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Cost-effectiveness of motivational intervention with significant others for patients with alcohol abuse

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Abstract

Aims—To estimate the incremental cost, cost-effectiveness, and benefit-cost ratio of incorporating a significant other (SO) into motivational intervention for alcohol misuse.

Design—We obtained economic data from the one year with the intervention in full operation for patients in a recent randomized trial.

Setting—The underlying trial took place at a major urban hospital in the USA.

Participants—The trial randomized 406 (68.7% male) eligible hazardous drinkers (196 during the economic study) admitted to the emergency department or trauma unit.

Intervention—The motivational interview condition consisted of one in-person session featuring personalized normative feedback. The significant other motivational interview condition comprised one joint session with the participant and SO in which the SO's perspective and support were elicited.

Measurements—We ascertained activities across 445 representative time segments through work sampling (including staff idle time), calculated the incremental cost in per patient of incorporating an SO, expressed the results in 2014 U.S. dollars, incorporated quality and mortality effects from a closely related trial, and derived the cost per quality-adjusted life year (QALY) gained.

Findings—From a health system perspective, the incremental cost per patient of adding an SO was \$341 [95% confidence interval (CI): \$244 to \$438]. The incremental cost per year per hazardous drinker averted was \$3,623 (CI: \$1,777 to \$22,709), the cost per QALY gained \$32,200 (CI: \$15,800 to \$201,700), and the benefit-cost ratio was 4.73 (95% CI: 0.75 to 9.66). If adding an

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Contributors

DSS, AKL and NPB drafted the manuscript. NM, SMC, and CG guided the collection of cost and effectiveness data. DSS and AKL analyzed the cost data. PMM designed the parent study and obtained funding. All authors contributed to and approved the final manuscript.

SO into the intervention strategy were concentrated during the hours with highest risk or in the trauma unit, it would become even more cost-beneficial.

Conclusions—Using criteria established by the World Health Organization (cost-effectiveness below the country's GDP per capita), incorporating a significant other into a patient's motivational intervention for alcohol misuse is highly cost effective.

Keywords

Motivational intervention; alcohol treatment; economic evaluation; cost-effectiveness analysis; benefit-cost analysis; significant other

Introduction

In the US adult population, about 60% are current drinkers and nearly 6% are heavy drinkers (1). Drinkers had 1.85 times the risk of an emergency department (ED) treated injury than non-drinkers (2). Half of adult patients admitted to trauma units (TU) are alcohol-positive, and these patients are also more likely to die from their injuries than their alcohol-negative counterparts (3). In addition, episodes of hazardous drinking in these patients create risks for injury readmission and subsequent death (4).

Brief individual motivational intervention (IMI), which provides a counseling approach of constructive conversation (5), has previously proved efficacious in reducing alcohol consumption and related problems (6, 7) and cost-effective (8). The involvement of a significant other (SO, an intimate person from the patient's social network), has often, but not universally, enhanced IMI (9, 10).

TUs and EDs, where SOs may accompany patients, are opportune places to initiate IMI or IMI with a significant other (SOMI). In a recent, A recent Brown University randomized trial of patients admitted to an ED or high-level TU found that SOMI significantly reduced hazardous drinking compared to IMI (11). However, involving an SO requires additional time and costs. This report extends this outcome trial through an economic analysis of SOMI to inform policy makers about its relative value. Specifically, we estimate the incremental cost of SOMI compared to IMI, compute its incremental cost-effectiveness (CE) ratio, and perform a benefit-cost (BC) analysis. We focus primarily on a health systems perspective, but also include a broader, societal perspective, which includes costs borne by participants.

Methods

Trial overview

Participants in the randomized trial had to score 8 or above on the Alcohol Use Disorders Identification Test (AUDIT) (12), and to identify one or more SOs with whom he/she could discuss issues related to alcohol use (11). Five treatment providers (all with graduate training), guided by two supervisors, administered the interventions in both treatment conditions. IMI consisted of one in-person session featuring personalized normative feedback (13). The SOMI condition comprised one joint session with the participant and SO in which the SO's perspective and support were elicited.

