

Primary Care Intervention to Reduce Alcohol Misuse Ranking Its Health Impact and Cost Effectiveness

Leif I. Solberg, MD, Michael V. Maciosek, PhD, Nichol M. Edwards, MS

Background: The U.S. Preventive Services Task Force (USPSTF) has recommended screening and behavioral counseling interventions in primary care to reduce alcohol misuse. This study was designed to develop a standardized rating for the clinically preventable burden and cost effectiveness of complying with that recommendation that would allow comparisons across many recommended services.

Methods: A systematic review of the literature from 1992 through 2004 to identify relevant randomized controlled trials and cost-effectiveness studies was completed in 2005. Clinically preventable burden (CPB) was calculated as the product of effectiveness times the alcohol-attributable fraction of both mortality and morbidity (measured in quality-adjusted life years or QALYs), for all relevant conditions. Cost effectiveness from both the societal perspective and the health-system perspective was estimated. These analyses were completed in 2006.

Results: The calculated CPB was 176,000 QALYs saved over the lifetime of a birth cohort of 4,000,000, with a range in sensitivity analysis from -43% to $+94\%$ (primarily due to variation in estimates of effectiveness). Screening and brief counseling was cost-saving from the societal perspective and had a cost-effectiveness ratio of \$1755/QALY saved from the health-system perspective. Sensitivity analysis indicates that from both perspectives the service is very cost effective and may be cost saving.

Conclusions: These results make alcohol screening and counseling one of the highest-ranking preventive services among the 25 effective services evaluated using standardized methods. Since current levels of delivery are the lowest of comparably ranked services, this service deserves special attention by clinicians and care delivery systems.

(Am J Prev Med 2008;34(2):143–152) © 2008 American Journal of Preventive Medicine

So many preventive services are effective that it is difficult for patients, payers, providers, and purchasers to know which ones are most important to focus on with limited time or resources. In order to provide such an aid to prioritization, the National Commission on Prevention Priorities was created by Partnership for Prevention with funding from the Centers for Disease Control and Prevention (CDC) and the Agency for Healthcare Research and Quality (AHRQ). The first ranking of prevention priorities was published in 2001, with an update and addition of other services added in 2006.^{1,2} As part of the 2006 update, a brief alcohol misuse screening and counseling intervention ranked in the top five, ahead of nearly 20 other effective services. This paper provides the information

on which that ranking was based, and the first cost-utility analysis of screening and brief intervention.

In 2004, the United States Preventive Services Task Force (USPSTF) released its recommendation for primary care interventions for alcohol problems. It gave a B rating for “screening and behavioral counseling interventions to reduce alcohol misuse by adults, including pregnant women.”^{3,4} The USPSTF found evidence that screening in primary care settings can accurately identify patients whose levels or patterns of alcohol consumption do not meet criteria for alcohol dependence, but do place them at risk for increased morbidity and mortality. It also found evidence that brief behavioral counseling interventions with follow-up in such patients can produce small-to-moderate reductions in alcohol consumption that are sustained over 6- to 12-month periods or longer. Finally, it identified some limited evidence that such interventions lead to positive health outcomes 4 or more years post-intervention, and that screening and behavioral counseling reduce alcohol-related morbidity. Since alcohol misuse is a serious common health problem, even indirect evidence that it can be affected by interventions in

From HealthPartners Research Foundation, Minneapolis, Minnesota
Address correspondence and reprint requests to: Leif I. Solberg, MD, HealthPartners Research Foundation, P.O. Box 1524, MS 21111R, Minneapolis MN 55440-1524. E-mail: leif.i.solberg@healthpartners.com.

The full text of this article is available via AJPM Online at www.ajpm-online.net; 1 unit of Category-1 CME credit is also available, with details on the website.

primary care suggests the need for such interventions. But if primary care settings are to focus their quality improvement and individual patient-care efforts on those conditions that have the greatest effects on health and the best cost effectiveness, it is important to have evidence-based information about the relative priority of all effective preventive services. Yarnall et al.⁵ has shown that if primary care clinicians tried to provide each of the services recommended by the USPSTF for each patient seen, it would take 7.5 hours per day for just that task.⁵ Thus, some prioritization information seems absolutely necessary.

Methods

The ability to compare different preventive services depends on applying the same methods to each service, which was done by utilizing the methods described previously.⁶ This article's methods adhere to the approach used with other services, but the description here is focused on the issues and details that are unique to this topic. Additional details of the models not presented here are available online.⁷

The approach used here was to estimate the health impact and cost effectiveness of regular screening for alcohol misuse by brief instruments such as CAGE (Cut-down, Annoyed, Guilty and Eye opener alcohol use disorders test) and AUDIT (Alcohol Use Disorders Identification Test) questionnaires, followed by evaluation of initial positives and brief counseling of true positives. Health impact was estimated by the clinically preventable burden (CPB), defined as the burden of disease prevented by the service when delivered regularly over the lifetime of a birth cohort of 4,000,000 individuals. Cost effectiveness was defined as the net gain in lifetime costs of delivering the service divided by net quality-adjusted life years (QALYs). The CPB and cost-effectiveness estimates were used to assign priority scores on a scale of 1 to 5 (5 being the highest) in order to depict the relative value of preventive services.⁶

Literature Search and Abstraction

In 2005 a systematic review of the literature to help ensure comparability of the estimates used to rank preventive services was completed.^{2,6} The literature review and estimates focused on randomized controlled trials (RCTs) of interventions that could be conducted in busy primary care practices on most of their alcohol-misusing patients, and that were tested under conditions consistent with those criteria. Trials of more intensive counseling or of interventions involving many follow-up contacts were eliminated as not feasible and outside the scope of the USPSTF recommendation. Seventy meta-analyses and systematic reviews of alcohol-misuse treatments were identified in PubMed from January 1992 through September 3, 2004. Another 1667 original articles were found in PubMed from January 2000 through October 25, 2004, including some articles referenced in the systematic reviews. These articles were reviewed against the following criteria, all of which had to be met for abstraction: (1) all services must be delivered in the primary care setting, (2) the population must not be restricted to those dependent on alcohol, (3) there must be a control group, (4) each intervention arm must have

at least 25 participants, (5) outcome measurements must include the percent of problem drinkers at baseline who were no longer problem drinkers at follow-up, and (6) outcomes must be measured for at least 6 months following intervention.

In order to identify cost-effectiveness articles of screening and brief intervention, a PubMed literature search⁸ from January 1992 to December 5, 2004 was performed. To be eligible for abstraction, these studies needed to meet all of the following four criteria: (1) analyze brief interventions, not limited to alcoholism or alcohol dependence, (2) be conducted on a U.S. population and report costs in U.S. dollars, (3) analyze full cost effectiveness with health outcomes measured as years of life with or without quality adjustment, and (4) analyze interventions delivered in a primary care setting. Five economic analyses were identified that met the first criteria.⁹⁻¹³ However, none of these met the other three criteria.

Model Estimation

Clinically preventable burden and cost effectiveness were estimated using an algebraic model as described elsewhere.^{6,8} The use of algebraic models rather than Markov models or microsimulations allowed more study resources to be devoted to producing consistent results across all services.

Methods for producing consistent estimates of cost effectiveness across preventive services are outlined in a methods article and a detailed technical report.^{6,8} These methods are consistent with the 'reference case' of the Panel on Cost Effectiveness in Health and Medicine (PCEHM).¹⁴ Keeping with these standards, the analysis from the societal perspective includes the value of patient time to obtain services and excludes productivity gains. All costs and benefits were discounted to their present value at the age of 18 using a 3% discount rate. Medical costs were updated to year 2000 dollars using the medical consumer price index (M-CPI), and all other costs were updated using the CPI for all items.

Results of Literature Review and Model Specification

The data points used in the model are shown in Table 1, along with their sources and the ranges over which each variable was explored in sensitivity analysis. All analyses were completed in 2006.

