrollment.

Intervention Costs

We estimated the total cost of intervention services from clinical trial records and study staff estimates. We divided intervention costs into fixed and variable costs. We allocated fixed costs across all randomized intervention participants and allocated variable costs according to each participant's use of intervention services. Information for the intervention cost estimates were collected throughout the trial. Study and HMO accounting records provided payroll costs, cost of facilities and overhead, and information on purchases of goods and services. Study staff used time sheets and written records of intervention activities to estimate the time to complete each intervention task. For example, the intervention therapists kept logs of time (in minutes) spent speaking with participants outside of intervention sessions. Study staff also reported use of capital equipment, space, and supplies needed to produce the intervention.

We included all costs of conducting the intervention, including costs of running the CBT groups, therapists' training, and all session materials (workbooks, handouts, etc). We also included the identification and outreach costs. Research-specific costs, such as randomization costs, were excluded.

Usual-Care (Nonprotocol) Services and Costs

We created comprehensive profiles of usual-care HMO services from the available electronic HMO data. These data, used in numerous previous studies, very accurately represent services paid for by the HMO. Services include all outpatient visits, including mental health specialty and other medical care; all inpatient care; drug utilization; laboratory tests; and radiology procedures. We supplemented HMO data with monthly mailed surveys asking participants to report any non-HMO services that they received for their depression symptoms.

For the HMO services, we estimated costs by applying unit costs developed and tested in previous studies[28-31] to the HMO utilization measures. These final cost variables represent HMO expenditures. For non-HMO services, we applied local market unit costs to create final cost variables (unit cost details are available on request).

Family Costs

We estimated family costs on the basis of patient utilization data and other study information collected during the trial. From these data, we created profiles of teen and parent time spent for the intervention, usual-care services, travel to services, and waiting. Study records contained the number of sessions each participant attended; sessions lasted 1 hour. The intervention therapists also collected data on time spent with participants individually either in person or over the telephone. Because the trial was not originally designed to collect family cost information, we did not have the amount of time teens and parents spent traveling and waiting. On the basis of information from study staff, we estimated that parents brought teens to intervention sessions about 50% of the time, with adolescents providing their own transportation for the remainder. We estimated travel time by using information on participant's residence and locations of health services. We used information from the HMO to estimate average usual-care appointment and waiting times.[32] For nonprotocol services, we used estimates of visit times and transportation costs from local information and from published research when local information was not available.[32-36]

Economic experts have suggested several approaches to valuing study participant or patient time.[27,37,38] Wages have been widely used as a proxy value for time spent in interventions or lost from work because of illness.[27] However, this approach may overvalue patient costs when earnings do not accurately reflect the amount of production lost to society.[37,39,40] Although methods that incorporate information about community economic conditions (eg, unemployment, replacement costs of workers) might calculate patient costs more accurately,[37,38] we were not able to use these methods because of data limitations. We also wanted the ability to compare our work with similar studies[33,34,41,42]; therefore, this study used wages to value family members' time. Because the RCT did not collect information on teen and parent wages, we priced teen and parent time by using national data on hourly wages for teens and parents in the same geographic region.[43,44] Other studies of the cost-effectiveness of mental health programs have used this approach.[45]

CLINICAL OUTCOMES

We used the primary clinical outcome data from the RCT (episodes of depression and depression symptom ratings) to create summary measures over time that could be converted into utility-based outcomes. Following a widely used approach to cost-effectiveness of depression treatment,[33-36,46] we developed measures of depression-free days (DFDs). For our main analysis, we incorporated information about the depression episodes and symptom information from the Center for Epidemiologic Studies Depression Scale score collected at each assessment. We identified depression episodes based on *DSM-IV* criteria for major depression evaluated at each clinical assessment. We summed across the clinical assessment periods to get the 12-month total days in a full depression episode. We also used data from each assessment to estimate days with elevated symptoms occurring outside of days in a full depression episode. This method estimates elevated symptom days during an interval between 2 assessments or between an assessment and a depression episode if one occurred. Each day in the interval is assigned a value by means of linear interpolation of clinical ratings at the beginning and end of the interval. We assigned weights to each day with elevated depression symptoms that was not in a depression episode. A Center for Epidemiologic Studies Depression Scale score of 21 or higher indicated elevated symptoms; weights increased (from 0.25 to 0.75) with higher scores. We then summed the number of DFDs during the 12-month period. This approach captures a more complete picture of the effects of the intervention, including both elevated symptom days and days in a full depression episode, and similar methods were used in previous work.[33-36,46]

To compare the cost-effectiveness of this intervention with that of others, we transformed the DFDs into quality-adjusted life-years (QALYs) by using utility weights assigned to depression from the literature. Transition from fully symptomatic depression to full remission is associated with a health utility improvement between 0.2 and 0.6.[47-52] On the basis of previous reports, we used 0.4 for the base-case analysis.[33-36]

DATA ANALYSIS

We conducted intent-to-treat analyses. We removed 1 significant outlier from the analysis—a study participant with a severe congenital chronic physical illness that led to multiple non–mental health hospitalizations. Clinical effects (DFDs) and cost variables were modeled by means of ordinary least squares regression, controlling for baseline patient differences that could remain after randomization. This method, used in several similar cost-effectiveness studies,[33-36,46] can more precisely estimate outcomes than simple analysis of variance.

