The Cost and Cost-Effectiveness of an Enhanced Intervention for People with Substance Abuse Problems at Risk for HIV

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Objective. To estimate the costs, effectiveness, and cost-effectiveness of prevention interventions for out-of-treatment substance abusers at risk for HIV. This is the first cost-effectiveness study of an AIDS intervention that focuses on drug use as an outcome.

Study Design. We examined data from the North Carolina Cooperative Agreement site (NC CoOp). All individuals in the study were given the revised NIDA standard intervention and randomly assigned to either a longer, more personalized enhanced intervention or no additional intervention. We estimated the cost of each intervention and, using simple means analysis and multiple regression models, estimated the incremental effectiveness of the enhanced intervention relative to the standard intervention. Finally, we computed cost-effectiveness ratios for several drug use outcomes and compared them to a "back-of-the-envelope" estimate of the benefit of reducing drug use.

Principal Findings. The estimated cost of implementing the standard intervention is $187.52, and the additional cost of the enhanced intervention is $124.17. Cost-effectiveness ratios range from $35.68 to $139.52 per reduced day of drug use, which are less than an estimate of the benefit per reduced drug day.

Conclusions. The additional cost of implementing the enhanced intervention is relatively small and compares favorably to a rough estimate of the benefits of reduced days of drug use. Thus, the enhanced intervention should be considered an important additional component of an AIDS prevention strategy for out-of-treatment substance abusers.

Key Words. Cost analysis, cost-effectiveness analysis, AIDS prevention

Applied research in human immunodeficiency virus (HIV) prevention with out-of-treatment substance abusers has been a priority for the National Institute on Drug Abuse (NIDA) since the mid-1980s. This research, which

has explored a number of prevention strategies in community-based studies, indicates that HIV infection is preventable in drug-using populations (Leshner 1998). In 1990, as part of its HIV prevention efforts, NIDA launched the 23-site Cooperative Agreement (CA) for AIDS Community-Based Outreach/Intervention Research, targeting out-of-treatment injection drug users (IDUs) and crack users. One of the important objectives of the CA was to develop and evaluate innovative interventions designed to reduce drug and sexual risk-taking behaviors. Findings from the CA suggest that NIDA's brief standard intervention has a positive effect in reducing HIV risk behaviors (Kotranski, Semaan, Collier, et al. 1998; Wechsberg, Dennis, and Stevens 1998; Cottler, Leukefeld, Hoffman, et al. 1998). More specifically, analysis of the CA data has shown significant reduction in injection use (He, Stark, Fleming, et al. 1996; Rhodes and Malotte 1996; Weeks, Himmelgreen, Singer, et al. 1996), cessation or reduction of crack use (Anderson, Hockman, and Smereck 1996; Booth, Crowley, and Zhang 1996; McCoy, McCoy, and Lai 1998; Rhodes and Malotte 1996; Kotranski, Semaan, Collier, et al. 1998; Stevens, Estrada, and Estrada 1998; Wechsberg, Dennis, and Stevens 1998), and decreased sexual risk (Kotranski, Semaan, Collier, et al. 1998; McCoy, McCoy, and Lai 1998; Stevens, Estrada, and Estrada, 1998). A more thorough review of findings and program effects for NIDA's present initiatives can be found in Coyle, Needle, and Normand (1998).

Given the positive findings from NIDA's prevention efforts, and given the costs associated with even one case of acquired immune deficiency syndrome (AIDS) and the social costs of drug abuse in general, a clear need exists for research on the costs, effectiveness, and cost-effectiveness of prevention interventions for out-of-treatment substance abusers at risk for HIV. To that end, this study examined data from the North Carolina Cooperative Agreement site (NC CoOp). NC CoOp offered the revised NIDA standard intervention for all individuals in the study and, for those who were randomized to it, a longer, more personalized enhanced intervention.

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It has been suggested through a threshold analysis of NC CoOp data that the benefits of the brief standard intervention could outweigh the costs (Norton, Martin, and Wechsberg 1998), but no previous research has estimated the costs and effectiveness of the additional sessions associated with the enhanced intervention or evaluated whether the additional costs of the enhanced intervention are justified by sufficiently better outcomes. Furthermore, to the best of our knowledge, this study is the first cost-effectiveness study of an AIDS intervention that focuses on drug use as an outcome.

In this article, we first estimate the costs of both the standard and enhanced interventions. We then estimate the incremental effectiveness of the enhanced intervention by comparing the difference in outcomes between individuals who were randomly assigned to the enhanced intervention and those who received no additional intervention and thus received the standard intervention only. Finally, to evaluate whether the enhanced intervention is justified on economic grounds, we estimate the cost-effectiveness of the enhanced intervention (relative to the standard intervention) for several drug use outcomes and compare these incremental cost-effectiveness estimates to an estimate of the incremental benefit of reducing drug use.