Effectiveness of Screening and Adherence

The effectiveness of screening depends on four factors: adherence with screening, sensitivity of screening tools, effectiveness of counseling in producing behavior change, and efficacy of behavior change in reducing the health consequences of hazardous drinking. As a result of the literature searches plus review of references in identified articles, 101 effectiveness articles were identified for potential abstraction.^{10,15-114} Only 16 of these articles met the above inclusion criteria and were abstracted by two reviewers independently.^{10,17,27,34,39,40,46,61,75,81,92,94,102,110,112,115}

Four studies reported (or allowed calculation of) completion rates for screening questionnaires^{39,40,81,94}; the mean (86%) was used as the estimate of screening

Table 1. Model parameters

Variable	Base case	Data source references	Range for sensitivity analysis
Adherence, effectiveness, and efficacy (%)			
Adherence with screening	86.0	39, 40, 81, 94	80% to 95%
Average sensitivity of CAGE and AUDIT questionnaires	70	116	60% to 90%
Effectiveness of counseling at changing behavior	17.4	10, 17, 34, 39, 61, 81, 102, 110, 112, 115	10% to 35%
Efficacy of behavior change at reducing burden of acute conditions	90	Assumed	75% to 100%
Efficacy of behavior change at reducing burden of chronic conditions	25	Assumed	10% to 50%
Lifetime burden of alcohol-attributable illness			
Total alcohol-attributable QALYs lost	0.662	—	—
Alcohol-attributable life years lost to chronic conditions	0.171	Appendix A, Table 1	±20%
Alcohol-attributable life years lost to acute conditions	0.366	Appendix A, Table 1	±20%
Alcohol-attributable morbidity-related QALYs lost from acute conditions	0.028	Appendix A, Table 2	±40%
Alcohol-attributable morbidity-related QALYs lost from chronic conditions	0.098	Appendix A, Table 2	±40%
% of problem drinkers screened and counseled	8.7	117	5 to 25
Costs of screening and counseling			
Cost of 10-minute office visit	\$43.63	118	±33%
Value of patient time and travel for office visit	\$42.32	119	±50%
Portion of 10 minute office visit for screen	10%	Assumed	5% to 20%
Portion of visit for evaluating false positives	20%	Assumed	10% to 25%
Portion of visit for evaluating true positives	50%	Assumed	25% to 75%
Average specificity of CAGE & AUDIT	85%	116	75% to 95%
Screens per year among ages 18–54	1.0	Assumed	0.5 to 2
Screens per year among ages 55+	0.5	Assumed	0.2 to 1.0
Average annual prevalence of problem drinking between ages 18–54	25.01%	120, 121	20% to 30%
Average annual prevalence of problem drinking after age 54	6.47%	120, 121	4% to 10%
Disease costs			
Alcohol-attributable medical costs	\$5143	122	±33%
Other alcohol-attributable costs, including alcohol-related crimes, motor vehicle crashes, fire destruction, and social welfare administration	\$9136	122	±33%
Portion of non-medical alcohol-attributable costs preventable through behavior change (%)	90	Assumed	75 to 100

AUDIT, Alcohol Use Disorder Identification Test; CAGE, Cut-down, Annoyed, Guilty and Eye opener (alcohol use disorders test); QALY, quality-adjusted life year.

adherence. While the four-question CAGE instrument is the most popular screening tool used in primary care to detect alcohol-dependent drinkers, the 10-item AUDIT questionnaire includes questions about quantity, frequency, and binge behavior, as well as symptoms of alcohol dependence. The midpoint of the combined sensitivity ranges of the CAGE and AUDIT (70%) was used for the sensitivity estimate.¹¹⁶

Most of the RCTs that met inclusion criteria for feasibility in primary care practice studied heavy drinking and/or hazardous drinking. Heavy drinking was defined in different ways among these studies, but focused on those drinking more than a certain quantity of alcohol per week, while hazardous drinking focused on those drinking more than a certain amount per occasion. An additional complication was that most of

the studies had <100% of subjects at baseline having whichever of these two problems were being tested. Therefore, reported results were used to compute reduction in problem drinking as the percent difference from the control-group level rather than using the percentage-point difference as frequently reported by the study authors.

Six studies that were abstracted were not included in the analysis because of fatal flaws or limited numbers or age groups of subjects.^{27,40,46,75,92,94} The final summary of effectiveness is based on the average effectiveness in 10 studies of reduction in heavy drinking,^{10,17,34,39,61,81,102,110,112,115} seven of which also measured reduction in hazardous drinking.^{10,17,34,39,61,112,115} The mean rate of effectiveness for heavy drinking was 17.3% and that for hazardous

drinking was 17.6%, for a composite effectiveness rate of 17.4% (9.8% to 30.1%). These estimates reflect behavior change at 6-months to 2-years post-intervention. In the absence of data about long-term and repeated interventions, it was assumed that the rate of 17.4% would be maintained over time with repeated intervention, while allowing for the possibility that effectiveness might wane to 10% over time or double to 35%.

Data on the efficacy of behavior change in reducing the health consequences of alcohol misuse are available for only some of the many alcohol-attributable conditions. It was assumed that the burden for acute alcohol-attributable conditions (injuries) would be reduced by 90% among individuals who adhered to clinician advice, since some alcohol-attributable injuries would still occur at lower levels of consumption. However, because chronic alcohol-attributable disease requires long-term behavior change, it was assumed that chronic conditions would be reduced by only 25%. Broad ranges for these variables were explored in sensitivity analysis.

Lifetime Burden of Alcohol-Attributable Disease

To estimate lifetime burden of alcohol-attributable disease, current mortality and morbidity for each condition were multiplied by published estimates of each condition's alcohol-attributable fraction (AAF) as documented in Appendix A (available online at www.ajpm-online.net). Mortality and morbidity have been reduced by screening and counseling practices. In order to estimate the total value of the service, the burden of deaths and illness that would have happened in the absence of screening was predicted first. Current mortality was influenced by the portion of the population screened and counseled, the effectiveness of counseling in changing behavior, and the effect of changing behavior in reducing burden. The estimates for these variables are described elsewhere in this section. In the Healthcare for Communities Survey, 8.7% of problem drinkers reported having been asked about drinking and receiving assistance beyond simple quit advice.¹¹⁷

Costs of Screening, History Taking, and Brief Counseling

The costs of screening include both patient and physician time. The lifetime costs of initial screening with evaluation and counseling for those who screen positive were computed. Based on the average of Medicare reimbursement and the median of private sector charges,¹¹⁸ the price of a 10-minute office visit was \$42.32 in Year 2000 dollars. It was assumed that 10% of that visit would be required for initial screening and that it would take 2 hours for patients at an average hourly earnings in 2000.¹¹⁹

False positives increase the costs of screening and history taking. The average specificity of the CAGE and AUDIT questionnaires was estimated as 85%.¹¹⁶ By assuming that false positives would require an additional 20% of a 10-minute office visit, true positive cases would require, on average, an additional 50% of a 10-minute visit for complete evaluation of positive screens.

Annual screening and counseling are probably necessary from ages 18 to 54 to maintain the 12-month rate of effectiveness, but biennial screening might be sufficient after the age of 54 when the prevalence of heavy drinking falls. To estimate the lifetime costs of screening, history taking, and brief counseling, the years of life lived after the age of 18 from U.S. life tables¹²⁰ were computed and the frequency of heavy drinking estimated. The distribution of years of life with and without risky or harmful drinking were determined from age-group and gender-specific estimates of the prevalence of heavy drinking on at least one occasion per year for 2003.¹²¹ The average for the two broad age groups that correspond with the different frequencies in screening are shown in Table 1.

Costs of Alcohol-Attributable Disease and Injury

The per-capita expenditures were calculated from Harwood's estimate of the annual societal costs of alcohol abuse,¹²² and were used to approximate lifetime costs. In calculating the cost savings from screening and counseling, the medical costs of alcohol-attributable disease and the costs of alcohol-related crimes, motor vehicle crashes, fire destruction, and social welfare administration (but not transfer payments of social welfare) were included. Costs in the absence of screening were calculated in the same manner as QALYs lost to alcohol in the absence of screening.

The estimates of adherence with screening, sensitivity of screening, and effectiveness of counseling were used to estimate the cost savings achieved. Using the same rationale as for acute medical conditions, it was assumed that 90% of non-medical alcohol-attributable costs are preventable through behavior change.

Results of Model: CPB and Cost Effectiveness Estimates

Results of calculations before discounting are shown in Table 2. The predicted gain per person in the target population is 0.045 QALYs, or 0.052 QALYs saved per person who completes screening. To rank this service, CPB was estimated as the total, undiscounted QALYs saved in a birth cohort of 4,000,000, factoring in patient non-adherence: 176,000 QALYs saved.

Without discounting, the lifetime costs of the service are divided nearly equally among clinician and patient time costs of screening and evaluation/counseling.

Table 2. Per person lifetime impact and cost effectiveness of screening

	Undiscounted			Discounted		
	No screening	With screening	Increment with screening	No screening	With screening	Increment with screening
QALYs lost to alcohol misuse	0.672	0.627	-0.045	0.187	0.175	-0.012
Medical costs of initial screen	0	179	179	0	88	88
Medical costs of evaluation and brief advice	0	171	171	0	84	84
Patient time cost of initial screen	0	174	174	0	86	86
Patient time costs of evaluation and brief advice	0	166	166	0	82	82
Alcohol-attributable medical costs	5218	4870	-348	2281	2129	-52
Other alcohol-attributable costs	9323	8444	-879	4724	4279	-445
Total screening, treatment, and other costs				7005	6747	-257
Total medical screening and treatment costs				22,281	2301	21
Clinically preventable burden for birth cohort of 4,000,000			177,029			
Societal CE (\$/QALY saved)						Not defined
Medical sector CE (\$/QALY saved)						1688

CE, cost effectiveness; QALY, quality-adjusted life year.