The raw cost data indicated a skewed distribution of health care costs. Following the Briggs and Gray approach,[53] we examined the distribution of costs before and after nonparametric bootstrapping and found that the bootstrap estimate of the sampling distribution closely approximated a normal distribution. Thus, we used nonparametric bootstrap methods with a single model. This method avoids the difficulties of transformation and retransformation in traditional 2-part models.[54,55]

Confidence intervals (CIs) for the clinical effects, cost measures, service use measures, and incremental cost-effectiveness ratios were derived by nonparametric bootstrapping methods with 1000 replications by means of the bias-corrected and accelerated method.[56-58] Adjusted differences between the intervention and usual-care groups were estimated by means of ordinary least-squares regression models with bootstrap interval estimates; all analyses were adjusted for baseline characteristics including age, sex, race, months of health plan enrollment, baseline depression severity, and comorbidity. Hypotheses tests for the clinical and cost outcomes were based on the significance of the group variable in the bootstrapped multiple regression equations.[59,60]

In addition to the base-case analysis, we evaluated several models to examine how sensitive the cost-effectiveness results were to our assumptions. We conducted 1-way sensitivity analyses on the clinical and cost variables, estimating the cost-effectiveness ratio by using each bound of the 95% CI for each variable. We conducted 2 additional sensitivity analyses of clinical effects. First, we used a more conservative method to estimate DFDs, excluding days with elevated symptoms that did not meet full criteria for depression diagnosis. Next, we examined the sensitivity of our cost-effectiveness estimates to the utility weights used when calculating QALYs by using a more conservative utility weight (0.20) from the literature.[47-51] We also analyzed the sensitivity of our cost estimates. First, we calculated incremental cost-effectiveness without family time and travel costs. We also estimated the incremental cost-effectiveness from the HMO perspective, including only HMO costs. Finally, we examined the sensitivity of our cost-effectiveness estimates to our assumption that parents would attend 50% of teen visits. This sensitivity analysis examined how our incremental cost-effectiveness estimates changed as we varied this assumption between 0% and 100%.

To help evaluate the cost-effectiveness results, we created a cost-effectiveness acceptability curve,[61,62] which presents the probability that an intervention would be deemed cost-effective at different maximum monetary values for a 1-unit increase in clinical outcome. Specifically, we used the boot-

Table 1. Baseline Characteristics by Group

	Usual Care (n = 49)	Group CBT (n = 45)	*P* Value
Youth demographics			
Age, mean (SD), y	14.7 (1.5)	14.4 (1.4)	.23
Sex, No. (%) F	32 (65.3)	24 (53.3)	.24
Race, No. (%) minority	2 (4.1)	8 (17.8)	.03
Psychopathology, mean (SD)			
CES-D score	23.8 (10.3)	25.2 (8.7)	.48
Total No. of K-SADS diagnoses	0.5 (0.8)	0.4 (0.8)	.40
Total health care expenditures,* mean (95% CI), 2000 US $	1816 (833-3116)	1289 (944-1661)	.59

Abbreviations: CBT, cognitive behavioral therapy; CES-D, Center for Epidemiologic Studies Depression Scale; CI, confidence interval; K-SADS, Schedule for Affective Disorders and Schizophrenia for School-Age Children.
*In 2000 US dollars. For the health maintenance organization only; no information was available on non–health maintenance organization services during the year before randomization. Excludes 1 outlier.

Table 2. Unadjusted Clinical Outcomes

Type of Outcome	Mean* (95% CI)		*P* Value†
	Usual Care	Group CBT	
DFDs, symptom and episode‡	248 (214-283)	301 (279-320)	.001
QALYs, symptom and episode	0.869 (0.831-0.907)	0.928 (0.903-0.949)	.001

Abbreviations: CBT, cognitive behavioral therapy; CI, confidence interval; DFDs, depression-free days; QALYs, quality-adjusted life-years.
*Means and 95% CIs calculated by means of bootstrapped data.
†Significance based on bootstrapped regression controlling for age, sex, baseline depression severity, and comorbidity.
‡Depression-free days were calculated as days not in a full depression episode as defined by *DSM-IV* criteria, *and* days not having significant depression symptoms on the Center for Epidemiologic Studies Depression Scale.

strapped multiple regression results to calculate the proportion of the time that the intervention was cost-effective for potential maximum dollar values, ranging from $0 to $50, that a decision maker might pay for an additional DFD.

RESULTS

Of 123 subsyndromal teens identified as eligible for the prevention trial, 94 agreed to be randomized to either intervention or control groups. The 2 groups did not differ on rates of current and past psychiatric disorder at baseline. The treatment group had more minority participants (17.8% vs 4.1%; $P=.03$) and slightly higher baseline Child Behavior Checklist depression scores (8.8 vs 6.8; $P=.04$) but did not differ on any other key measures at baseline. The mean total health care cost for the year before the intervention was higher in the control group, but not significantly so (mean, $1816 vs $1289; $P=.59$). **Table 1** reports selected baseline characteristics of randomized teens; detailed group comparisons are available elsewhere.[18]

Table 3. Total Costs of Delivering the Group CBT Intervention

Type of Cost	Cost, 2000 US $
Teen group intervention sessions	19 286
Parent group information sessions	583
Group leader training	5315
Identification and outreach	
Electronic identification of population	1450
Chart review for parent depression status	11 233
HMO provider time	15 200
Outreach and recruitment of parents and teens	18 780
Total Intervention Cost	**71 847**
Average cost of intervention per participant	1632

Abbreviations: CBT, cognitive behavioral therapy; HMO, health maintenance organization.