Over the full study, 406 patients were randomized. This cost analysis is based on the annual flow of patients and costs during Brown University's fiscal year beginning July 1, 2007, the year in the middle of the trial and most representative part of the intervention period.

Aggregate costs

Health systems costs of the intervention consist of personnel costs (salaries and fringe benefits) of treatment providers and supervisors, non-personnel costs (e.g. provider transportation), and indirect costs (such as occupancy costs). We collected this information from treatment providers and supervisors using the Treatment Cost Assessment Tool (14). Direct costs consisted of their salaries, fringe benefits (averaging 14.5% based on the part-time employment of some providers) and transportation expenses (travel from their offices to hospital sites to deliver interventions) during the fiscal year. As the services were funded through a federal research grant to Brown University, we added indirect costs (55% of modified direct costs) to cover office expenses and activities.

We obtained the data for allocating provider time prospectively by asking the five treatment providers to complete provider logs during two sample weeks. This instrument recorded all activities from the beginning to the end of the sampled workdays. Each entry represented a sequential time segment with a start time, stop time, activity code, sub-activity code, and any comments. The activities were screening (SC), recruitment (RC), baseline assessment (BA), delivering the motivational intervention (IT), significant others-related activities (SO – only for SOMI intervention), study-related activities (SR; e.g., meetings, general training and supervision, and preparing research materials) and non-study related (NSR; e.g., lunch and personal breaks). Sub-activity codes identified phases of an activity, such as scheduling, preparing, walking, traveling, and performing administrative tasks. The sample workweeks were representative of typical work patterns and excluded weeks containing holidays. As some providers worked part-time, they averaged three workdays per week.

Only clinical activities (services that would be delivered in future treatment) were relevant for this economic analysis. Since the parent trial required detailed documentation, however, the treatment providers' time represented a mixture of clinical and research-related activities. While SC and IT were entirely clinical, other activities (RC, BA, and SR, and SO) included both clinical and research components. For example, BA contained measures used to derive the personalized feedback in IMI and SOMI (i.e., a clinical purpose) but also included research measures. To determine the correct proportions of these "mixed" activities to clinical and research domains, a provider simulated the typical performance of each activity component while an observer recorded the duration of the research and clinical parts.

Cost analysis

The non-study-related activities (NSR, e.g. breaks, emails, phone calls, and meetings, and paid absences not directly related to this study) are a necessary part of the cost of employing treatment staff to deliver the intervention. In a process analogous to step-down accounting (15), we first redistributed (i.e. reallocated) NSR to other program activity components relative to its proportion of all activities. Then, we allocated costs of joint clinical and

research activities (RC, BA, SO, SR) based on the time and content of each item. Next, we distributed SR to the more specific activities that they supported. Subsequently, we attributed the time for each clinical activity to the intervention arm(s) it served. As patients in both treatment conditions had the same interactions with providers outside of the intervention conditions, we estimated that the time per subject for all non-SO activities (i.e., RC, BA, and IT) was the same in both conditions. Thus, we allocated non-SO clinical activity costs into conditions based on the number of final patients in each condition.

Dividing costs by the numbers of patients who received treatment during the study year in each condition, we calculated the average unit cost for treatment per patient. Subtracting the average unit cost per patient in the IMI condition from the SOMI condition gave the incremental cost per patient of adding a SO to the IMI condition. For clarity, we converted all economic data to mid-2014 dollar values based on the United States gross domestic product (GDP) deflator (i.e., the relationship between GDP in constant and current prices), the most general measure of inflation in the economy (16). Additionally, the GDP deflator is applicable to non-medical expenses, such as travel.

Client costs

Client costs consist of transportation expenses to and from the treatment site and the value of time spent by the participant and SO (who were assumed to come from similarly located neighborhoods) in travel and obtaining treatment. Based on session logs, client time for IMI was estimated at 1.00 hours and for SOMI at 1.25 hours each for the client and SO, valued at Rhode Island's per capita income (17). As actual travel data were not recorded, the study assumed equal use of bus, taxi, and auto and estimated travel costs to the treatment sites from the neighborhoods of 10 randomly chosen clients through online tools (18–21).