METHODS

Study Protocol

NIDA's revised standard intervention as structured for the CA is a two-session educational and counseling intervention with HIV antibody testing (Wechsberg, Inciardi, Leukefeld, et al. 1998; Wechsberg, MacDonald, Inciardi, et al. 1997). The study protocol consists of five parts:

1. outreach and recruitment of study participants (screened for eligibility);
2. the intake process, which includes completion of an informed consent form and a locator form, drug use verification (inspection for recent needle tracks and a urine test), and administration of the Risk Behavior Assessment (RBA), the primary data collection instrument;
3. session I, an HIV prevention counseling session held the day of the RBA (or within seven days), supported by cue cards (HIV antibody testing is also conducted at the client's option);
4. session II, a booster session of additional counseling with test results held within 21 days of session I; and

5. random assignment of clients to either the enhanced intervention or three-month follow-up (i.e., no additional intervention). Follow-up for both groups occurs three months after randomization. The follow-up data collection instrument is the Risk Behavior Follow-Up Assessment (RBFA).

NC CoOp's enhanced intervention consisted of three sessions and focused on the individual's risk patterns as determined from his or her responses on the initial RBA (NIDA 1993). Drug use, sexual patterns, and HIV risk were graphed to provide a visual representation of risk, relative to the cross-site national data sample, on 20 composite scales (Dennis and Wechsberg 1996; Dennis et al. 1995). After reviewing personal risk with the participant, a personal risk—reduction plan was developed with the help of a counselor; the plan included specific action for risk reduction, health promotion, and maintenance, making use of enhancing internal and external resources. Referral to treatment was offered, and the importance of treatment was emphasized. After this initial session, two additional sessions concentrated on problem-solving and communication skills; both of these sessions incorporated role playing and other interactive techniques.

Data

Although the NC CoOP was implemented in both Wake and Durham counties, the experimental design was limited to the Durham site. Our cost and cost-effectiveness analysis focuses on the $N = 477$ individuals who entered the Durham site between January 1, 1996 and December 31, 1997. All 477 individuals received the standard intervention, but only a subset was eligible for randomization into the enhanced intervention. Of the 477 individuals, 438 individuals were eligible for randomization, 262 individuals were randomized to the enhanced intervention, and 176 were randomized into the three-month follow-up (i.e., received the standard intervention only). This 60/40 ratio of enhanced to standard interventions was by design. Because the enhanced intervention entailed multiple sessions, a larger N was chosen for the enhanced intervention to allow for the possibility of sample attrition. Of the remaining 39 individuals (477 — 438), 36 dropped out of the study before randomization and 3 were not included in the random assignment because they entered the Durham clinic before the randomization process began.

The cost analysis included all 477 individuals who entered the Durham site in 1996 and 1997. The main outcome analysis is performed on the 331

individuals who completed a follow-up interview. This is the same sample inclusion rule that has been used by Wechsberg, Dennis, and Stevens (1998). The overall response rate is 76 percent (331/438), which is better than the average 66 percent follow-up rate across the National AIDS Demonstration and Cooperative Agreements (Coyle, Needle, and Normand 1998) and is considered good for studies of a drug-abusing population. The response rate for the enhanced intervention is 72 percent (188/262), and the response rate for the standard intervention is 81 percent (143/176). The NC CoOP study has evaluated the importance of attrition in Wechsberg, McDermeit, Perritt, et al. (1999) and Reif (2000). In general, there were relatively few differences between those who completed the study and those who were lost to follow-up. For a detailed discussion on attrition, see the main findings report (Wechsberg, Dennis, Zarkin, et al. 2000).

We also briefly discuss a secondary outcome analysis on the 438 individuals who were eligible for randomization. This analysis represents an intent-to-treat perspective. For the 107 individuals who did not have a follow-up interview, we assumed that their postintervention values of the analysis variables equaled their preintervention values. Because we assume that these individuals were not affected by the intervention, the estimated effect of the intervention in our secondary analysis is smaller than in the main analysis. Below, we briefly note, but do not present, the results of this secondary analysis.

Data used in the cost estimation were collected from the Significant Individual Contact (SIC) form and a cost instrument, a variant of the Drug Abuse Treatment Cost Analysis Program (DATCAP) (French, Dunlap, Zarkin, et al. 1997), both of which were developed at Research Triangle Institute (RTI). NC CoOP staff completed an SIC for each significant contact that project staff had with clients throughout the standard and enhanced sessions. SIC data provided information on the time spent on the standard and enhanced interventions and the amount of intervention materials distributed. The cost instrument collected information on set-up costs, wages, building and utilities costs, and costs of testing, supplies, and other miscellaneous material.