Discounted results, including cost effectiveness, are shown in **Table 2**. Cost-effectiveness results are also presented from the health-system perspective in which all costs and savings outside the health system are excluded. If net costs were positive, the cost-effectiveness ratio from the societal perspective would be calculated by dividing the net discounted costs (-\$254 lifetime per person in year 2000 dollars) by the discounted lifetime QALYs saved (0.012). However, the cost-effectiveness ratio is not defined when net costs are negative (i.e., net cost savings), and therefore the summary measure for cost effectiveness for ranking clinical preventive service is the net savings of \$254 per person offered screening.

When including medical care costs only by excluding both patient time costs and non-medical cost offsets (the "health-system perspective"), the resulting cost-effectiveness ratio is \$1755/QALY saved.

Sensitivity Analysis

In single-variable sensitivity analysis, undiscounted QALYs saved per person and CPB were found to be highly sensitive to the effectiveness of counseling at changing behavior. They varied by -43% to +94% (0.026 to 0.091 QALYs per person). In multivariate analysis, combinations of three variables led to differences as great as -60% to +209% (0.081 to 0.138 QALYs per person). The lower estimates from multivariate sensitivity analysis would reduce the CPB priority score from its base-case score of 4 to a score of 3 (out of 5), and the higher multivariable sensitivity analysis would increase the score to a 5. This level of sensitivity in scores was typical of other service calculations.²

Net discounted savings are relatively small when measured as a percent of either discounted service costs

or cost offsets. As a result, changes to variables that affect the estimates of service costs or savings often produced large changes to net costs and the cost-effectiveness ratio. Nine variables changed the net costs by more than 25% (**Table 3**). Despite some highly influential variables, net costs remained negative in single-variable sensitivity analysis except when changing the effectiveness of counseling in changing behavior. However, in multivariate sensitivity analysis, changes in combinations of three variables at a time resulted in a range of from -\$1400 per person up to \$98,800 per QALY saved (+\$484 per person). The base case and the higher estimate of net savings from sensitivity analysis are consistent with a cost-effectiveness score of 5 (out of 5), while the estimated least cost-effective combination of variables is consistent with a cost-effectiveness score of 2. More than 10 combinations of three variables would produce a cost-effectiveness score of 2, and other combinations would produce a score of 3 or 4. Although regular screening and counseling are undoubtedly very cost effective, there is uncertainty as to whether it is cost saving.

No data are available to quantify the relationship between the frequency of service delivery and the level of sustained behavior change. **Figures 1** and **2** examine some scenarios by showing the effectiveness of counseling needed to obtain various cost-effectiveness thresholds at each frequency of service delivery. The frequencies shown on the horizontal axis are for individuals aged 18-54 years and in each case the frequency for ages 55+ is 50% lower. For example, at the base-case frequencies of annual screening and biennial screening for adults to age 54 and adults age 55+ (1.0 and 0.5 per year), sustained effectiveness of 10% would be needed to achieve cost neutrality from the societal perspective

Table 3. Sensitivity analysis for cost-effectiveness results

Variable	Base case	Range used in sensitivity analysis	Single-variable sensitivity analysis results: net cost per person
Sensitivity of screening	70%	60% to 70%	−\$393 to −\$190
Effectiveness of counseling at changing behavior	17.4%	10% to 35%	−\$885 to +\$82 ^a
Cost of a 10 minute office visit	\$43.63	±33%	−\$344 to −\$171
Value of patient time spent for travel and visit attendance	\$42.43	±50%	−\$344 to −\$88
Portion of visit needed for screening and evaluation of all positives	10% (screening) 20% (history)	5% to 20% 10% to 25%	−\$351 to −\$185
Frequency of screening and counseling needed to maintain effectiveness of counseling	1.0 (to age 54) 0.5 (ages 55+)	0.5 to 2.0 0.2 to 1.0	−\$55 to −\$434
Non-medical alcohol-attributable costs	\$9,136	±33%	−\$404 to −\$109
Efficacy of behavior change in preventing non-medical alcohol-attributable costs	90%	75% to 100%	−\$307 to −\$183

^a\$82 per person and \$6,774 per QALY saved at 10% effectiveness. QALY, quality-adjusted life year.

(Figure 1), 8.3% would be needed to achieve a cost-effectiveness ratio of \$10,000/QALY, and so on. The figures show that if screening at or more frequent than the base-case levels achieve sustained effectiveness of 10% or less, then the cost savings found in the base case would not be realized. Further, substantially higher cost-effectiveness ratios may be realized even while leaving all other variables at their base-case estimates.

Discussion

Although wide variation in costs per QALY are produced by changes in the assumptions about effectiveness and the cost-effectiveness variables noted above,

the mean of those ranges still results in a CPB score of 4 and cost-effectiveness score of 5 (on a 1–5 geometric scale).² Among the 25 services studied, all given positive recommendations by the USPSTF, alcohol misuse achieved a combined score of 9, similar to screening for colorectal cancer, hypertension, or vision (adults over 64), and to influenza or pneumococcal immunization.

In contrast to those other services, however, alcohol-misuse screening and counseling currently are delivered at much lower rates. In a national survey of problem drinkers, only 8.7% reported having been asked and counseled about their alcohol use in the last 12 months.¹¹⁷ Given the ever-growing competing priorities facing physicians, this is not surprising. It is also a problem

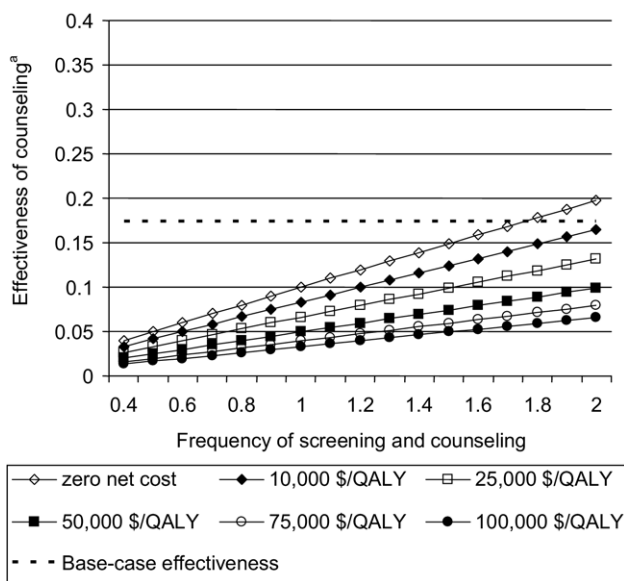


Figure 1. Threshold values of effectiveness of counseling for various frequencies of service delivery: societal perspective. (Times per year to age 54 shown; frequency for age 55+ are 50% lower in each case; base case=1.0 to age 54 and 0.50 ages 55+.) ^aBase case=17%

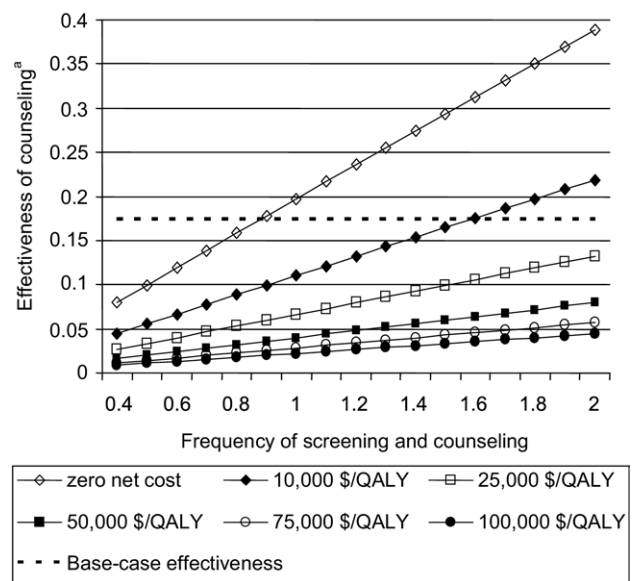


Figure 2. Threshold values of effectiveness of counseling for various frequencies of service delivery: medical costs only. (Times per year to age 54 shown; frequency for age 55+ are 50% lower in each case; base case=1.0 to age 54 and 0.50 ages 55+.) ^aBase case=17%

that is similar to depression, in that physicians perceive that identifying it during an otherwise crowded office visit will necessitate a prolonged and perhaps awkward discussion with uncertain patient benefit.

Others have found that brief interventions can be delivered at low costs on a one-time basis.^{13,123} Fleming et al.^{9,10} observed net medical cost savings with one-time screening and brief intervention in the TrEAT trial (Trial for Early Alcohol Treatment) and additional savings when health outcomes were monetized. Lindhold et al.¹² found more intensive primary care programs could be very cost effective or cost saving, depending on long-term effectiveness. The findings of this paper suggest that investments in regular screening are likely to be very cost effective from the health-system perspective and to be cost saving from the societal perspective, thus adding to the literature that suggests alcohol screening and brief intervention in primary care is a valuable and underutilized service.