Beneficial clinical effects of the intervention have been detailed elsewhere.[18] For the incremental cost-effectiveness analysis, we used clinical outcome data from the trial and published utility weights to estimate DFDs and QALYs (**Table 2**). Intervention participants reported significantly fewer DFDs ($P=.001$), with an average of 53 fewer depressed days in the year after intake than control participants. This translated into a significant increase in QALYs for the intervention group, with an average increase in QALYs of 0.059 for the intervention group compared with controls.

Given that the clinical effects of the intervention were significantly better than usual care, we next examined the economic impact of the intervention. The average cost per participant of delivering the group CBT intervention was $1632 (**Table 3**). Identifying at-risk teens and recruiting families to the intervention accounted for about 65% of costs. Recruitment included $11 233 to conduct chart reviews of HMO paper medical records to identify at-risk teens. Outreach costs included time that HMO providers spent attending informational sessions about the program, screening medical records to provide assent to contact families, and reviewing and signing letters to participant families; these activities cost about $15 200. The final outreach steps were creating and sending invitation letters to parents of at-risk youth, calling them on the telephone to screen for the intervention, and conducting a brief in-person intake assessment; these activities cost about $18 780. The costs were about $25 184 for running the CBT groups, which includes teen CBT and parent information group sessions, out-of-group telephone contact with teens, group leader training, and supervision of group leaders. Overhead costs (including space and capital costs) are included in the estimates and were about 28% of the total intervention costs.

Table 4 presents patterns of service use by group and type of service for the 12 months after the intervention. Teens in both groups reported use of services in a variety of sectors outside the HMO, including schools, specialty mental health services, and family counseling. Multiple regression results indicated that the intervention participants used significantly ($P\leq.05$) fewer services in 7 of the 13 categories of service use. Intervention participants used significantly more services in 4 of the 13 categories. Generally, in categories where the control group had signifi-

Table 4. Mean Unadjusted Service Use During 12 Months After CBT Intervention

Type of Service Use	Mean (95% CI)* Usual Care	Group CBT	*P* Value†
HMO services			
Inpatient mental health days	0.041 (0.000-0.111)	0.024 (0.000-0.070)	.06
Outpatient mental health visits			
Group visits	0.905 (0.089-1.956)	0.116 (0.000-0.333)	<.001
Individual psychotherapy	0.789 (0.267-1.444)	0.504 (0.222-0.867)	<.001
Psychiatrist	0.310 (0.067-0.644)	0.390 (0.089-0.844)	.001
Inpatient other medical days	0.360 (0.133-0.644)	0.024 (0.000-0.070)	<.001
Outpatient other medical visits	4.158 (3.133-5.311)	3.603 (2.643-4.711)	.001
Protocol intervention visits	NA	9.383 (7.867-11.000)	NA
Non-HMO services			
Inpatient mental health days	1.048 (0.033-2.700)	0.244 (0.000-0.700)	.003
Day treatment	0.768 (0.000-2.400)	0.000 (0.000-0.000)	.15
Psychiatrist visits	0.088 (0.000-0.233)	0.370 (0.000-0.800)	.01
Group therapy visits	0.314 (0.000-0.889)	0.994 (0.178-2.022)	.002
Family therapy visits	0.640 (0.000-1.789)	0.441 (0.000-1.178)	.005
School-based mental health visits	1.427 (0.278-3.056)	0.705 (0.200-1.322)	.001
Individual counseling or psychotherapy visits	1.179 (0.067-2.744)	1.221 (0.189-2.478)	.001

Abbreviations: CBT, cognitive behavioral therapy; CI, confidence interval; HMO, health maintenance organization; NA, not applicable.
*Means and CIs were calculated by means of bootstrapped data.
†Based on bootstrapped regression controlling for age, sex, months of enrollment, baseline depression severity, and comorbidity.

Table 5. Mean Unadjusted Cost per Participant During 12 Months

Type of Cost	Mean (95% CI),* 2000 US $ Usual Care	Group CBT	*P* Value†
Direct costs			
Nonprotocol costs			
HMO, mental health specialty	538 (224-910)	436 (204-741)	.26
HMO, other medical	948 (629-1363)	544 (388-729)	.03
Non-HMO services	735 (155-1660)	194 (70-367)	.07
Total nonprotocol costs‡	2219 (1334-3317)	1173 (800-1573)	.01
Protocol intervention cost	0	1632 (1554-1714)	NA
Total Direct Costs	**2219** (1334-3317)	**2805** (2413-3224)	.83
Indirect costs			
Family time and travel costs			
Family costs for nonprotocol service	496 (262-821)	255 (162-365)	.05
Family costs for protocol service	0	265 (232-299)	NA
Total Indirect Costs	**496** (262-821)	**520** (423-630)	.67
Total Costs (Direct and Indirect)	**2715** (1619-4069)	**3325** (2861-3830)	.81

Abbreviations: CBT, cognitive behavioral therapy; CI, confidence interval; HMO, health maintenance organization; NA, not applicable.
*Means and 95% CIs were calculated by means of bootstrapped data.
†Based on bootstrapped regression controlling for age, sex, months of enrollment, baseline depression severity, and comorbidity.
‡Because of rounding, total nonprotocol costs may not equal the sum of individual nonprotocol costs.

cantly more service use, the magnitude of difference was greater, with the control group using as much as 15 times more of a service than teens who received the intervention. Intervention participants went to an average of 9.383 (95% CI, 7.867-11.000) CBT group intervention visits.