CE and BC analyses

As the most policy-relevant measure of effectiveness, we selected hazardous drinking, which can adversely affect driving, employment, and interpersonal relations. Based on national recommendations, we defined hazardous drinking as more than 7 drinks per week for women and more than 14 drinks per week for men (22). The gross effectiveness of each arm was the reduction in percentage of patients with hazardous drinking from the baseline to the 12-month follow-up assessment. The incremental effectiveness was the added improvement in the SOMI arm compared to the IMI arm (i.e., percentage of patients with hazardous drinking averted). The incremental CE ratio was calculated as the incremental cost of SOMI compared to IMI divided by the incremental effectiveness. We conservatively assumed that the benefits of IMI and SOMI lasted one year, the period of follow-up in the parent study (11).

We obtained approximate CE results in cost per quality-adjusted life year (QALY) gained by building on a closely related study in EDs in the same city (8). We calculated that each patient whose alcohol problems were averted gained 0.1126 QALYs and considered that study's "alcohol problems" as a reasonable proxy for "hazardous drinking" in the present trial.

BC ratios are the economic cost of a year of hazardous drinking divided by the cost of averting it from health systems and societal perspectives. Adjusting costs from a 2006 study (23) to 2014 dollars (16) and dividing by the 5% share of the US population (including children) with hazardous or more serious drinking (24) gave a national cost per hazardous drinker per year of \$17,159. The average educational attainment of study participants (12.0 years) was below the national average of 13.4 years (25). Compared to national averages, their income might therefore have been lower but their medical and other societal costs higher due to their presenting at an ED or TU.

Uncertainty analysis

To implement acceptability analysis and probabilistic sensitivity analyses on CE and BC results, we conducted a Monte Carlo simulation with 10,000 iterations using the random number function (RAND) in Microsoft Excel 2010 (Redmond, WA). As all aggregate expenditures have been submitted to the federal sponsors, were subject to audit and have not been questioned, we considered their uncertainty negligible. Thus, the uncertainty in cost estimation arose from sampling variation in the shares of provider time attributed to each intervention. As the time segments were independent samples, the standard error of the mean (SEM) of the proportion of time (p) devoted to an activity or group of activities is given by the formula for a binomial proportion, $[p(1-p)/n]^{1/2}$, where n is the entire number of segments sampled. We estimated the mean cost and its SEM for an activity or group of activities by multiplying its percentage of time and SEM times the total annual cost. As incremental costs and outcomes were both derived from large samples of independent observations (provider time segments for costs and trial participants for drinking), we treated them as independently distributed normal variables. For each iteration in the Monte Carlo simulation, we obtained randomly estimated values for SOMI of its net cost, net effectiveness, incremental CE, and BC ratio.

We used the simulation results to conduct a CE acceptability analysis. We assigned alternative cutoff economic values (i.e., potential values that society would be willing to invest) to avoid one year of hazardous drinking and estimated the resulting probability that the economic benefit of the hazardous drinking averted exceeded the incremental costs based on the proportion of simulation results satisfying that criterion.

Results

Patient flow

During the one-year period of the economic study, 2912 patients were screened, 355 (12%) found eligible, and 196 patients were randomized. After accounting for losses to treatment (e.g., no SO available, SO withdrew, participant subsequently found ineligible, lost contact etc.), 171 patients received the assigned treatment (IMI 96; SOMI 100). Completion of assigned interventions was high (95% for IMI, 80% for SOMI, and 87% overall).

Characteristics of participants

Detailed characteristics of participants are provided elsewhere (11). The majority (68.7%) of participants in the study year were male. Participants' mean age $\pm$ standard deviation was

33±11 years and their mean education was 12.0±2.3 years. The sample was primarily white (68%) with the rest composed of Black or African Americans (19%), and other race or multi-racial (14%); also 16% reported Hispanic ethnicity. SOs were primarily female (67%) and either family members (e.g., romantic partners, 39%; mothers, children, siblings, 29%), friends (29%), or others (3%). At baseline, participants reported 9.4±6.4 drinks per drinking day.