Any study with multiple data points, assumptions, extrapolations, and dependence on highly aggregate data will have limitations. One problem is that the USPSTF focused on nondependent alcohol misuse, but studies of the disease burden and the effectiveness of brief counseling for alcohol misuse generally include dependent drinkers in the study population. Therefore, the estimates of these studies reflect the average for both dependent and nondependent problem drinkers. In usual practice, primary care clinicians would have limited ability to distinguish dependent and nondependent problem drinkers, so averaging across both groups likely provides a realistic estimate of overall effect.

Data on the health and financial burden by type of alcohol misuse also are limited to a subset of the consequences of alcohol misuse. Data are lacking on the relationship between an individual's disease risk and the probability of adhering with the steps necessary to achieve risk reduction. In particular, differences in adherence between dependent and nondependent alcohol misuse could be significant. The results of studies that use intention-to-treat analysis in entire populations and measure final health outcomes reflect differential adherence among subpopulations. Such studies would allow this modeling step to be bypassed and eliminate this data limitation. However, very few studies of brief counseling for alcohol misuse measure health outcomes, and none have long enough follow-up to observe differences in chronic conditions and associated mortality.

Similarly, individuals with high baseline alcohol use are likely to have larger health benefits from moderating behavior than individuals with lower use. If the relationship between alcohol use and health risks is not linear, the simple population average estimates would tend to understate the benefits of behavior change. Whether or not CPB and cost effectiveness ultimately

are understated depends on whether or not individuals with higher baseline alcohol use are equally likely to adhere with advice as individuals with lower baseline use.

Relative to some behavioral preventive services, the literature on the effectiveness of clinician counseling in producing changes to hazardous drinking among non-dependent drinkers is strong. However the available studies with longer-term follow-up indicate that effectiveness may wane after 12 months, and there are no studies of the long-term effectiveness (5+ years) with repeated screening and counseling. There was one study by Kristenson et al.^{124,125} of a moderately intensive intervention over 2 years in individuals with high serum-gamma-glutamyltransferase (GGT) values that provided follow-up of 6 years, but that approach was judged to be infeasible in primary care and incomparable to the studies used in this analysis. Therefore, the long-term effectiveness of the repeated interventions that would occur in real-life practice is unknown, and the assumption was made that the 12-month effectiveness equals that of long-term repeated interventions. It also is possible that subjects in randomized trial intervention groups may have underreported their drinking when asked at follow-up about drinking behaviors they had been counseled to avoid. Other variables for which data are sparse are the proportion of nonfatal conditions that is attributable to alcohol, and the efficacy of reducing alcohol misuse in preventing all alcohol-attributable morbidity, mortality, and costs.

The benefits and costs of the service for dependent problem drinkers are limited to what they would derive from brief counseling from a primary care clinician (as reflected in the estimate of effectiveness in counseling averaged across both dependent and nondependent problem drinkers). In practice, clinicians usually will refer the portion of dependent problem drinkers who are identified by screening to outside resources. For the portion that adheres to clinician recommendations to seek additional help, such services may lead to additional service costs, health benefits, and financial savings. These effects were not included in the estimates, due to data limitations. First, no estimates of rates of adherence with referrals to treatment for dependent drinking were found that could be generalized to the primary care setting. Studies that provide rates of successful referral relate to patients seen in emergency rooms and hospitals^{32,38,126,127} or are limited to patients with prior trauma.⁵⁰ These studies report that approximately 25% of referral patients kept the first appointment with treatment for dependence, but generally do not report adherence with subsequent appointments or program completion. Individuals with dependence that are identified through a screen in primary care may be even less likely to follow through on a referral.

Finally, cost effectiveness is highly unstable because net costs are very small relative to the costs of the service and the financial savings. Small changes to variables that affect total costs or savings can have a large impact on net costs and the cost-effectiveness ratio. However, it is worth noting that missing data on effectiveness of repeated counseling in producing sustained behavior change contribute substantial uncertainty to the model estimates.

Despite these uncertainties and limitations, it is clear that brief screening and counseling for alcohol misuse in primary care is both more effective and more cost-effective than most other effective preventive services. Since current rates of providing this service are so low, it becomes an even more important target for improvement. It remains for primary care practices to learn how to incorporate it into routine practice in a way that is cost-effective for them and for payers and health plans to make reimbursement changes that will facilitate that change.

This work has been supported by the Agency for Healthcare Research and Quality and the Centers for Disease Control and Prevention through Partnership for Prevention.

No financial disclosures were reported by the authors of this paper.

References

- Coffield AB, Maciosek MV, McGinnis JM, et al. Priorities among recommended clinical preventive services. *Am J Prev Med* 2001;21:1-9.
- Maciosek MV, Coffield AB, Edwards NM, Flottemesch TJ, Goodman MJ, Solberg LI. Priorities among effective clinical preventive services results of a systematic review and analysis. *Am J Prev Med* 2006;31:52-61.
- Whitlock EP, Polen MR, Green CA, Orleans T, Klein J. Behavioral counseling interventions in primary care to reduce risky/harmful alcohol use by adults: a summary of the evidence for the U.S. Preventive Services Task Force. *Ann Intern Med* 2004;140:557-68.
- Harris RP, Helfand M, Woolf SH, et al. Current methods of the U.S. Preventive Services Task Force: a review of the process. *Am J Prev Med* 2001;20(3S):21-35.
- Yarnall KS, Pollak KI, Ostbye T, Krause KM, Michener JL. Primary care: is there enough time for prevention? *Am J Public Health* 2003;93:635-41.
- Maciosek MV, Edwards NM, Coffield AB, et al. Priorities among effective clinical preventive services methods. *Am J Prev Med* 2006;31:90-6.
- Solberg LI, Maciosek MV, Edwards NM, McGree DA. Alcohol misuse screening and behavioral counseling: technical report prepared for the National Commission on Prevention Priorities, 2007. Available online at www.prevent.org.
- Maciosek MV, Coffield AB, Edwards NM, Flottemesch TJ, Goodman MJ, Solberg LI. Methods for prioritizing clinical preventive services. Technical report prepared for the National Commission on Prevention Priorities, 2006. Available online at: <http://www.prevent.org/images/stories/clinicalprevention/studymethods.pdf>.
- Fleming MF, Mundt MP, French MT, Manwell LB, Stauffacher EA, Barry KL. Benefit-cost analysis of brief physician advice with problem drinkers in primary care settings. *Med Care* 2000;38:7-18.
- Fleming MF, Mundt MP, French MT, Manwell LB, Stauffacher EA, Barry KL. Brief physician advice for problem drinkers: long-term efficacy and benefit-cost analysis. *Alcohol Clin Exp Res* 2002;26:36-43.
- Kunz FM Jr, French MT, Bazargan-Hejazi S. Cost-effectiveness analysis of a brief intervention delivered to problem drinkers presenting at an inner-city hospital emergency department. *J Stud Alcohol* 2004;65:363-70.
- Lindholm L. Alcohol advice in primary health care—is it a wise use of resources? *Health Policy* 1998;45:47-56.
- Zarkin GA, Bray JW, Davis KL, Babor TF, Higgins-Biddle JC. The costs of screening and brief intervention for risky alcohol use. *J Stud Alcohol* 2003;64:849-57.
- Gold MR, Siegel JE, Rusell LB, et al. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1996.
- Aalto M, Saksanen R, Laine P, et al. Brief intervention for female heavy drinkers in routine general practice: a 3-year randomized, controlled study. *Alcohol Clin Exp Res* 2000;24:1680-6.
- Aalto M, Seppa K, Mattila P, et al. Brief intervention for male heavy drinkers in routine general practice: a three-year randomized controlled study. *Alcohol Alcohol* 2001;30:36:224-30.
- Anderson P, Scott E. The effect of general practitioners' advice to heavy drinking men. *Br J Addict* 1992;87:891-900.
- Andreasson S, Hjalmarsson K, Rehnman C. Implementation and dissemination of methods for prevention of alcohol problems in primary health care: a feasibility study. *Alcohol Alcohol* 2000;35:525-30.
- Antti-Poika I, Karaharju E, Roine R, Salaspuro M. Intervention of heavy drinking: a prospective and controlled study of 438 consecutive injured male patients. *Alcohol Alcohol* 1988;23:115-21.
- Baer JS, Kivlahan DR, Blume AW, McKnight P, Marlatt GA. Brief intervention for heavy-drinking college students: 4-year follow-up and natural history. *Am J Public Health* 2001;91:1310-6.
- Barnett NP, Monti PM, Cherpitel C, et al. Identification and brief treatment of alcohol problems with medical patients: an international perspective. *Alcohol Clin Exp Res* 2003;27:262-70.
- Barnett NP, Tevyaw TO, Fromme K, et al. Brief alcohol interventions with mandated or adjudicated college students. *Alcohol Clin Exp Res* 2004;28:966-75.
- Bernstein E, Bernstein J, Levenson S. Project ASSERT: an ED-based intervention to increase access to primary care, preventive services, and the substance abuse treatment system. *Ann Emerg Med* 1997;30:181-9.
- Blow FC, Barry KL. Older patients with at-risk and problem drinking patterns: new developments in brief interventions. *J Geriatr Psychiatry Neurol* 2000;13:115-23.
- Borsari B, Carey KB. Effects of a brief motivational intervention with college student drinkers. *J Consult Clin Psychol* 2000;68:728-33.
- Bradley KA, Epler AJ, Bush KR, et al. Alcohol-related discussions during general medicine appointments of male VA patients who screen positive for at-risk drinking. *J Gen Intern Med* 2002;17:315-26.
- Burton LC, Paglia MJ, German PS, Shapiro S, Damiano AM. The effect among older persons of a general preventive visit on three health behaviors: smoking, excessive alcohol drinking, and sedentary lifestyle. The Medicare Preventive Services Research Team. *Prev Med* 1995;24:492-7.
- Carter CA, Kahnweiler WM. The efficacy of the social norms approach to substance abuse prevention applied to fraternity men. *J Am Coll Health* 2000;49:66-71.
- Chafetz ME, Blane HT, Abram HS, et al. Establishing treatment relations with alcoholics. *J Nerv Ment Dis* 1962;134:395-409.
- Chapman PL, Huygens I. An evaluation of three treatment programmes for alcoholism: an experimental study with 6- and 8-month follow-ups. *Br J Addict* 1988;83:67-81.
- Cordoba R, Delgado MT, Pico V, et al. Effectiveness of brief intervention on nondependent alcohol drinkers (EBIAL): a Spanish multi-centre study. *Fam Pract* 1998;15:562-8.
- Crawford MJ, Patton R, Touquet R, et al. Screening and referral for brief intervention of alcohol-misusing patients in an emergency department: a pragmatic randomised controlled trial. *Lancet* 2004;364:1334-9.
- Cunningham JA, Sdao-Jarvie K, Koski-Jannes A, Breslin FC. Using self-help materials to motivate change at assessment for alcohol treatment. *J Subst Abuse Treat* 2001;20:301-4.
- Curry SJ, Ludman EJ, Grothaus LC, Donovan D, Kim E. A randomized trial of a brief primary-care-based intervention for reducing at-risk drinking practices. *Health Psychol* 2003;22:156-65.
- Cutler SF, Wallace PG, Haines AP. Assessing alcohol consumption in general practice patients—a comparison between questionnaire and interview (findings of the Medical Research Council's general practice research framework study on lifestyle and health). *Alcohol Alcohol* 1988;23:441-50.
- Davidson D, Saha C, Scifres S, Fyffe J, O'Connor S, Selzer C. Naltrexone and brief counseling to reduce heavy drinking in hazardous drinkers. *Addict Behav* 2004;29:1253-8.
- Dinh-Zarr T, Goss C, Heitman E, Roberts I, DiGiuseppi C. Interventions for preventing injuries in problem drinkers. *Cochrane Database Syst Rev* 2004;(3):CD001857.