For the 12 months after the intervention, the multiple regression results (**Table 5**) indicated that the intervention participants incurred fewer costs on nonprotocol services ($P=.01$). On average, the intervention group incurred less cost for all types of nonprotocol services, although only the difference in HMO–other medical expenditures was statistically significant at the .05 level or less. The mean protocol services cost was $1632 (95% CI, $1554-$1714) per intervention participant. Total direct costs, the sum of nonprotocol and protocol services costs, was not significantly different between the groups ($P=.83$).

Time and waiting costs for the families associated with nonprotocol services were significantly lower in the intervention group ($P=.05$). Families of intervention participants incurred an average of $265 (95% CI, $232-$299) in intervention-related costs. Total indirect costs, the sum of nonprotocol and protocol time and waiting costs to families, was not significantly different between groups. Including all direct and indirect costs, the average total cost of services for intervention participants was about $610 greater than that for usual care; however, this

Table 6. Adjusted Incremental Cost-effectiveness Ratios: Base-Case and Sensitivity Analyses

Type of Analysis	Cost/DFD,* 2000 US $	Cost/QALY,* 2000 US $
Base-case analysis (95% CI†)	10 (–13 to 52)	9275 (–12 148 to 45 641)
Sensitivity analyses		
One-way analyses using 95% CI		
Low cost	–13	–11 854
High cost	23	26 266
Weak clinical effect	12	34 518
Strong clinical effect	10	3279
Conservative clinical effects	23	19 655
Conservative utility weights	NA	20 171
Excluding family costs	9	8419
HMO costs only	18	16 178
Parent attendance at teen visits		
0% of visits	9	8176
25% of visits	10	8725
75% of visits	11	9825
100% of visits	12	10 375

Abbreviations: CI, confidence interval; DFD, depression-free day; HMO, health maintenance organization; NA, not applicable; QALY, quality-adjusted life-year.

*Negative numbers indicate cost savings.

†The 95% CIs were calculated by means of 1000 bootstrapped replications with bias correction.

difference was not statistically significant at the .05 level. Although the increased intervention cost was not significant, health systems would have to increase expenditures initially to provide the program. Detailed information on cost-effectiveness could aid in the decision of whether to provide this intervention vs other investments for health improvement.

In the base-case analysis, including teen and parent time and travel costs, the average incremental cost-effectiveness ratio (ICER) was $10 per DFD (95% CI, –$13 to $52) or $9275 per QALY (95% CI, –$12 148 to $45 641) (**Table 6**).

Sensitivity analyses indicated that the ICER estimate was sensitive to several factors. One-way sensitivity analyses using the 95% CI for costs and clinical effects indicated that if the intervention cost was at the low end of the 95% CI, the ICER would be negative on average (–$13 per DFD or –$11 854 per QALY). If the intervention cost was at the high end of the 95% CI, the intervention would cost on average more than double our base-case estimates ($23 per DFD or $26 266 per QALY). If the clinical effect was at the weaker tail of the 95% CI, the average ICER would be higher than the base-case estimates ($12 per DFD or $34 518 per QALY). If the clinical effect was at the stronger tail of the 95% CI, the average ICER would be lower ($10 per DFD or $3279 per QALY). Using a more conservative method for calculating the clinical effects (including only days in full depression episodes to calculate DFD), we found an average ICER of $23 per DFD or $19 655 per QALY. Using the more conservative utility weight (0.2), we estimated a mean ICER of $20 171 per QALY. When we excluded family costs from the calculation of the base case, we found an average ICER of $9 per DFD or $8419 per QALY. With only HMO-incurred costs, we found an average ICER of $18 per DFD or $16 178 per QALY. Finally, when we examined our assumption about parents' attendance, the average ICER ranged from $9 per DFD or $8176 per QALY if parents attended no visits, to $12 per DFD or $10 375 per QALY if parents attended all visits.

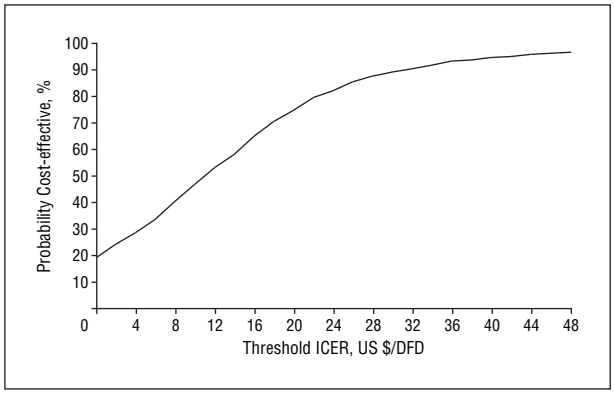

Figure. Cost-effectiveness acceptability curve (2000 US dollars). DFD indicates depression-free day; ICER, incremental cost-effectiveness ratio.