Data on behavioral outcomes were collected with the RBA and RBFA. The RBA was administered during the intake stage of standard intervention. It included questions on demographics, drug use, and sexual behavior. The RBFA was conducted at the three-month follow-up. It included the same questions on drug use and sexual behavior as were asked in the RBA.

Cost Estimation Methodology

Our goal was to estimate the cost per client of the standard and enhanced interventions. Costs are estimated from the program provider perspective. We calculated the cost for calendar years 1996 and 1997 when the program was fully operational. We divided the cost of the standard and enhanced interventions into two major categories: set-up costs and implementation costs. Set-up costs are one-time costs incurred at the beginning of the NC CoOp program, including the cost of office furniture, computer equipment, and laboratory equipment. We allocated the set-up costs between the standard and enhanced interventions according to the percentage of time spent on each of the interventions (discussed below). To estimate the set-up cost per person, we divided the total set-up cost allocated to each intervention by 477 for the standard intervention and 262 for the enhanced intervention.

Implementation costs are costs incurred during the provision of the interventions. These costs included personnel costs, the incentives provided to the participants, building and utilities costs, HIV/syphilis and urine tests, and intervention materials. Personnel expenses constituted the largest component of the intervention costs. These costs were based on the time spent on the interventions and the average hourly wage of the staff performing the interventions. NC CoOp employed two full-time equivalent (FTE) employees to administer the program, perform the research activities, and implement the two-session standard intervention. NC CoOp also employed 0.1 FTE to implement the additional enhanced sessions.

The SIC was designed to collect only the significant client contact time spent by NC CoOp staff. We calculated the total person-hours spent on NC CoOp in calendar years 1996 and 1997 (8,400 hours) and found that only 25 percent of the total time reported was spent on direct patient contact. We developed an algorithm to allocate the remaining 75 percent of the time to the other activities performed by NC CoOp staff. These activities included research time and indirect time spent on intervention activities (i.e., time spent on the interventions that was not face to face) that was not captured in the SIC form. Based on discussions with the NC CoOp principal investigator (Wechsberg) and the Durham site coordinator, we allocated 60 percent of the unrecorded time to research and 40 percent to the standard and enhanced interventions. This split was based on an estimate of the amount of time spent by project staff conducting research-related activities versus intervention-related administrative tasks such as scheduling interventions, ordering supplies, and preparing for the interventions. Sensitivity analyses

(scenarios 2 and 3) were performed to assess whether our results were sensitive to the 60/40 allocation rule.

After allocating the unrecorded time between research and intervention, we allocated the intervention time between the standard and enhanced interventions. Of the unrecorded time allocated to the interventions, we distributed 95 percent to the standard intervention and 5 percent to the enhanced intervention. We allocated more of the unreported time to the standard intervention because all participants (including those who were later randomized to the enhanced intervention) were given the standard intervention—and thus more overhead tasks were associated with that intervention—and, most importantly, almost all the time spent on the enhanced intervention was reported in the SIC. Thus, the estimated total time spent on the standard and enhanced interventions is equal to the sum of the time recorded in the SIC form and the overhead time allocated to each type of intervention. Sensitivity analyses (scenarios 1 and 3) were performed to evaluate the sensitivity of our results to changes in the 95/5 ratio.

Wages in calendar year 1997 were used to calculate personnel cost. The two full-time employees were employed through a local employment agency and did not receive fringe benefits. The employment agency charged a surcharge of 20.40 percent of the employees' salary and paid the FICA tax of 7.65 percent. The employment agency fee and the FICA tax were included in the average hourly wage of the personnel who performed the standard intervention (wage = $16.65). We believe that this wage is comparable to what other sites would pay for similar labor. The enhanced sessions were conducted by RTI staff (0.10 FTE). The average hourly wage of these staff (average wage = $40.96) included base salary plus employment taxes/fringe benefits (40 percent). The wages for the two FTE employees and the part-time RTI staff person are representative of what other sites would pay for these functions. However, the education level (and hence the wage) of the part-time RTI person is higher than would be needed in full implementation of the enhanced intervention. Thus, our baseline enhanced intervention costs are higher than typical sites would face. Scenarios 4 and 5 of the sensitivity analysis varied the hourly cost of the enhanced intervention.