Intervention costs

Table 1 presents sample hours and overall costs of treatment providers during the reporting year. During this year, the treatment providers and their supervisors worked for a combined total of 6,128 hours. The total input costs of the year amounted to \$281,015, with direct personnel costs comprising 63.0%, direct non-personnel costs 1.5%, and indirect costs representing 35.5%.

Table 2 presents providers' sample hours and costs by activity, showing the evolving estimates from initial provider logs to the final reallocated costs. The two general categories of time, SR and NSR, represent the time for which staff were paid to ensure that they were present when clients were available for screening, assessment or intervention. These proved to be the two most time consuming categories, totaling 165.5 (55.1%) of the 265.8 sample hours. Thus, all specific clinical activities (the remaining time) constituted 44.9% of total working time. Screening, the start of the treatment process, took 26.7% of staff time and cost \$16.28 per person screened.

Observations of mixed activities found that RC averaged 15 minutes per client, of which 2 minutes were related to clinical services while 13 minutes served research activities, giving proportions of 13.3% and 86.7%, respectively. The clinical shares were 16.7% for BA, 26.2% for SC, 100.0% for IT, and 100.0% for SO. Thus, screening and recruitment represent the majority (55%) of clinical activities, while the remaining clinical activities (BA, inclusion of SOs, and delivery of intervention) were less than half (45%) the time of clinical activities.

The average health system cost (±SEM) of the 91 patients receiving IMI was \$718.49±61.85 and that of the 80 patients receiving SOMI was \$1,059.58±76.43. The incremental health system cost per patient of adding SO to the IMI condition was \$341.09±49.31 with a 95% confidence interval (CI) of \$244.44 to \$437.74.

Effectiveness and cost-effectiveness

From baseline to 12-month follow-up, the percentage of hazardous drinking declined by 22.9% in SOMI and by 13.5% in IMI. The net incremental improvement of SOMI (22.9% minus 13.5%) was 9.4% (CI: 1.4% to 17.4%). For every 10.6 patients (CI: 5.9 to 100.0) receiving SOMI instead of just IMI (i.e., 1/9.4%), one will avoid hazardous drinking. The health systems median CEs are \$3,623 (i.e. \$341.09/9.4%) per hazardous drinker averted at 12 months (95% CI: \$1,777 to \$22,709) and \$32,200 per QALY gained (CI: \$15,800 to \$201,700), calculated as \$3,623/0.1126. Table 3 shows the joint frequency distribution of costs and effectiveness, where each cell shows the percentage of valid results from the 10,000 Monte Carlo draws. This distribution describes the uncertainty in effectiveness due to

variation among trial participants and in costs due to variation in allocation of sampled time segments. For example, the middle entry in this table shows that 24.5% of the valid simulation results had cost per participant in the range of \$300-\$399 combined with net effectiveness (reduction in hazardous drinking) of 10%–14%.

Figure 1 shows the health systems cost-acceptability curve. The median value of \$3,623 corresponds to the point estimates of the incremental CE ratio of SOMI. The interquartile range is \$2,706 to \$5,121 and the CI is \$1,777 to \$22,709. Using the national cost estimate of \$17,159, there is a 96.8% probability that the addition of SOMI to IMI is cost-effective.

Benefit-cost analysis

Figure 2 presents the health systems BC results. The central BC ratio of adding SOMI to IMI over one year is 4.73 (i.e. \$17,159 / \$3,623). For every \$1.00 invested in SOMI, the estimated economic gain is \$4.73, indicating that investment in SOMI is economically advantageous. Incorporating uncertainty, the probability that SOMI is economically advantageous (i.e. the BC ratio is 1.00 or more) is 96.8% while the chance that the net benefit of SOMI is negative (i.e., counterproductive) is only 3.2%. The interquartile range on the BC ratio is 3.35 to 6.34 and its CI is 0.75 to 9.66.

Societal perspective

The overall societal costs per participant (including transportation and time) were \$783.99±61.97 for IMI and \$1,197.90±76.86 for SOMI, with an incremental cost of \$413.91±40.12. The societal CE ratios were \$4,403 per participant effectively treated and \$39,100 per QALY gained; the societal BC ratio was 3.90. SOMI is very likely, but not positively, cost-beneficial from both health systems and societal perspectives.