A cost-effectiveness acceptability curve for the base-case analysis (**Figure**) shows the intervention in relation to different amounts a decision maker might be willing to pay to increase the number of DFDs in a population. For instance, if a decision maker is willing to pay $20, the probability of CBT being cost-effective is about 75%.

COMMENT

We found that a group CBT intervention with at-risk teens led to more DFDs and cost an average of $1632 per participant to deliver; this cost was partially offset by a statistically significant cost offset in general medical costs, and a close-to-significant cost offset to other sectors (outside the HMO). We need to understand whether the costs to provide the intervention are worth its benefits.

Some commonly cited guidelines[63-65] indicate that if a new intervention is more effective than existing ones and costs less than $20 000, $50 000, or $100 000 per QALY, it should be adopted. Our base-case analysis ($9275 per QALY) indicated that the intervention is cost-effective on average by any of these standards. Most of the sensitivity analyses also indicate that the intervention is cost-effective on average by any of these standards. In all cases, our base-case and sensitivity analyses indicate that the intervention is cost-effective on average with the criterion of $50 000 per QALY or less.

We could also evaluate this intervention by comparing its cost-effectiveness with that of similar interventions. However, to our knowledge, no other studies have examined the cost-effectiveness of interventions to *prevent or treat* depression in at-risk teens. We therefore have to compare the cost-effectiveness of this intervention with the cost-effectiveness of other depression *treatments* for *adults*. Comparing interpersonal psychotherapy with usual care for depression treatment, Lave and colleagues[33] reported average cost-effectiveness for 2 types of depression treatment at $13 and $18 per DFD for direct costs only and $15 and $25 per DFD for costs including patient time and transportation. Simon and colleagues[42] reported average cost-effectiveness for system-

atic depression treatment for high utilizers of general medical care of about $41 per DFD for direct costs and $52 per DFD including patient time cost. Valenstein and colleagues[41] reported average cost-effectiveness of $32 053 per QALY for one-time screening for depression in primary care, $50 988 per QALY for screening every 5 years, and $192 444 per QALY for annual screening. A study comparing cost-effectiveness of quality improvement programs for depression reported average cost per QALY of $9478 to $30 663 (range depending on utility weight selected).[34] Another study comparing cost-effectiveness of collaborative care for persistent depression reported cost per DFD of between $21 and $35 depending on the types of costs included.[35] Finally, a study comparing cost-effectiveness of collaborative care for depression in a veteran population reported cost per DFD of between $2 and $33 depending on the types of costs included.[46] Our results are within the same range as these results.

This study has several limitations. We examined the effects and costs of this group CBT intervention in a single HMO, with a relatively small group of teens, and therefore we cannot be certain our results would be generalizable to other locations or health care systems. We evaluated cost-effectiveness during 12 months after the intervention. Thus, we cannot provide information on the long-term impact of the intervention. The RCT was not designed to collect complete information on patient costs, so we relied on a combination of information from the trial and published literature to estimate patient costs. This study was designed to use systems similar to those used in cancer screening and other prevention services that use health plan records to identify at-risk groups and then conduct outreach to bring them in for services. We found that identification and outreach were very costly. However, at the time of this study, we had to rely on paper chart review to identify parents of at-risk teens. This health plan has since adopted comprehensive electronic medical records. The identification process would likely be significantly less expensive with the use of electronic methods to identify teens.

To estimate QALYs, we relied on utility weights assigned to depression from published literature. These utility weights were estimated for adults with depression; however, utility weights for teens with depression might be different.[66] Epidemiologic information on depression indicates that once a teen has had 1 episode of depression, that teen may be at risk for a number of adverse outcomes.[4-6] Therefore, teens, parents, or communities might value reducing depression in teens more highly than in adults because of the possibility of preventing these adverse consequences and increasing the total lifetime benefit of improved functioning and productivity. In addition, there is ongoing debate about whether QALYs adequately capture mental health outcomes.[66] We know of no studies that have collected data for estimating the value of mental health treatments for children or teens.

Although we attempted to implement the intervention in a manner that would represent the "real world," it is likely that our supervision and training standards exceeded usual practice standards. These standards may have led to better outcomes and greater costs than would be experienced in a typical health plan.

Our findings suggest that health plans, and other integrated systems of health care, can intervene to prevent depression in at-risk teens for a cost similar to or more attractive than that of other generally accepted medical interventions. However, these promising results need to be verified by examining the clinical effectiveness and associated costs of this intervention in a larger and more diverse population. Members of this research team and collaborators from 3 other sites are currently replicating this intervention with a larger sample size (planned N=320) in 4 sites in the United States (Oregon, Tennessee, Pennsylvania, and Massachusetts).

Our results indicate that it is possible in a real-world setting to prevent depression in at-risk teens in a cost-effective manner. At this time, few managed care organizations provide coverage for any type of mental health prevention services.[67] Previous studies[68] indicate that managed care organizations and other insurers are often reluctant to adopt or cover new services that might attract persons at risk for mental health problems to their system because of concerns about possibly increasing costs. Changes in the priorities of health systems, changes in the insurance system, or public policy initiatives to provide incentives for implementing depression prevention programs would probably be necessary for this intervention to be adopted in real-world settings.