Finally, we accounted for intervention costs incurred during the intake interview, which was prior to session I of the standard intervention. Based on discussions with the study leader and the Durham site director, we assumed that 40 percent of the time spent in the intake process should be allocated to the enhanced intervention (the remainder of the time was allocated to research costs). This time was spent abstracting specific information from

an individual's drug and sexual behavior history to develop a personal risk reduction plan that was discussed in the first session of the enhanced intervention. None of the information collected at intake was used as part of the standard intervention. Because changes in the 40 percent ratio over the range of plausible values had little effect on the costs of the enhanced intervention, we do not present sensitivity analyses for this parameter.

Incentives made up the second largest cost category. NC CoOp offered each participant $25 per session as an incentive to attend the standard intervention sessions. The incentives for the first two enhanced sessions were an additional $10 each, and the final enhanced session had an incentive of an additional $20. Thus, a participant who completed the standard intervention would have received $50, and a participant who completed all of the enhanced intervention sessions would have received an additional $40 (or $90 total). In our cost estimation, we included only the cost of the actual number of sessions each participant attended.

The NC CoOp program rented three rooms for the implementation of the standard and enhanced interventions. Two rooms were used for the standard intervention, and one room was used for the enhanced sessions. Since the rooms were approximately equal in size, we divided the annual NC CoOp rental payment (which included utilities) in 1997 by the number of rented rooms and used the resulting rental cost per room for the standard and enhanced interventions.

Every participant in the standard intervention was tested for HIV and syphilis and provided a urine sample to test for heroin and cocaine usage. The phlebotomist drew blood during the standard intervention, using disposable phlebotomy supplies (valued at $6.34), and sent the sample to the North Carolina Department of Health, where the HIV and syphilis tests were performed at no cost to NC CoOp. Because we are interested in the opportunity costs of each component of the interventions (i.e., the true value of a good or service, even though NC CoOP might receive it "free" or at a subsidized price), we included an HIV and syphilis test at a cost of $5.00 per test. [This estimate is taken from Norton, Martin, and Wechsberg (1998) after adjusting for inflation.] Participants also provided urine samples to test for the presence of cocaine and morphine (at a cost of $4.17 per test). No testing was performed in the enhanced intervention sessions.

Most of the intervention materials were distributed during the standard intervention. Everyone participating in the standard intervention received a standard risk reduction kit containing condoms, bleach for needle cleaning, and information pamphlets. In addition, participants received female

condoms and dental dams upon request. The materials given out during the enhanced sessions included a personal assessment and individual risk reduction plan used to facilitate the intervention. Any other materials given out during the enhanced sessions were noted on the SIC form.

According to the protocol, each participant should have received one standard risk reduction kit, but the SIC data did not record that everyone received it. However, we assumed that one standard kit was given out per participant. For the other materials (e.g., dental dams, additional condoms, informational brochures), we used the SIC to estimate the total amount of each type of material provided to all participants in each intervention; we placed a dollar value on each material type by estimating the average cost per unit from invoices. We also included the cost of office and housekeeping supplies and miscellaneous costs. We allocated these costs to the standard and enhanced intervention by prorating them according to the ratio of total time spent on each type of intervention.

To estimate the client cost, we computed the personnel, incentives, lab tests, materials, and supplies cost per person. To these costs, we added the per person cost of the fixed expenses, which included the cost of the building, utilities, and office and housekeeping supplies. These per-person fixed costs were computed by dividing the total fixed costs by the total number of individuals who entered the Durham program in 1996 and 1997 ($N = 477$). In the sensitivity analysis (scenarios 5 and 6), total costs were spread only over those individuals who completed the standard ($N = 143$) and enhanced ($N = 188$) interventions during 1966 and 1997 ($N = 331$ total). Thus, by construction, these costs are greater than the baseline costs.

Effectiveness Methodology

The effectiveness analysis compared the postintervention drug use outcomes of the standard and enhanced interventions. The baseline outcomes analysis includes 331 individuals who completed a follow-up interview, with 143 completing the standard intervention and 188 completing the enhanced intervention. The drug use variables used in the analysis included separate variables for the number of days in the past 30 days that the individual used crack, cocaine, or heroin; the number of days in the past 30 days that the individual injected heroin; the number of times in the past 30 days that the individual injected heroin; and the number of times in the past 30 days that the individual injected any drugs.

