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Cost and Cost-Effectiveness of Abstinence Contingent Wage Supplements

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Abstract

Background—Substance use disorders are correlated with unemployment and poverty. However, few interventions aim to improve substance use, unemployment, and, distally, poverty. The Abstinence-Contingent Wage Supplement (ACWS) randomized controlled trial combined a therapeutic workplace with abstinence-contingent wage supplements to address substance use and unemployment. The ACWS study found that abstinence-contingent wage supplements increased the percentage of participants who had negative drug tests, who were employed, and who were above the poverty line during the intervention period. This study presents the cost of ACWS and calculates the cost-effectiveness of ACWS compared with usual care.

Methods—To calculate the cost and cost-effectiveness of ACWS, we used activity-based costing methods to cost the intervention and calculated the costs from the provider and healthcare sector perspective. We calculated incremental cost-effectiveness ratios and cost-effectiveness acceptability curves for negative drug tests and employment.

Results—ACWS cost \$11,310 per participant over the 12-month intervention period. Total intervention and healthcare costs per participant over the intervention period were \$20,625 for usual care and \$30,686 for ACWS. At the end of the intervention period an additional participant with a negative drug test cost \$1,437 while an additional participant employed cost \$915.

Conclusions—ACWS increases drug abstinence and employment and may be cost-effective at the end of the 12-month intervention period if decision makers are willing to pay the incremental cost associated with the intervention.

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Author Contributions

SO, GAZ, and LJD monitored the acquisition of data for the study. SO, GAZ, and LJD oversaw data analysis and interpretation of findings. SO and JL conducted analyses and wrote the first draft of the manuscript with essential input from GZ and LD. MDN, AFH, FT, and KS provided substantive feedback on subsequent drafts. All authors contributed to and have approved the final manuscript.

Conflict of Interest

No conflicts declared.

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Keywords

Cost-effectiveness; Therapeutic workplace; Contingency management; Cocaine; Opioids; Employment

1. Introduction

Unemployment increases the risk of substance use disorders, which increases the risk of unemployment (Henkel, 2011). Experiencing poverty also increases the risk of substance use regardless of employment status (Williams and Latkin, 2007). These interacting effects contribute to an estimated U.S. societal cost of over \$740 billion annually in 2011 due to substance use disorders (National Institute on Drug (NIDA), n.d.). A more recent 2017 estimates of the societal costs of opioid use disorder (OUD) is \$471 billion with productivity losses alone accounting for \$31 billion (Florence et al., 2021). Because substance use disorders, unemployment, and poverty co-occur, addressing these issues simultaneously may increase the effectiveness of a substance use disorder intervention. However, addressing all of these at the same time is challenging, and few interventions address them all (Holtyn et al., 2017; Magura et al., 2004; Svikis et al., 2012).

In previous analyses, Silverman and colleagues showed that a therapeutic workplace using an employment-based abstinence reinforcement contingency management model, where participants' pay is contingent upon drug-negative urine samples, can address both substance use and employment issues (Silverman et al. 2016). By promoting abstinence and increasing participation in the therapeutic workplace, the intervention can increase employment and reduce poverty over time (Silverman et al., 2019). The Abstinence-Contingent Wage Supplement model (ACWS) was developed by combining elements from the therapeutic workplace with abstinence-contingent wage supplements and an employment specialist who supports participants' efforts to gain employment (Holtyn et al., 2020a). ACWS participants attend a therapeutic workplace office space to work with an employment specialist. By working with the employment specialist and providing negative urine drug samples, ACWS participants earned financial incentives. The financial incentives were called stipends when working with the employment specialist and were called wage supplements when participants were employed at a community job.

The ACWS study found that abstinence-contingent wage supplements increased attendance in the therapeutic workplace (Holtyn et al., 2020b), the percentage of participants with negative drug tests, the percentage of participants ever employed, and the percentage ever living above the Federal poverty level (Holtyn et al., 2020a). These effects were maintained while the intervention was in place but did not persist after the intervention was discontinued (Novak et al., 2022). This is consistent with other outcome studies using a therapeutic workplace and employment-based abstinence reinforcement (Silverman et al., 2019). This study calculated the cost and cost-effectiveness of ACWS.

To our knowledge cost and cost-effectiveness studies of abstinence-contingent wage supplements to address substance use, employment, and poverty have not been conducted. Instead, contingency management has been frequently studied for people with OUD (e.g.,

Bolivar et al., 2021). And although cost and cost-effectiveness studies of contingency management for substance use disorders have been conducted, the ACWS study is not comparable to these studies. ACWS provides incentives (wage stipends and supplements) based on hours attending the therapeutic workplace or working at a community job with the value of these wage supplements determined by abstinence from opiates and cocaine; this allows ACWS to incentivize both abstinence and employment. Most other contingency management interventions with cost studies provided incentives based only on abstinence (Hartz et al., 1999; Olmstead et al., 2007a; Schumacher et al., 2002; Sindelar et al., 2007b) or abstinence and treatment attendance (Olmstead et al., 2007b; Olmstead and Petry et al., 2009; Sheidow et al., 2012; Sindelar et al., 2007a). ACWS also provided cash wage supplements or stipends directly to participants while other contingency management studies used vouchers or gift certificates (Hartz et al., 1999; Olmstead et al., 2007; Sheidow et al., 2012) or lottery-based rewards (Olmstead et al., 2007; Olmstead and Petry et al., 2009; Sindelar et al., 2007a; Sindelar et al., 2007b).