Submitted for Publication: March 8, 2004; final revision received March 31, 2005; accepted April 29, 2005.
Correspondence: Frances L. Lynch, PhD, MSPH, Kaiser Permanente Center for Health Research, 3800 N Interstate Ave, Portland, OR 97227-1098 (frances.lynch@kp.org).
Funding/Support: This study was supported by grant 1R01-MH51318-01A1 from the National Institute of Mental Health, Bethesda, Md (Dr Clarke).
Acknowledgment: We thank Kimberly Hoagwood, PhD, Lauren Haworth, and Jennifer Coury, MA, for their assistance on this project.

REFERENCES

1. Birmaher B, Ryan ND, Williamson DE, Brent DA, Kaufman J, Dahl RE, Perel J, Nelson B. Childhood and adolescent depression: a review of the past 10 years, part I. *J Am Acad Child Adolesc Psychiatry*. 1996;35:1427-1439.
2. Lewinsohn PM, Hops H, Roberts RE, Seeley JR, Andrews JA. Adolescent psychopathology, I: prevalence and incidence of depression and other *DSM-III-R* disorders in high school students [published correction appears in *J Abnorm Psychol*. 1993;102:517]. *J Abnorm Psychol*. 1993;102:133-144.
3. National Institute of Mental Health. *Depression in Children and Adolescents: A Fact Sheet for Physicians*. Bethesda, Md: Dept of Health and Human Services, National Institutes of Health; September 2000. NIMH publication 00-4744.
4. Birmaher B, Brent DA, Benson RS. Summary of the practice parameters for the assessment and treatment of children and adolescents with depressive disorders. *J Am Acad Child Adolesc Psychiatry*. 1998;37:1234-1238.
5. Ryan ND, Puig-Antich J, Ambrosini P, Rabinovich H, Robinson D, Nelson B, Iyengar S, Twomey J. The clinical picture of major depression in children and adolescents. *Arch Gen Psychiatry*. 1987;44:854-861.
6. Weissman MM, Wolk S, Goldstein RB, Moreau D, Adams P, Greenwald S, Klier CM, Ryan ND, Dahl RE, Wickramaratne P. Depressed adolescents grown up. *JAMA*. 1999;281:1707-1713.
7. Simon GE, VonKorff M, Barlow W. Health care costs of primary care patients with recognized depression. *Arch Gen Psychiatry*. 1995;52:850-856.
8. Simon GE, Revicki D, Heiligenstein J, Grothaus L, VonKorff M, Katon WJ, Hylan TR. Recovery from depression, work productivity, and health care costs among primary care patients. *Gen Hosp Psychiatry*. 2000;22:153-162.
9. Dhossche D, van der Steen F, Ferdinand R. Somatoform disorders in children and adolescents: a comparison with internalizing disorders. *Ann Clin Psychiatry*. 2002;14:23-31.
10. Downey G, Coyne JC. Children of depressed parents: an integrative review. *Psychol Bull*. 1990;108:50-76.
11. Beardslee WR, Versage EM, Gladstone TR. Children of affectively ill parents: a review of the past 10 years. *J Am Acad Child Adolesc Psychiatry*. 1998;37:1134-1141.
12. Roberts RE. Epidemiological issues in measuring preventive effects. In: Munoz