We estimated the effects of the enhanced intervention relative to the standard intervention in two steps. First, we calculated the difference between

the mean outcomes of the standard and enhanced interventions and tested the significance of the difference in the means using a *t*-test. Second, to increase the power of the analysis, we performed multivariate regression analyses of post-intervention drug use as a function of an indicator variable for the enhanced intervention (the reference category was standard intervention) and the pre-intervention value of the relevant drug use variable, age, and gender. Finally, our extended regression models examined whether the effect of the enhanced intervention differed by gender and by whether an individual injected. These analyses were performed by interacting the enhanced intervention indicator with each of the subgroups of interest. For example, to allow for differential effects between injectors and noninjectors, we included separate indicator variables for the enhanced intervention and for whether the individual was an injector; we also included a variable created by interacting the enhanced indicator variable and the injector indicator variable. In all regression models, we estimate Huber/White standard errors that produce asymptotically valid test statistics in the presence of general forms of heteroscedasticity.

Finally, we performed a cost-effectiveness analysis in which we formed the ratio of the baseline costs of the enhanced intervention to the incremental effectiveness of the enhanced intervention (relative to the standard intervention). Because we were evaluating several drug use outcomes associated with the NC CoOp, we estimated several cost-effectiveness ratios. These ratios provide estimates of the incremental costs per unit change in the drug use measures.

Table 1: Costs of Standard and Enhanced Interventions per Person

	Standard ($) *(N = 477)*	*Incremental Enhanced ($)* *(N = 262)*
Set-up costs	2.53	1.18
Implementation costs		
Personnel	98.12	82.29
Incentives	43.50	22.33
Building and utilities	21.15	18.79
HIV/syphilis/urine tests	15.26	0.00
Intervention materials	7.97	0.05
Implementation supplies	1.52	0.71
Total implementation costs	187.52†	124.17†
	(7.16)	(51.71)

†The standard deviation of total implementation costs is presented in parentheses below the cost estimates.

RESULTS

Table 1 presents the estimated cost per person of standard and enhanced interventions. The estimated set-up cost per person for each of the interventions was minimal—$2.53 for the standard intervention and $1.18 for the enhanced intervention. The implementation cost per person of standard intervention was $187.52, and the additional implementation cost per person associated with the enhanced intervention was $124.17. Personnel cost made up the largest proportion of costs—52 percent for the standard and 66 percent for the enhanced interventions. The larger proportion of personnel cost for the enhanced intervention was accounted for by the relatively expensive labor used during enhanced sessions. Incentives made up 23 percent of the standard intervention cost and 18 percent of the enhanced intervention cost. The costs of tests, materials, supplies, and miscellaneous items constituted 13 percent of the cost of standard intervention, while they made up less than 1 percent of the additional cost of the enhanced intervention.

To assess the sensitivity of our cost results to changes in key parameters, we performed a sensitivity analysis. Scenario 1, presented in Table 2, changes the ratio of unreported standard intervention time to unreported enhanced intervention time from 95/5 to 75/25. The ratio of 75/25 represents a lower bound on the allocation of unreported standard intervention time because of the reasons noted earlier. As this ratio decreases, the cost of the standard intervention decreases and the cost of the enhanced intervention increases. Scenario 2 changes the ratio of unreported research time to unreported intervention time to a lower bound of 33/67. As this ratio decreases, the cost of both interventions increases, but the cost of the standard intervention increases by a larger percentage. As noted above, the estimated standard intervention cost had a large proportion of unreported intervention time, so as we allocate proportionately more time to unreported intervention time, its costs increase by a relatively large amount. Scenario 3 combines both scenarios 1 and 2 and yields the highest cost of the enhanced intervention in the sensitivity analysis. Scenario 4 changes the average hourly cost of labor for the enhanced intervention to $16.65, which is the hourly wage of staff conducting the standard intervention. This change substantially reduces the cost of the enhanced intervention. Scenario 5 builds on the assumptions of scenario 4, but it allocates the total costs of the interventions over the 331 individuals who completed the follow-up and therefore increases the cost of the interventions. Finally, scenario 6 returns to the baseline assumptions but computes the average cost of the interventions over the 331 completers.

Table 2: Cost Sensitivity Analysis

	Parameters				*Estimated Cost per Person*	
	Allocation of Unreported Time: Research Versus Intervention	*Allocation of Unreported Time: Standard Versus Enhanced*	*Average Hourly Cost of Labor for Enhanced Intervention*	*Sample Size Used in the Calculations*	*Standard Intervention*	*Enhanced Intervention*
Baseline	60/40	95/5	$40.96	All intakes ($N = 477$)	$187.52	$124.17
Scenario 1	60/40	75/25	$40.96	All intakes ($N = 477$)	$169.07	$157.74
Scenario 2	33/67	95/5	$40.96	All intakes ($N = 477$)	$246.65	$129.83
Scenario 3	33/67	75/25	$40.96	All intakes ($N = 477$)	$215.76	$186.07
Scenario 4	60/40	95/5	$16.65	All intakes ($N = 477$)	$187.51	$87.40
Scenario 5	60/40	95/5	$16.65	Completers only ($N = 331$)	$265.72	$111.30
Scenario 6	60/40	95/5	$40.96	Completers only ($N = 331$)	$265.72	$153.84