Discussion

To our knowledge, this study is the first comparative analysis of costs and cost effectiveness of IMI and SOMI treatments in alcohol abuse. Our work sampling approach systematically included general costs. Our breakdown of costs by component found that general study-related activity (SR) was the most costly single component, representing 40.2% of all costs. While we removed the costs of pure research activities, we also observed that the context of an efficacy trial also raised intervention costs due to extra investment in training, supervision, and staffing to ensure that staff were available when eligible participants were identified. This research context likely also contributed to the cost of screening. Our cost (\$16.28) fell between the median (\$8.03) and the upper quartile (\$77.21) in a systematic review of costs of screening (31). As this study was conducted in a research setting, its cost and effectiveness were both higher than expected in routine practice. However, our CE and BC results, being based the ratio between those two variables, would likely be comparable, if not better, in routine practice.

For example, assume an efficient community setting was able to maintain the same effectiveness while eliminating half of SR, the cost per client would reduce by 20%. This reduction would lower the cost per hazardous drinker averted (the CE ratio) per case of

hazardous drinking averted to \$2,898 (i.e., 80% of \$3,623), hence the CE per QALY gained to \$26,000, and improve the one-year BC ratio to 5.92 (i.e. \$17,159/\$2,898).

Our CE acceptability and BC sensitivity analyses suggest while the numerical values of our CE and BC results could vary substantially due to data uncertainties, we have high confidence that the addition of SOMI to IMI would be economically advantageous.

To our knowledge, only two previous publications have studied the costs of motivational intervention treatment. They addressed alcohol-involved youth (8) and smoking (28). With enhanced screening, costs per recipient in the youth study (\$173 in 2008 dollars), equivalent to \$189 in 2014 dollars, represent only 26.3% of the \$718 cost per recipient in the present study. The costs of motivational intervention in the smoking study (\$309 in 1997 dollars or \$430 in 2014 dollars) represents 59.9% of the corresponding costs in the present study. The lower costs in the earlier alcohol (8) and smoking studies (28) partly reflect those studies' narrower perspective that did not attribute any costs of staff availability (i.e., SR and NSR) that we included. Based on the 55.1% share of staff time involved in SR and NSR activities, removal of SR and NSR costs would have reduced the cost per client to \$322, a level between the two prior results. Since clients coming to an ED or TU were generally seeking treatment of their physical injuries, alcohol treatment providers often needed to wait. Therefore, our estimated health systems CE (\$32,200) and societal CE (\$39,100) per QALY gained, while still highly cost-effective, are not as favorable as the previous study (8) (\$8,795 per QALY gained in 2008 prices, equivalent to \$9,608 in 2014 prices).

Although each patient could be screened in only a few minutes, only one in seventeen (5.9%) was eligible and completed the treatment, so aggregate screening time was substantial. If screening could be targeted to days of the week and times of day when hazardous drinking represents the highest proportion of ED admissions, the yield would be higher and the CE of the intervention would be even more favorable. Furthermore, in the parent trial the effectiveness of SOMI was found to vary between settings (34); TU patients reported greater improvements than ED patients (11). Thus, adding SO specifically in a TU would be even more cost-effective than the pooled results reported here.

Four limitations need to be acknowledged. First, we used costs derived during a randomized efficacy trial in a research setting of SOMI over IMI. While our activity codes allowed us to exclude purely research tasks, the research setting likely contributed to time and costs in the non-specific SR category. In addition, the graduate trained providers contributed to higher costs than would have occurred in a community setting. On the other hand, if SOMI had been compared to no counseling, as occurs in some EDs, the cost effectiveness might have been more favorable. Second, our CE and BC analyses have wide confidence intervals due to the broad CIs on net impact. The parent study was powered to test whether SOMI added significantly to the efficacy of IMI, but not to quantify the benefit precisely. Third, no outcome data were available on possible offsets to medical costs and were not available beyond 12 months; had these been available, the CE and BC results might have been even more favorable. Fourth, our conversion of CE results to cost per QALY was not adjusted for differences in terminology and participants' age (alcohol problems and youth) between the previous (8) and the present study (hazardous drinking and primarily adults), so it should be

considered approximate. However, due to discounting (35), differences in participant ages between the previous study (8) and this one have little impact on CE or BC. Despite participants having mean ages of 18.5 years in the previous study (8) and 33 in this study, the discounted remaining life expectancy of participants in this study was only 10% below that in the previous study (36).