RF, ed. *Depression Prevention: Research Directions*. New York, NY: Hemisphere Publishing Corp; 1987:45-68.
13. Horwath E, Johnson J, Klerman GL, Weissman MM. Depressive symptoms as relative and attributable risk factors for first-onset major depression. *Arch Gen Psychiatry*. 1992;49:817-823.
14. Weissman MM, Fendrich M, Warner V, Wickramaratne P. Incidence of psychiatric disorder in offspring at high and low risk for depression. *J Am Acad Child Adolesc Psychiatry*. 1992;31:640-648.
15. Beardslee WR, Salt P, Porterfield K, Rothberg PC, van de Velde P, Swatling S, Hoke L, Moilanen DL, Wheelock I. Comparison of preventive interventions for families with parental affective disorder. *J Am Acad Child Adolesc Psychiatry*. 1993;32:254-263.
16. Clarke GN, Hawkins W, Murphy M, Sheeber LB. Targeted prevention of unipolar depressive disorder in an at-risk sample of high school adolescents: a randomized trial of group cognitive intervention. *J Am Acad Child Adolesc Psychiatry*. 1995;34:312-321.
17. Jaycox LH, Reivich KJ, Gillham J, Seligman ME. Prevention of depressive symptoms in school children. *Behav Res Ther*. 1994;32:801-816.
18. Clarke GN, Hornbrook M, Lynch F, Polen M, Gale J, Beardslee W, O'Connor E, Seeley J. A randomized trial of a group cognitive intervention for preventing depression in adolescent offspring of depressed parents. *Arch Gen Psychiatry*. 2001; 58:1127-1134.
19. Zimmerman M, Coryell W, Pfohl B, Stangl D. The reliability of the family history method for psychiatric diagnoses. *Arch Gen Psychiatry*. 1988;45:320-322.
20. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Revised Third Edition*. Washington, DC: American Psychiatric Association; 1987.
21. Beardslee WR, Podorefsky D. Resilient adolescents whose parents have serious affective and other psychiatric disorders: importance of self-understanding and relationships. *Am J Psychiatry*. 1988;145:63-69.
22. Clarke GN, Hornbrook M, Lynch F, Polen M, Gale J, O'Connor E, Seeley JR, Debar L. Group cognitive-behavioral treatment for depressed adolescent offspring of depressed parents in a health maintenance organization. *J Am Acad Child Adolesc Psychiatry*. 2002;41:305-313.
23. Clarke GN, Lewinsohn PM. *Instructor's Manual for the Adolescent Coping With Stress Course*. Portland, Ore: Kaiser Permanente Center for Health Research; 1995. Available at: http://www.kpchr.org/public/acwd/acwd.html.
24. Clarke GN, Lewinsohn PM, Hops H. *Instructor's Manual for the Adolescent Coping With Depression Course*. Portland, Ore: Kaiser Permanente Center for Health Research; 1990. Available at: http://www.kpchr.org/research/depressiontrials/cwda.html.
25. Clarke GN, Rohde P, Lewinsohn PM, Hops H, Seeley JR. Cognitive-behavioral treatment of adolescent depression: efficacy of acute group treatment and booster sessions. *J Am Acad Child Adolesc Psychiatry*. 1999;38:272-279.
26. Lewinsohn PM, Clarke GN, Hops H, Andrews JA. Cognitive-behavioral group treatment of depression in adolescents. *Behav Ther*. 1990;21:385-401.
27. Gold MR, Seigel JE, Russell LB, Weinstein MC. *Cost-effectiveness in Health and Medicine*. Oxford, England: Oxford University Press; 1996.
28. Hornbrook MC, Goodman MJ. Assessing relative health plan risk with the RAND-36 health survey. *Inquiry*. 1995;32:56-74.
29. Hornbrook MC, Goodman MJ. Chronic disease, functional health status, and demographics: a multi-dimensional approach to risk adjustment. *Health Serv Res*. 1996;31:283-307.
30. Hornbrook MC, Goodman MJ, Bennett MD. Assessing health plan case mix in employed populations: ambulatory morbidity and prescribed drug models. In: Hornbrook MC, ed. *Advances in Health Economics and Health Services Research*. Vol 12. Greenwich, Conn: JAI Press; 1991:197-232.
31. Hornbrook MC, Goodman MJ, Bennett MD, Greenlick MR. Assessing health plan case mix in employed populations: self reported health status models. In: Hornbrook MC, ed. *Advances in Health Economics and Health Services Research*. Vol 12. Greenwich, Conn: JAI Press; 1991:233-272.
32. Freeborn DK, Pope CR. *Promise and Performance in Managed Care: The Prepaid Group Practice Model*. Baltimore, Md: Johns Hopkins University Press; 1994.
33. Lave JR, Frank RG, Schulberg HC, Kamlet MS. Cost-effectiveness of treatments for major depression in primary care practice. *Arch Gen Psychiatry*. 1998;55: 645-651.
34. Schoenbaum M, Unützer J, Sherbourne C, Duan N, Rubenstein LV, Miranda J, Meredith LS, Carney MF, Wells K. Cost-effectiveness of practice-initiated quality improvement for depression. *JAMA*. 2001;286:1325-1330.
35. Simon GE, Katon WJ, VonKorff M, Unützer J, Lin EHB, Walker EA. Cost-effectiveness of a collaborative care program for primary care patients with persistent depression. *Am J Psychiatry*. 2001;158:1638-1644.
36. Simon GE, VonKorff M, Ludman EJ, Katon WJ, Rutter C, Unützer J. Cost-effectiveness of a program to prevent depression relapse in primary care. *Med Care*. 2002;40:941-950.
37. Koopmanschap MA, van Ineveld BV. Towards a new approach for estimating indirect costs of disease. *Soc Sci Med*. 1992;34:1005-1010.
38. Sculpher M. The role and estimation of productivity costs in economic evaluation. In: Drummond M, McGuire A, eds. *Economic Evaluation in Health Care: Merging Theory With Practice*. Oxford, England: Oxford University Press; 2001:94-112.
39. Glied S. Estimating the indirect cost of illness: an assessment of the forgone earnings approach. *Am J Public Health*. 1996;86:1723-1728.