38. Elvy GA, Wells JE, Baird KA. Attempted referral as intervention for problem drinking in the general hospital. *Br J Addict* 1988;83:83-9.
39. Fleming MF, Barry KL, Manwell LB, Johnson K, London R. Brief physician advice for problem alcohol drinkers: a randomized controlled trial in community-based primary care practices. *JAMA* 1997;277:1039-45.
40. Fleming MF, Manwell LB, Barry KL, Adams W, Stauffacher EA. Brief physician advice for alcohol problems in older adults: a randomized community-based trial. *J Fam Pract* 1999;48:378-84.
41. Freeborn DK, Polen MR, Hollis JF, Senft RA. Screening and brief intervention for hazardous drinking in an HMO: effects on medical care utilization. *J Behav Health Serv Res* 2000;27:446-53.
42. Gassman RA. Medical specialization, profession, and mediating beliefs that predict stated likelihood of alcohol screening and brief intervention: targeting educational interventions. *Subst Abus* 2003;24:141-56.
43. Greber RA, Allen KM, Soeken KL, Soloumias BL. Outcome of trauma patients after brief intervention by a substance abuse consultation service. *Am J Addict* 1997;6:38-47.
44. Halliday A, Bush B, Cleary P, Aronson M, Delbanco T. Alcohol abuse in women seeking gynecologic care. *Obstet Gynecol* 1986;68:322-6.
45. Heather N. Psychology and brief interventions. *Br J Addict* 1989;84:357-70.
46. Heather N, Campion PD, Neville RG, Maccabe D. Evaluation of a controlled drinking minimal intervention for problem drinkers in general practice (the DRAMS scheme). *J R Coll Gen Pract* 1987;37:358-63.
47. Heather N, Kissoon-Singh J, Fenton GW. Assisted natural recovery from alcohol problems: effects of a self-help manual with and without supplementary telephone contact. *Br J Addict* 1990;85:1177-85.
48. Heather N, Whittton B, Robertson I. Evaluation of a self-help manual for media-recruited problem drinkers: six-month follow-up results. *Br J Clin Psychol* 1986;25 (Pt 1):19-34.
49. Helmus TC, Saules KK, Schoener EP, Roll JM. Reinforcement of counseling attendance and alcohol abstinence in a community-based dual-diagnosis treatment program: a feasibility study. *Psychol Addict Behav* 2003;17:249-51.
50. Israel Y, Hollander O, Sanchez-Craig M, et al. Screening for problem drinking and counseling by the primary care physician-nurse team. *Alcohol Clin Exp Res* 1996;20:1443-50.
51. Kaner E, Lock C, Heather N, McNamee P, Bond S. Promoting brief alcohol intervention by nurses in primary care: a cluster randomised controlled trial. *Patient Educ Couns* 2003;51:277-84.
52. Kaner EF, Heather N, Brodie J, Lock CA, McAvoy BR. Patient and practitioner characteristics predict brief alcohol intervention in primary care. *Br J Gen Pract* 2001;51:822-7.
53. Kelly AB, Halford WK, Young RM. Maritally distressed women with alcohol problems: the impact of a short-term alcohol-focused intervention on drinking behaviour and marital satisfaction. *Addiction* 2000;95:1537-49.
54. Kristenson H, Ohlin H, Hulten-Nosslin MB, Trelle E, Hood B. Identification and intervention of heavy drinking in middle-aged men: results and follow-up of 24-60 months of long-term study with randomized controls. *Alcohol Clin Exp Res* 1983;7:203-9.
55. Kristenson H, Osterling A, Nilsson JA, Lindgarde F. Prevention of alcohol-related deaths in middle-aged heavy drinkers. *Alcohol Clin Exp Res* 2002;26:478-84.
56. Kypri K, Saunders JB, Gallagher SJ. Acceptability of various brief intervention approaches for hazardous drinking among university students. *Alcohol Alcohol* 2003;38:626-8.
57. Larimer ME, Turner AP, Anderson BK, et al. Evaluating a brief alcohol intervention with fraternities. *J Stud Alcohol* 2001;62:370-80.
58. Lock CA, Kaner EF. Implementation of brief alcohol interventions by nurses in primary care: do nonclinical factors influence practice? *Fam Pract* 2004;21:270-5.
59. Maheswaran R, Beevers M, Beevers DG. Effectiveness of advice to reduce alcohol consumption in hypertensive patients. *Hypertension* 1992;19:79-84.
60. Maisto SA, Conigliaro J, McNeil M, Kraemer K, Conigliaro RL, Kelley ME. Effects of two types of brief intervention and readiness to change on alcohol use in hazardous drinkers. *J Stud Alcohol* 2001;62:605-14.
61. Manwell LB, Fleming MF, Mundt MP, Stauffacher EA, Barry KL. Treatment of problem alcohol use in women of childbearing age: results of a brief intervention trial. *Alcohol Clin Exp Res* 2000;24:1517-24.
62. Marlatt GA, Baer JS, Kivlahan DR, et al. Screening and brief intervention for high-risk college student drinkers: results from a 2-year follow-up assessment. *J Consult Clin Psychol* 1998;66:604-15.
63. Martinus T, Anderson B, Carter H. Counselling for alcohol problems in primary care in Forth Valley—an innovative approach? *Health Bull (Edinb)* 2001;59:158-62.
64. McCambridge J, Platts S, Whooley D, Strang J. Encouraging GP alcohol intervention: pilot study of change-orientated reflective listening (CORL). *Alcohol Alcohol* 2004;39:146-9.
65. McCambridge J, Strang J. The efficacy of single-session motivational interviewing in reducing drug consumption and perceptions of drug-related risk and harm among young people: results from a multi-site cluster randomized trial. *Addiction* 2004;99:39-52.
66. McIntosh MC, Leigh G, Baldwin NJ, Marmulak J. Reducing alcohol consumption. Comparing three brief methods in family practice. *Can Fam Physician* 1997;43:1959-62, 1965-7.
67. Miller WR. Motivation for treatment: a review with special emphasis on alcoholism. *Psychol Bull* 1985;98:84-107.
68. Miller WR, Gribskov CJ, Mortell RL. Effectiveness of a self-control manual for problem drinkers with and without therapist contact. *Int J Addict* 1981;16:1247-54.
69. Miller WR, Taylor CA. Relative effectiveness of bibliotherapy, individual and group self-control training in the treatment of problem drinkers. *Addict Behav* 1980;5:13-24.
70. Moore AA, Morton SC, Beck JC, et al. A new paradigm for alcohol use in older persons. *Med Care* 1999;37:165-79.
71. Morgenstern J, Bux DA, Labouvie E, Morgan T, Blanchard KA, Muench F. Examining mechanisms of action in 12-Step community outpatient treatment. *Drug Alcohol Depend* 2003;72:237-47.
72. Murphy JG, Benson TA, Vuchinich RE, et al. A comparison of personalized feedback for college student drinkers delivered with and without a motivational interview. *J Stud Alcohol* 2004;65:200-3.
73. Murphy JG, Duchnick JJ, Vuchinich RE, et al. Relative efficacy of a brief motivational intervention for college student drinkers. *Psychol Addict Behav* 2001;15:373-9.
74. Nilssen O. The Tromsø Study: identification of and a controlled intervention on a population of early-stage risk drinkers. *Prev Med* 1991;20:518-28.
75. Ockene JK, Adams A, Hurley TG, Wheeler EV, Hebert JR. Brief physician-and nurse practitioner-delivered counseling for high-risk drinkers: does it work? *Arch Intern Med* 1999;159:2198-205.
76. Ockene JK, Wheeler EV, Adams A, Hurley TG, Hebert J. Provider training for patient-centered alcohol counseling in a primary care setting. *Arch Intern Med* 1997;157:2334-41.
77. Oslin DW, Sayers S, Ross J, et al. Disease management for depression and at-risk drinking via telephone in an older population of veterans. *Psychosom Med* 2003;65:931-7.
78. Patton R, Crawford MJ, Touquet R. Impact of health consequences feedback on patients acceptance of advice about alcohol consumption. *Emerg Med J* 2003;20:451-2.
79. Persson J, Magnusson PH. Early intervention in patients with excessive consumption of alcohol: a controlled study. *Alcohol* 1989 Sep-1989;6:403-8.
80. Reid AL, Webb GR, Hennrikus D, Fahey PP, Sanson-Fisher RW. Detection of patients with high alcohol intake by general practitioners. *Br Med J (Clin Res Ed)* 1986;293:735-7.
81. Richmond R, Heather N, Wodak A, Kehoe L, Webster I. Controlled evaluation of a general practice-based brief intervention for excessive drinking. *Addiction* 1995;90:119-32.
82. Rollnick S, Heather N, Gold R, Hall W. Development of a short 'readiness to change' questionnaire for use in brief, opportunistic interventions among excessive drinkers. *Br J Addict* 1992;87:743-54.
83. Romelsjo A, Andersson L, Barrner H, et al. A randomized study of secondary prevention of early stage problem drinkers in primary health care. *Br J Addict* 1989;84:1319-27.
84. Saitz R, Horton NJ, Sullivan LM, Moskowitz MA, Samet JH. Addressing alcohol problems in primary care: a cluster randomized, controlled trial of a systems intervention. The screening and intervention in primary care (SIP) study. *Ann Intern Med* 2003;138:372-82.
85. Saitz R, Sullivan LM, Samet JH. Training community-based clinicians in screening and brief intervention for substance abuse problems: translating evidence into practice. *Subst Abus* 2000;21:21-31.
86. Sanchez-Craig M, Davila R, Cooper G. A self-help approach for high-risk drinking: effect of an initial assessment. *J Consult Clin Psychol* 1996;64:694-700.
87. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO

- Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption—II. *Addiction* 1993;88:791–804.
88. Savage SA, Hollin CR, Hayward AJ. Self-help manuals for problem drinking: the relative effects of their educational and therapeutic components. *Br J Clin Psychol* 1990;29(Pt 4):373–82.
 89. Schneider RJ, Casey J, Kohn R. Motivational versus confrontational interviewing: a comparison of substance abuse assessment practices at employee assistance programs. *J Behav Health Serv Res* 2000;27:60–74.
 90. Schonfeld L, Dupree LW, Dickson-Euhrmann E, et al. Cognitive-behavioral treatment of older veterans with substance abuse problems. *J Geriatr Psychiatry Neurol* 2000;13:124–9.
 91. Schutte KK, Nichols KA, Brennan PL, Moos RH. A ten-year follow-up of older former problem drinkers: risk of relapse and implications of successfully sustained remission. *J Stud Alcohol* 2003;64:367–74.
 92. Scott E, Anderson P. Randomized controlled trial of general practitioner intervention in women with excessive alcohol consumption. *Drug and Alcohol Review* 1991;10:313–21.
 93. Sellman JD, Sullivan PF, Dore GM, Adamson SJ, MacEwan I. A randomized controlled trial of motivational enhancement therapy (MET) for mild to moderate alcohol dependence. *J Stud Alcohol* 2001;62:389–96.
 94. Senft RA, Polen MR, Freeborn DK, Hollis JF. Brief intervention in a primary care setting for hazardous drinkers. *Am J Prev Med* 1997;13:464–70.
 95. Seppa K. Intervention in alcohol abuse among macrocytic patients in general practice. *Scand J Prim Health Care* 1992;10:217–22.
 96. Shakeshaft AP, Bowman JA, Burrows S, Doran CM, Sanson-Fisher RW. Community-based alcohol counselling: a randomized clinical trial. *Addiction* 2002;97:1449–63.
 97. Sieck CJ, Heirich M, Major C. Alcohol counseling as part of general wellness counseling. *Public Health Nurs* 2004;21:137–43.
 98. Sitharthan T, Kavanagh DJ, Sayer G. Moderating drinking by correspondence: an evaluation of a new method of intervention. *Addiction* 1996;91:345–55.
 99. Skutle A, Berg G. Training in controlled drinking for early-stage problem drinkers. *Br J Addict* 1987;82:493–501.
 100. Spivak K, Sanchez-Craig M, Davila R. Assisting problem drinkers to change on their own: effect of specific and nonspecific advice. *Addiction* 1994;89:1135–42.
 101. Tomson Y, Romelsjo A, Aberg H. Excessive drinking—brief intervention by a primary health care nurse. A randomized controlled trial. *Scand J Prim Health Care* 1998;16:188–92.
 102. Wallace P, Cutler S, Haines A. Randomised controlled trial of general practitioner intervention in patients with excessive alcohol consumption. *BMJ* 1988;297:663–8.
 103. Walsh DC, Hingson RW, Merrigan DM, et al. The impact of a physician's warning on recovery after alcoholism treatment. *JAMA* 1992;267:663–7.
 104. Walters ST, Bennett ME, Miller JH. Reducing alcohol use in college students: a controlled trial of two brief interventions. *J Drug Educ* 2000;30:361–72.
 105. Weisner C, Matzger H. Missed opportunities in addressing drinking behavior in medical and mental health services. *Alcohol Clin Exp Res* 2003;27:1132–41.
 106. Werch CE, Pappas DM, Carlson JM, DiClemente CC, Chally PS, Sinder JA. Results of a social norm intervention to prevent binge drinking among first-year residential college students. *J Am Coll Health* 2000;49:85–92.
 107. Wilk AI, Jensen NM. Investigation of a brief teaching encounter using standardized patients: teaching residents alcohol screening and intervention. *J Gen Intern Med* 2002;17:356–60.
 108. Woollard J, Beilin L, Lord T, Puddey I, MacAdam D, Rouse I. A controlled trial of nurse counselling on lifestyle change for hypertensives treated in general practice: preliminary results. *Clin Exp Pharmacol Physiol* 1995;22:466–8.
 109. Wright S, Moran L, Meyrick M, O'Connor R, Touquet R. Intervention by an alcohol health worker in an accident and emergency department. *Alcohol Alcohol* 1998;33:651–6.
 110. Wutzke SE, Conigrave KM, Saunders JB, Hall WD. The long-term effectiveness of brief interventions for unsafe alcohol consumption: a 10-year follow-up. *Addiction* 2002;97:665–75.
 111. Zweben A, Pearlman S, Li S. A comparison of brief advice and conjoint therapy in the treatment of alcohol abuse: the results of the Marital Systems Study. *Br J Addict* 1988;83:899–916.
 112. A cross-national trial of brief interventions with heavy drinkers. WHO Brief Intervention Study Group. *Am J Public Health* 1996;86:948–55.
 113. Matching alcoholism treatments to client heterogeneity: Project MATCH posttreatment drinking outcomes. *J Stud Alcohol* 1997;58:7–29.
 114. Matching alcoholism treatments to client heterogeneity: Project MATCH three-year drinking outcomes. *Alcohol Clin Exp Res* 1998;22:1300–11.
 115. Reiff-Hekking S, Ockene JK, Hurley TG, Reed GW. Brief physician and nurse practitioner-delivered counseling for high-risk drinking. Results at 12-month follow-up. *J Gen Intern Med* 2005;20:7–13.
 116. Fiellin DA, Reid MC, O'Connor PG. Screening for alcohol problems in primary care: a systematic review. *Arch Intern Med* 2000;160:1977–89.
 117. D'Amico EJ, Paddock SM, Burnam A, Kung FY. Identification of and guidance for problem drinking by general medical providers: results from a national survey. *Med Care* 2005;43:229–36.
 118. National Fee Analyzer Charge data for evaluating fees nationally. Salt Lake City UT: Ingenix, Inc., 2004.
 119. Employer Costs for Employee Compensation Historical Listing (Annual), 1986–2001. 2002.
 120. Arias E. United States life tables, 2000. *Natl Vital Stat Rep* 2002;51:1–38.
 121. National Institute on Alcohol Abuse and Alcoholism (NIAAA). Percent distribution of heavy drinking days (5+ drinks/day) for males 18 years of age and older according to selected characteristics: United States, NHIS, 1997–2003. Available online at: <http://www.niaaa.nih.gov/databases/dkpat28.htm>.
 122. Harwood H. Updating estimates of the economic costs of alcohol abuse in the united states: estimates, update methods, and data. Rockville MD: National Institutes of Health, 1998. Report prepared by The Lewin Group for the National Institute on Alcohol Abuse and Alcoholism, 2000. Based on estimates, analyses, and data reported in Harwood H, Fountain D, Livermore G. The economic costs of alcohol and drug abuse in the United States 1992. Report prepared for the National Institute on Drug Abuse and the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, Department of Health and Human Services.; 2000. Report No.: NIH Publication No. 98-4327.
 123. Babor TF, Higgins-Biddle JC, Dauser D, Bursleson JA, Zarkin GA, Bray J. Brief interventions for at-risk drinking: patient outcomes and cost-effectiveness in managed care organizations. *Alcohol Alcohol* 2006;41:624–31.
 124. Berglund G, Nilsson P, Eriksson KF, et al. Long-term outcome of the Malmo preventive project: mortality and cardiovascular morbidity. *J Intern Med* 2000;247:19–29.
 125. Kristenson H, Trelle E, Hood B. Serum-gamma-glutamyltransferase in screening and continuous control of heavy drinking in middle-aged men. *Am J Epidemiol* 1981;114:862–72.
 126. Green M, Setchell J, Hames P, Stiff G, Touquet R, Priest R. Management of alcohol abusing patients in accident and emergency departments. *J R Soc Med* 1993;86:393–5.
 127. Batel P, Pessione F, Bouvier AM, Rueff B. Prompting alcoholics to be referred to an alcohol clinic: the effectiveness of a simple letter. *Addiction* 1995;90:811–4.