Table 3 presents the mean post-intervention drug use outcomes and demographic variables used in the effectiveness analysis for the standard and enhanced samples. Individuals in the enhanced group consistently used drugs less than those in the standard intervention, with days of crack, cocaine, and heroin use showing a significant difference between the standard and enhanced intervention. Our results indicate that those in the enhanced intervention had 2.39 fewer days of crack use in the past 30 days, 1.46 fewer days of cocaine use, and 1.57 fewer days of heroin use than those in the standard intervention.

Table 3 follows the tradition of much of the clinical trial literature (and the methodology of other NC CoOP manuscripts) of analyzing data with pre- and post-intervention observations only ($N = 331$). We also reran the data from Table 3 for the $N = 477$ sample, where, as described above, we assumed no change in outcomes for the 146 individuals who did not complete the follow-up interview. As expected, the estimated effect of the enhanced intervention was substantially reduced. Focusing on the outcomes in Table 3 that showed a significant difference between standard and enhanced

Table 3: Mean Postintervention Outcomes and Demographic Variables†

	Standard (N = *143*)	*Enhanced* (N = *188*)
Drug use		
Days used crack in the past 30 days	11.78	9.39**
	(11.04)	(9.94)
Days used cocaine in the past 30 days	3.38	1.92**
	(7.72)	(5.50)
Days used heroin in the past 30 days	3.08	1.51**
	(8.38)	(5.49)
Days injected heroin in the past 30 days	2.54	1.44
	(7.94)	(5.49)
Times injected heroin in the past 30 days	3.92	2.60
	(13.06)	(12.14)
Times injected drugs in the past 30 days	9.40	5.88
	(27.51)	(20.76)
Demographics		
Male (%)	57.64	52.13
	(0.50)	(0.50)
Age	37.39	36.90
	(7.58)	(7.09)

**Significant difference between standard and enhanced at 5 percent level (two-tailed test).

†Standard deviation in parentheses.

intervention, that is, days used crack, cocaine, and heroin in the past 30 days, we found that the estimated differences between enhanced and standard were −1.39, −0.38, and −0.43, respectively, a decrease of approximately 42 percent, 74 percent, and 73 percent from the Table 3 values. Because some of the individuals who were lost to follow-up likely improved, these latter results represent very conservative estimates of the effect of enhanced intervention.

Table 4 summarizes the estimated impact of the enhanced intervention on drug use for various models. Column 1 presents the simple difference in means (enhanced minus standard) that are based on the Table 3 results. In column 2, we present the results of our basic regression model. The enhanced intervention was associated with significant decreases in days used heroin in the past 30 days ($p < .05$) and days used cocaine in the past 30 days ($p < .10$).

The rest of Table 4 presents the estimated effects of the enhanced intervention (relative to the standard intervention) for various subpopulations. Column 3 presents the estimated effects of the enhanced intervention for men and women; however, no significant differences were found between men and women for any of the outcome variables. Column 4 presents the estimated effect of the enhanced intervention for injectors and noninjectors. We found that injectors who received the enhanced intervention had a much greater reduction in days used heroin in the past 30 days ($p < .01$) than noninjectors who received the enhanced intervention. No significant differences in the effect of the enhanced intervention between injectors and noninjectors were found for the outcome variables.

Focusing on the overall drug use results from column 2 and recalling the estimated cost of implementing the enhanced intervention of $124.17 (from Table 1), the cost-effectiveness ratios are $90.64 per reduced day of crack use, $91.98 per reduced day of cocaine use, $86.23 per reduced day of heroin use, $139.52 per reduced day of heroin injection, $82.78 per reduced time of heroin injection, and $35.68 per reduced time of any drug injection (see column 5). As many of the effectiveness results are not significant, their associated cost-effectiveness ratios should be viewed as illustrative.

DISCUSSION

NIDA's standard two-session AIDS education and counseling intervention has been shown to be effective at reducing drug use and some HIV risk behaviors, and analysis of the NC CoOp data has yielded similar results (Wechsberg, Dennis, and Stevens 1998; Wechsberg, Dennis, Rasch, et al.