40. Lofland JH, Locklear JC, Frick KD. Different approaches to valuing the lost productivity of patients with migraine. *Pharmacoeconomics*. 2001;19:917-925.
41. Valenstein M, Vijan S, Zeber JE, Boehm K, Buttar A. The cost-utility of screening for depression in primary care. *Ann Intern Med*. 2001;134:345-360.
42. Simon GE, Manning WG, Katzelnick DJ, Pearson SD, Henk HJ, Helstad CS. Cost-effectiveness of systematic depression treatment of high utilizers of general medical care. *Arch Gen Psychiatry*. 2001;58:181-187.
43. US Department of Labor, Bureau of Labor Statistics. National compensation survey. Available at: http://www.bls.gov/ncs/ocs/sp/ncbl0338.pdf. Accessed August 30, 2005.
44. Report on the youth labor force. Chapter 4: trends in youth employment: data from the current population survey. US Department of Labor Web site. November 2000. Available at: http://www.bls.gov/opub/rylf/rylfhome.htm. Accessed December 27, 2003.
45. Chisholm D, Godfrey E, Ridsdale L, Chalder T, King M, Seed P, Wallace P, Wessely S; Fatigue Trialists' Group. Chronic fatigue in general practice: economic evaluation of counselling versus cognitive behaviour therapy. *Br J Gen Pract*. 2001;51:15-18.
46. Liu CF, Hedrick SC, Chaney EF, Heagerty P, Felker B, Hasenberg N, Fihn S, Katon W. Cost-effectiveness of collaborative care for depression in a primary care veteran population. *Psychiatr Serv*. 2003;54:698-704.
47. Wells KB, Sherbourne CD. Functioning and utility for current health of patients with depression or chronic medical conditions in managed, primary care practices. *Arch Gen Psychiatry*. 1999;56:897-904.
48. Revicki D, Wood M. Patient-assigned health state utilities for depression-related outcomes: differences by depression severity and antidepressant medications. *J Affect Disord*. 1998;48:25-36.
49. Fryback DG, Dasbach EJ, Klein R, Klein BE, Dorn N, Peterson K, Martin PA. The Beaver Dam Health Outcomes Study: initial catalog of health state quality factors. *Med Decis Making*. 1993;13:89-102.
50. Pyne JM, Patterson TL, Kaplan RM, Ho S, Gillin JC, Golshan S, Grant I. Preliminary longitudinal assessment of quality of life in patients with major depression. *Psychopharmacol Bull*. 1997;33:23-29.
51. Unutzer J, Patrick DL, Simon G, Grembowski D, Walker E, Rutter C, Katon W. Depressive symptoms and the cost of health services in HMO patients aged 65 and older: a 4-year prospective study. *JAMA*. 1997;277:1618-1623.
52. Bennett KJ, Torrance GW, Boyle MH, Guscott R. Cost-utility analysis in depression: the McSad utility measure for depression health states. *Psychiatr Serv*. 2000; 51:1171-1176.
53. Briggs A, Gray A. The distribution of health care costs and their statistical analysis for economic evaluation. *J Health Serv Res Policy*. 1998;3:233-245.
54. Duan N. Smearing estimate: a non-parametric retransformation method. *J Am Stat Assoc*. 1983;78:605-610.
55. Diehr P, Yanez D, Ash A, Hornbrook M, Lin DY. Methods for analyzing health care utilization and costs. *Annu Rev Public Health*. 1999;20:125-144.
56. Thompson SG, Barber JA. How should cost data in pragmatic randomized trials be analysed? *BMJ*. 2000;320:1197-1200.
57. O'Brien BJ, Briggs AH. Analysis of uncertainty in health care cost-effectiveness studies: an introduction to statistical issues and methods. *Stat Methods Med Res*. 2002;11:455-468.
58. O'Brien BJ, Drummond MF, Labelle RJ, Willan A. In search of power and significance: issues in the design and analysis of stochastic cost-effectiveness studies in health care. *Med Care*. 1994;32:150-163.
59. Mooney CZ, Duval RD. *Bootstrapping: A Nonparametric Approach to Statistical Inference*. Thousand Oaks, Calif: Sage Publications; 1993. Sage Publications Series: Quantitative Applications in the Social Sciences; vol 95.
60. Knapp M, McCrone P, Fombonne E, Beecham J, Wostear G. The Maudsley long-term follow-up of child and adolescent depression, 3: impact of comorbid conduct disorder on service use and costs in adulthood. *Br J Psychiatry*. 2002; 180:19-23.
61. Briggs A, Tambour M. *The Design and Analysis of Stochastic Cost-effectiveness Studies for the Evaluation of Health Care Interventions*. Stockholm, Sweden: Stockholm School of Economics; April 1998:1-22. Working Paper Series in Economics and Finance No. 234.
62. Stinnett AA, Mullahy J. Net health benefits: a new framework for the analysis of uncertainty in cost-effectiveness analysis. *Med Decis Making*. 1998;18(2, suppl) :S68-S80.
63. Laupacis A, Feeny D, Detsky AS, Tugwell PX. How attractive does a new technology have to be to warrant adoption and utilization? tentative guidelines for using clinical and economic evaluations. *CMAJ*. 1992;146:473-481.
64. Hirth RA, Chernew ME, Miller E, Fendrick AM, Weissert WG. Willingness to pay for a quality-adjusted life year: in search of a standard. *Med Decis Making*. 2000; 20:332-342.
65. Neumann PJ. *Using Cost-effectiveness Analysis to Improve Health Care: Opportunities and Barriers*. Oxford, England: Oxford University Press; 2005:157-158.
66. Chisholm D, Healey A, Knapp M. QALYs and mental health care. *Soc Psychiatry Psychiatr Epidemiol*. 1997;32:68-75.
67. Dorfman S. *Preventive Interventions Under Managed Care: Mental Health and Substance Abuse Services*. Rockville, Md: Center for Mental Health Services, Substance Abuse and Mental Health Services Administration; 2000. DHHS publication (SMA) 00-3437.
68. US Department of Health and Human Services. Organization and financing of mental health services. In: *Mental Health: A Report of the Surgeon General*. Rockville, Md: National Institute of Mental Health; 1999:418-420.