Appendix A. Quality-Adjusted Life Years Lost Due to Alcohol-Attributable Mortality and Morbidity

For each data point, the most recently available data were used unless more reliable estimates for an earlier year were available. To calculate clinically preventable burden (CPB), the burden of disease attributable to alcohol use was estimated first. This required that the portion of mortality and morbidity for each relevant condition that could be attributable to alcohol be estimated, and then multiply that alcohol-

attributable fraction (AAF) by the mortality (years of life lost) and the morbidity (QALYs or quality-adjusted life years) for each condition. The estimates in Tables A-1 and A-2 have been scaled to 1,000,000 individuals (rather than 4,000,000) to facilitate comparisons to the per-person estimates reported in the article.

Alcohol-Attributable Fraction

The AAFs were taken from direct AAFs reported on the Alcohol-Related Disease Impact (ARDI) website (<http://>

Table A-1. Years of life lost attributable to alcohol use in a birth cohort of 1,000,000

Conditions	Alcohol-attributable fraction	Total deaths	Alcohol-attributable deaths	Average life expectancy	Years of life lost
Chronic					
Acute pancreatitis	0.24	1,017	244	13.8	3,375
Alcohol abuse	1	251	251	27.8	6,979
Alcoholic cardiomyopathy	1	257	257	20.8	5,349
Alcohol dependence syndrome	1	0	0	0.0	0
Alcoholic polyneuropathy	1	1.8	1.8	15.0	27
Alcoholic gastritis	1	15	15	22.4	342
Alcoholic liver disease	1	3,757	3,757	22.0	82,554
Alcoholic psychosis	1	146	146	13.4	2,391
Breast cancer	0.0085	15,012	128	15.4	1,967
Chronic hepatitis	0.013	83	1	15.0	16
Chronic pancreatitis	0.84	100	84	17.1	1,429
Epilepsy	0.15	392	59	23.3	1,372
Esophageal cancer	0.036	4,641	167	13.4	2,243
Esophageal varices	0.4	75	30	15.8	476
Fetal alcohol syndrome	0.47	25	12	11.9	139
Gastroesophageal hemorrhage	0.025	19,391	485	9.9	4,776
Hypertension	0.0018	204,497	368	9.1	3,356
Ischemic heart disease	0.061	1,506	92	14.0	1,284
Laryngeal cancer	0.052	4,860	253	13.2	3,326
Liver cancer	0.4	4,836	1,934	15.7	30,342
Liver cirrhosis, unspecified	0.033	1,045	35	77.9	2,652
Low birthweight/Prematurity	0.057	2,530	144	14.0	2,020
Oropharyngeal cancer	0.4	41	16	15.5	251
Portal hypertension	0.0076	16,228	123	7.6	932
Prostate cancer	0.051	13,155	671	12.5	8,402
Stroke, hemorrhagic	0.031	11,659	361	7.7	2,766
Stroke, ischemic	0.017	3,490	59	6.6	394
Supraventricular cardiac dysrhythmia		309,009	9,692		169,158
Chronic total	0.24	1,017	244	13.8	3,375
Acute					
Air space transport	0.18	196	35	28.8	1,013
Alcohol poisoning	1	75	75	33.3	2,492
Aspiration	0.18	408	74	13.6	997
Child maltreatment	0.16	294	47	72.1	3,392
Drowning	0.34	827	281	34.1	9,589
Excessive blood alcohol level	1	1.8	1.8	21.9	36
Fall injuries	0.32	7,243	2,318	9.4	21,888
Fire injuries	0.42	907	381	20.2	7,706
Firearm injuries	0.18	203	37	38.8	1,415
Homicide	0.47	4,339	2,039	41.5	84,638
Hypothermia	0.42	155	65	15.9	1,032
Motor vehicle non-traffic crashes	0.18	328	59	28.8	1,703
Motor vehicle traffic crashes (men)	0.33	8,263	2,722	37.0	100,691
Motor vehicle traffic crashes (women)	0.2	4,132	812	41.3	33,550
Occupational and machine injuries	0.18	468	84	25.2	2,120
Other road vehicle crashes	0.18	190	34	34.0	1,163
Poisoning (not alcohol)	0.29	2,760	800	34.1	27,329
Suicide	0.23	8,816	2,028	29.5	59,835
Water transport	0.18	186	34	33.5	1,122
Acute total		39,790	11,926		361,709
Grand total		348,799	21,618		530,867

Table A-2. Quality of life reduction attributable to alcohol use in a birth cohort of 1,000,000