In conclusion, the CE of adding SOMI to IMI was \$32,200 from a health systems perspective and \$39,100 from a societal perspective. The World Health Organization considers an intervention to be highly cost-effective if its incremental CE ratio is less than the country's GDP per capita (33). In 2014, the per capita GDP of the United States was \$54,630 (37). Under both perspectives, SOMI was a highly cost-effective intervention for hazardous drinking.

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Figure 1.
Health systems cost-effectiveness acceptability curve for SOMI to reduce hazardous drinking

Figure 2.
Histogram of health systems benefit-cost ratios for SOMI.

Table 1

Annual inputs and costs *

Item	Value
Number of treatment staff and supervisors	7
Average hours per person per week worked	18.27
Aggregate person months worked during year	78.00
Aggregate treatment staff hours worked	6,128
Average hourly wage	\$25.30
Fringe benefit rate	14.5%
Aggregate earnings	\$155,020
Aggregate fringe benefits	\$22,507
Aggregate direct personnel costs	\$177,527
Indirect cost rate	55%
Aggregate direct non-personnel costs	\$5,848
Aggregate input costs	\$281,015

* Inputs were compiled for fiscal year 2007–2008. Costs were adjusted for inflation to mid-2014 prices.

Table 2

Estimation of cost per year by activity from provider logs

Activity	Activity code	Sample working hours [†]	Redistributed sample hours	% of hours		Cost per year	
				Mean	SEM	Mean	SEM
Screening	SC	44.8	70.84	26.7%	2.1%	\$47,400	\$2,607
Recruitment	RC	11.8	17.06	6.4%	1.2%	\$12,493	\$798
Baseline assessment	BA	21.2	5.57	2.1%	0.7%	\$22,360	\$274
Inclusion of significant others	SO	16.3	25.81	9.7%	1.4%	\$17,268	\$1,167
Delivery of intervention	IT	25.2	39.79	15.0%	1.7%	\$26,625	\$1,698
Study-related activities	SR	97.3	106.7	40.2%	2.3%	\$102,852	\$3,202
Non-study-related activities	NSR	49.2	0.0 [*]	0.0% [*]	0.0%	0 [*]	\$0
TOTAL		265.8	265.8	100.0%	0.0%	\$281,015	\$0

[†] Sample working hours are those during the periods of work sampling containing 445 time segments.

[‡] Costs were adjusted for inflation to mid-2014 prices.

^{*} Non-study-related activities have been redistributed pro-rata to all other activities, which they support. Thus, after redistribution, the non-study related hours and costs show values of zero.

Notation: SC denotes screening; RC denotes recruitment; BA denotes baseline assessment; SO denotes significant other; SR denotes study related; NSR denotes non-study related; SEM denotes standard error of the mean.

Two-dimensional frequency distribution of incremental costs and effectiveness of SOMI over IMI under sensitivity analysis

Table 3

Net cost per participant	Net reduction in hazardous drinking					
	0%–4%	5%–9%	10%–14%	15%–19%	20%–24%	TOTAL
\$100-\$199	0.0%	0.1%	0.1%	0.1%	0.0%	0.3%
\$200-\$299	2.8%	9.1%	7.2%	1.6%	0.1%	20.7%
\$300-\$399	9.0%	28.3%	24.5%	5.5%	0.3%	67.6%
\$400-\$499	1.4%	4.9%	4.2%	0.9%	0.0%	11.4%
\$500-\$599	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
ALL	13.2%	42.4%	35.9%	8.1%	0.4%	100.0%

Note: SOMI denotes significant other motivational intervention. IMI denotes individual motivational intervention.