Table 4: Estimated Impact of Enhanced Intervention on Various Outcomes ($N = 331$)†

	1	2	3		4		5
	Means	*OLS*	*OLS with Male/Female Differential*		*OLS with Noninjector/Injector Differential*		*Cost-Effectiveness Ratios*‡
	Difference in Means (Enhanced – Standard)	*Enhanced Effect (Relative to Standard*	*Male Enhanced Effect (Relative to Standard)*	*Female Differential (Relative to Male Enhanced Effect)*	*Noninjector Enhanced Effect (Relative to Standard)*	*Injector Differential (Relative to Noninjector Enhanced Effect)*	$\frac{\Delta \text{Cost}}{\Delta \text{Effectiveness}} = \frac{\$124.17}{\text{Overall Results from Column 2}}$
Drug use							
Days used crack in the past 30 days	−2.39** (1.16)	−1.37 (1.05)	−1.18 (1.35)	−0.43 (2.15)	−1.93 (1.42)	1.27 (2.13)	$90.64
Days used cocaine in the past 30 days	−1.46** (0.73	−1.35* (0.72)	−0.40 (0.96)	−2.08 (1.46)	−0.71 (0.48)	−1.52 (1.55)	$91.98
Days used heroin in the past 30 days	−1.57** (0.76)	−1.44** (0.61)	−1.42 (0.89)	−0.04 (1.21)	−0.16 (0.28)	−2.95** (1.34)	$86.23
Days injected heroin in the past 30 days	−1.10 (0.74)	−0.89 (0.59)	−0.88 (0.89)	−0.03 (1.16)	0.043 (0.082)	−2.15 (1.32)	$139.52
Times injected heroin in the past 30 days	−1.33 (1.39)	−1.50 (1.15)	−1.29 (1.81)	−0.47 (2.27)	−1.74** (0.87)	0.54 (1.29)	$82.78
Times injected drugs in the past 30 days	−3.52 (2.65)	−3.48 (2.21)	−3.94 (3.10)	1.02 (4.39)	−1.05 (0.94)	−5.56 (4.79)	$35.68

*Significant at the 10 percent level; **significant at the 5 percent level.

†Robust standard errors in parentheses. All regression models include gender, age, and the preintervention value of the outcome variables.

‡Because a negative coefficient is associated with an improvement in outcome for the enhanced intervention group relative to the standard intervention, the effectiveness measure used in the cost-effectiveness ratios is defined as the negative of the parameter estimates.

1998). The main contribution of this article is the estimation of the cost of implementing the revised NIDA standard intervention and the cost of an additional intervention, the enhanced intervention. In this cost analysis, we include all individuals who entered the Durham, North Carolina site between 1996 and 1997. We estimate that the cost of implementing the standard intervention is $187.52 per client. The enhanced intervention consists of an additional three sessions. We estimate that the cost of these additional sessions is $124.17 per client. We found that personnel expenses constituted the largest component of costs for each intervention, comprising 52 percent of the standard intervention and 66 percent of the enhanced intervention. The financial incentives that were paid to study participants also accounted for a relatively large proportion of the costs—23 percent of the standard intervention and 18 percent of the enhanced intervention costs.

One of the limitations of our cost analysis was that the time spent on research activities and on the standard and enhanced interventions was incompletely recorded. As a result, we made some reasonable assumptions about time spent on the interventions versus research and other noninterven-tion time. Our sensitivity results suggested that our estimates were robust to changes in assumptions that we made about unreported research and inter-vention time. However, the sizeable decrease in the enhanced intervention cost as a result of the reduction in the average hourly cost of labor showed that the cost per person of the enhanced intervention is sensitive to the cost of labor. This is certainly not surprising given that personnel costs comprise such a large proportion of the enhanced intervention costs. The results suggest that if the staff performing the standard intervention also conducted the enhanced intervention, the expected implementation cost per person of the enhanced intervention would decrease by approximately 30 percent; however, it is not clear whether the quality of the enhanced intervention, which is designed with a more sophisticated protocol than the standard intervention, would be maintained. This is an area for future research.

We also perform an outcome analysis for individuals who completed a follow-up interview. We found that individuals who were randomized to an additional enhanced intervention had significantly fewer mean days of crack, cocaine, and heroin use in the previous 30 days than individuals who only received the standard intervention; with the exception of days used crack, we found similar results in our multiple regression results. However, there are study limitations of these effectiveness results worth noting involving the three-month follow up period and self-report data. The NIDA cohort investigators revised the NIDA standard to address some issues found in

earlier studies (Wechsberg, Inciardi, Leukefeld, et al. 1998). As part of their revision, they changed the follow-up time to three months, predicated on the fact that the instrumentation in the national cooperative (RBA/RBFA) only captures 30-day behaviors. Thus, short-term follow-up seemed more realistic to capturing true behaviors (Wechsberg, Inciardi, Leukefeld, et al. 1998). A current ongoing study that follows a subset of the NC CoOP sample has a more longitudinal perspective.