Conditions	Alcohol-attributable fraction	Incidence rate	Alcohol-attributable disease cases	Type	Duration	QALY weight	AA QALYs lost
Chronic							
Acute pancreatitis	0.24	0.0010948071	14,789	Inpatient stays	0.058	0.3	256
Alcohol abuse	1	0.0003334185	18,767	Inpatient stays	1.6	0.3	9,008
Alcohol dependence syndrome	1	0.0005872147	33,052	Inpatient stays	1.6	0.3	15,865
Alcoholic gastritis	1	0.0000298584	1,681	Inpatient stays	0.058	0.3	29
Alcoholic liver disease	1	0.0002786782	15,686	Inpatient stays	7.8	0.2	24,470
Alcoholic psychosis	1	0.0006021439	33,892	Inpatient stays	1.6	0.3	16,268
Breast cancer	0.0085	0.0009925897	243	New cases	4.3	0.2	209
Chronic pancreatitis	0.84	0.0000995279	4,706	Inpatient stays	0.058	0.3	82
Epilepsy	0.15	0.0002687254	2,269	Inpatient stays	9.2	0.2	4,175
Esophageal cancer	0.036	0.0000630210	128	New cases	1.8	0.3	70
Gastroesophageal hemorrhage	0.47	0.0000646931	1,712	Inpatient stays	0.058	0.3	30
Hypertension	0.025	See strokes below					
Ischemic heart disease	0.0018	0.010405644	1,054	Inpatient stays	0.058	0.3	18
Laryngeal cancer	0.061	0.0000490163	168	New cases	4.3	0.2	145
Liver cancer	0.052	0.0000770257	226	New cases	1.77	0.3	120
Liver cirrhosis, unspecified	0.4	0.0001691975	3,809	Inpatient stays	7.8	0.2	5,943
Low birth weight/ Prematurity	0.033	0.000154268	287	Inpatient stays	0.25	0.3	22
Oropharyngeal cancer	0.057	0.0001512504	485	New cases	4.3	0.2	417
Prostate cancer	0.0076	0.0025141264	523	New cases	4.5	0.2	471
Stroke	0.043	0.0024881980	6,022	Inpatient stays	7.8	0.4	18,789
Supraventricular cardiac dysrhythmia	0.017	0.0022344018	2,138	Inpatient stays	0.058	0.3	37
Chronic total			141,635				96,420
Acute							
Air space transport	0.18	0.0023325110	24,665	Injuries	0.077	0.3	569
Alcohol poisoning	1	See poisoning below					
Aspiration	0.18	0.0001112050	1,416	Injuries	0.077	0.3	33
Child maltreatment	0.16	0.0045711630	10,749	Injuries	0.115	0.3	372
Drowning	0.34	0.0000045621	95	Injuries	0.077	0.3	2
Fall injuries	0.32	0.0241142810	525,979	Injuries	0.077	0.3	12,138
Fire injuries	0.42	0.0016581250	39,947	Injuries	0.077	0.3	922
Firearm injuries	0.18	0.0000580598	602	Injuries	0.115	0.3	21
Homicide and assault	0.47	0.0070389760	180,342	Injuries	0.115	0.3	6,243
Motor vehicle traffic crashes	0.29	0.0096394490	232,358	Injuries	0.077	0.3	5,362
Occupational and machine injuries	0.18	0.0013293210	13,602	Injuries	0.077	0.3	314
Poisoning	0.29	0.0018290890	30,468	Injuries	0.077	0.3	703
Suicide and self harm	0.23	0.0013852150	17,385	Injuries	0.115	0.3	602
Water transport	0.18	included in air space transport above					
Acute total			1,077,605				27,280
Grand total			1,219,240				123,700

apps.nccd.cdc.gov/ARDI/HomePage.aspx), but when ARDI reported indirect AAFs, AAFs from information provided on the ARDI website were calculated (dividing the number of alcohol-attributable deaths from the condition by the total deaths from that same condition). The AAFs were based upon the portion of mortality attributable to alcohol use and misuse (technically speaking, they are population-attributable fractions). The analysis was limited to those conditions in which the alcohol-attributable mortality reported by ARDI was >0. Lacking other data for most alcohol-attributable illnesses and injuries, the mortality-based AAFs were applied to morbidity data.

Mortality (Years of Life Lost)

As with most other services in this project, the projected lifelong burden of disease of a birth cohort using annual incidence rates over all relevant age groups was estimated. This provided an approximately correct estimate of the number of years of life lost, both overall and for each age group. For this service, the quality of this approximation varies from condition to condition, since previous risk factors and the medical technologies available to the current cross-section of age groups differ from those that a single birth cohort would face over time. In addition, the applicability of

AAFs varies with changes in the alcohol-use rates and other risk factors in the population. AAFs that reflect the age distribution of the hypothetical birth cohort are likely to be somewhat different than the average AAFs used here, which reflect the age distribution of the current U.S. cross-section.

For chronic conditions, the number of alcohol-attributable deaths per 1,000,000 population was computed from the age of 20 years for deaths from any cause. For acute conditions, the number of alcohol-attributable deaths was computed from the age of 15. For cases of low birth weight/prematurity, child maltreatment, and motor vehicle traffic crashes, years of life lived from birth were used. Mortality was estimated from 1998 death rate data, using the CDC Wonder engine (<http://wonder.cdc.gov/mortSQL.html>), which included mortality data for the same ICD-9 codes for the conditions as listed in the ARDI report. Whenever U.S. population estimates were needed for calculations, the 2000 census data were used.¹ Whenever age- and gender-specific data were available, the calculations reflect weighted averages, but none of the AAFs presented are age-specific estimates.

Morbidity (QALYs Lost)

Alcohol-attributable QALYs lost to morbidity is the product of lifetime incidence of alcohol-attributable disease, duration of disease, and the associated quality-of-life reduction (QALY weight). For each condition, alcohol-attributable incidence was calculated as (the number of life years lived by a birth cohort of 1,000,000) \times (the annual incidence of disease) \times (the alcohol-attributable fraction). The annual incidence rate for cancer cases was based on 2002 incidence rates, age-adjusted to the 2000 population (unadjusted rates were not reported).² Stroke incidence was approximated by the incidence of first stroke.³ Incidence data for many chronic conditions were not available, so when necessary, the estimate of annual inpatient stays was substituted. Thus, this may have overstated or understated the incidence, depending on how many individuals had an inpatient stay with a listed primary diagnosis during the course of their disease and how many had more than one such stay.

To determine morbidity for the various conditions listed by the ARDI report, the following three references were used:

- 2001 National Hospital Discharge Survey for inpatient stays⁴
- 2003 National Hospital Ambulatory Medical Care Survey for emergency department visits⁵
- an MMWR report on injury surveillance for detailed injury reports by age.⁶

Efforts were made to match each condition listed by ARDI with the closest condition in these three reference sources. The following conditions did not have detailed incidence information on morbidity in the three references listed above: alcoholic cardiomyopathy, alcoholic polyneuropathy, chronic hepatitis, esophageal varices, fetal alcohol syndrome, portal hypertension, excessive blood-alcohol level, motor-

vehicle nontraffic crashes, hypothermia, and other road vehicle crashes. The nonfatal burden of these conditions was therefore not reflected in the estimates. The conditions omitted from the morbidity calculation consisted of 2.7% of mortality. If they included a similar portion of morbidity and had a duration of illness similar to the average of other included morbidities, then total alcohol-attributable QALYs lost (mortality plus morbidity) was understated by about one half of 1%. The impact is small because years of life lost contribute substantially more to QALYs than do illness or disability.

The duration of illness for many conditions (all cancers, mental disorders, stroke, cirrhosis of the liver) were taken from closely corresponding (i.e., not always identical) disease categories of the Global Burden of Disease for Established Market Economies.⁷ The basis for injury duration is self-reported days of restricted activity. Hospitalizations other than injuries were assigned a duration of 3 weeks in order to be consistent with the approach used for other services.

For morbid conditions, the estimates of the number of episodes in Table 2 may be overstated because the available hospitalization rates include younger individuals, for which the AAFs are not applicable. The prevalence of chronic conditions in those less than 35 years of age is very low, and therefore the resulting overstatement as a percent of total QALYs lost to alcohol is necessarily very small.

Estimates of the QALYs lost per year lived with an illness (QALY weight) were the standard ranges used in the general methods for acute conditions (0.1 to 0.5, midpoint 0.3) and chronic conditions (0.1 to 0.3, midpoint 0.2). Cancers of duration <2 years (indicative of low survival rates) were treated as acute illnesses, as were alcohol abuse, alcohol dependence syndrome, and alcoholic psychosis. An alternative estimate of QALYs lost per year for stroke of 0.40 (range 0.25 to 0.55) was used, based on published estimates from utility scales.⁸ This contributed 9400 (1.4%) of the total 655,000 alcohol-attributable QALYs lost.

References

1. U.S. Census Bureau. Population by age, sex, race, and Hispanic or Latino origin for the United States. 2000.
2. Ries LAG, Eisner MP, Kosary CL, et al. SEER Cancer Statistics Review, 1975-2002. National Cancer Institute (NCI): Bethesda MD.
3. <http://www.americanheart.org/downloadable/heart/1105390918119HDSS tats2005Update.pdf>.
4. http://www.cdc.gov/nchs/data/hdasd/sr13_156t12.pdf.
5. McCaig LF, Burt CW. National Hospital Ambulatory Medical Care Survey: 2003 emergency department summary. *Adv Data* 2005;358:1-40.
6. Vyrostek SB, Annett JL, Ryan GW. Surveillance for fatal and nonfatal injuries—United States, 2001. *MMWR Surveill Summ* 2004;53:1-57.
7. Murray CJL, Lopez AD. Global health statistics: Volume II. A compendium of incidence, prevalence and mortality estimates for over 200 conditions. Cambridge MA: The Harvard School of Public Health on behalf of The World Health Organization and The World Bank, 1996.
8. Tengs TO, Yu M, Luistro E. Health-related quality of life after stroke a comprehensive review. *Stroke* 2001;32:964-72.