The accuracy of behavioral self-reports has often been questioned among drug users and may be considered a limitation. However, numerous studies from the NIDA CA have been conducted with regard to self-report with urinalysis and visual examinations for recent needle marks to corroborate drug use (Needle, Fisher, Weatherby, et al. 1995). Furthermore, the investigators of NC CoOp conducted a kappa test for self-report of drug use in the last 48 hours and urinalysis results at follow-up and found agreement with cocaine use at 80 percent with an adjusted kappa of 0.59, and agreement with opiate use of 95 percent with a kappa of 0.91. There was 99 percent agreement for positive cocaine use and admitted use in the last 30 days (Wechsberg, Dennis, Zarkin, et al. 2000).

Given the costs and outcomes of the enhanced intervention, the fundamental policy question is whether the enhanced intervention yields sufficiently large outcomes to justify the small but additional costs. To answer this question, we calculated the ratio of the incremental cost of the enhanced intervention ($124.17) to the estimated incremental effect of the enhanced intervention (relative to standard). Because we had multiple outcomes, we presented multiple cost-effectiveness ratios, one for each drug use outcome. Our estimates ranged from $35.68 to $139.52 per reduced drug use outcome.

Our estimated costs and cost-effectiveness ratios are very small, indicating that achieving the reductions in drug use attributable to the enhanced intervention costs relatively little. To compare our cost-effectiveness results to others in the AIDS and substance abuse literature, we must identify studies that use the same outcome measure that we have used here (drug use). However, other economic research in this area has focused on changes in sexual behavior (e.g., Holtgrave and Kelly 1996; Pinkerton, Holtgrave, DiFranceisco, et al. 1998). In these studies, changes in sexual risk behavior observed during the intervention were used in conjunction with models of HIV/AIDS transmission to predict the change in the number of future AIDS cases. These models require many assumptions about sexual behavior and underlying epidemiological parameters related to the transmission of HIV/AIDS, the length of time behavioral effects will last, and the extent of

secondary transmissions that are beyond the scope of this article. Instead, we focused on intermediate outcomes (drug use) that could be measured during the course of the intervention and that did not require either cumulative probability equations or dynamic compartmental models.

To judge the economic viability of the enhanced intervention with our drug use outcomes, we sought an estimate of the benefits of reducing drug use to compare to our estimated costs of reducing drug use through the enhanced intervention. Unfortunately, there are no direct estimates in the literature of the net benefits per reduced day of drug use, but we developed a "back-of-the-envelope" estimate from the economics of drug treatment literature. Gerstein, Johnson, Harwood, et al. (1994), in a frequently cited study, estimate the economic costs to society per substance abuser the year before and the year after treatment for patients discharged from treatment in California. The benefits of drug treatment reflect the reduction in social costs associated with drug treatment. Gerstein and colleagues estimate that the per-client social costs of drug use decrease from $32,151 in the year before treatment to $27,035 in the year after treatment, yielding a one-year cost savings (social benefit) of drug treatment equal to $5,116 per person treated (Gerstein, Johnson, Harwood, et al. 1994, Table 29, p. 73). As additional benefits to drug treatment undoubtedly accrue in future years, this estimate represents an underestimate of the total dollar value of drug treatment. For our purposes, this benefit estimate would ideally be combined with an average reduction in days of drug use attributable to drug treatment, but no such number is provided in the study by Gerstein and colleagues. Instead, they report the pretreatment/posttreatment change in the proportion of days of abuse of the main drug in the month of peak use, a different measure of drug use than we would prefer. Translating their change in drug use estimate into days yields an estimate of an eight-day reduction in the use of the main drug in the month of peak use (Gerstein, Johnson, Harwood, et al. 1994, Table 6, p. 25). Based on these numbers, an estimate of the incremental benefit of drug treatment per reduced day of drug use is $5,116/8 = $639.50 per day of reduced drug use.

This estimated incremental benefit per day of reduced drug use exceeds all the cost-effectiveness ratios, including those outcomes that do not show a significant difference between the standard and enhanced interventions. For example, the largest cost-effectiveness ratio, $139.52 for days injected heroin, is only about 22 percent of the estimated incremental benefit. These results are suggestive, but certainly not conclusive, that the benefits of the enhanced intervention exceed the costs and that the enhanced intervention

is justified on economic grounds. However, given the low cost of the enhanced intervention, combined with the significant reductions in some of the drug use variables, the enhanced intervention should be considered an important additional component of an AIDS prevention strategy for out-of-treatment substance abusers.

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