2. Methods

2.1. Study Design

The study population consisted of unemployed adults receiving opioid agonist treatment who met inclusion criteria detailed in Holtyn et al. (2020a). Prior to randomization, participants attended a 90-day training and screening (Phase 1), which we did not include in the cost analyses. Participants who completed Phase 1 were randomized into an intervention group that received ACWS (N = 44) and a usual care control group that did not (N = 47). The randomization process used educational attainment and the percentage of opiate- and cocaine-positive drug samples from monthly assessments conducted during the training and screening phase as stratification variables. During the 12-month intervention period, all participants had access to the therapeutic workplace and employment specialist. The therapeutic workplace, an office space that could accommodate more than 20 participants at a time in individual computer-equipped workstations, was open to participants Monday through Friday and located at the Center for Learning and Health on the Johns Hopkins Bayview Campus in Baltimore, Maryland, USA. At the therapeutic workplace, participants worked independently and with an employment specialist on writing resumes, conducting job searches, applying to jobs, and other job-seeking behaviors. Usual care participants received no stipend to attend the therapeutic workplace, whereas participants in the ACWS group could earn stipends while attending the therapeutic workplace or abstinence-contingent wage supplements when working at their job in the community. The magnitude of the stipend and wage supplements was conditional on providing opiate- and cocaine-negative urine samples and hours worked at the therapeutic workplace or having a job (hours worked were verified by collecting pay stubs). At the therapeutic workplace, ACWS participants earned stipends (up to \$8 per hour) when working with the employment specialist for up to 20 hours per week. ACWS participants could also earn a \$2 per hour bonus for engaging in specific job seeking behaviors; the bonus was not affected by their drug test results and added to their stipend (Holtyn et al. 2020a). Employed participants earned wage supplements (up to \$8 per hour) on the first 40 hours of work. The stipend base pay and the wage supplement were decreased to \$1 per hour if the participant provided

an opiate- or cocaine--positive urine sample or failed to provide a scheduled urine sample. After a reset, the stipend base pay and wage supplement increased by \$1 per hour back up to the maximum base pay of \$8 per hour each day that the participant provided an opiate- and cocaine-negative sample and worked at least 5 minutes. Participants, including those with community jobs, were initially required to provide urine samples three times per week. Testing became less frequent for participants who consistently provided opiate- and cocaine-negative samples. Stipend payments were made when a participant attended the therapeutic workplace and wage supplement payments were made when a participant provided a pay stub. All participants were contacted every month for assessments during the 12-month intervention period. After the 12-month intervention period, all services and wage supplements were discontinued; all participants were contacted every 3 months for follow-up assessments during the 12-month post-intervention period (Holtyn et al. 2020a, Novak et al., 2022).

2.2. Economic Data

We collected economic data on the intervention using a modified version of the Substance Abuse and Cost Analysis Program (SASCAP; Zarkin et al., 2004). The modified SASCAP captured the intervention's use of labor, supplies, equipment, and building space. We supplemented the SASCAP data with study records to calculate the material, space, and non-labor costs of drug testing and the total amount of wage supplements paid out to participants. Our goal was to calculate the ongoing implementation costs of ACWS, excluding start-up costs.

From participants, interviewers on the research team collected self-reported healthcare utilization data using a modified Economic Form-90 (EF-90) (Bray et al., 2007; Dunlap et al., 2018). During the intervention period, interviewers asked participants to look back over the past 30 days and report the number of general and behavioral health hospitalization nights, emergency department visits, behavioral health outpatient treatment days, and medical outpatient doctor visits. The EF-90 also asked participants to report any criminal justice involvement: the number of arrests, court appearances, and convictions by type of crime, however we did not use these data due to the small number of participants reporting incidents. Participants completed EF-90 assessments every month during the intervention and every 3 months post-intervention—conducted at the same time as other study assessments and urine sample collection—for a total of 16 assessments.

2.3. Outcome Data

We used two primary outcome measures assessed at two points of time: the percentage of negative drug (opiates and cocaine) tests and the percentage of participants employed at the end of the intervention and post-intervention periods.

2.4. Missing Cost and Outcome Data

We reviewed missing data separately for the intervention period and the post-intervention period. For the intervention period, two participants in the usual care group were missing all assessments (Holtyn et. al., 2020a). Additionally, nine usual care and seven ACWS participants were missing at least one assessment out of 12 during the intervention period.

The usual care group was missing 6.5% of assessments (35 out of 540 assessments) and the ACWS group was missing 5.9% of assessments (31 out of 528 assessments). During the post-intervention period, four participants in each group were missing all assessments; and 12 usual care participants and 10 ACWS participants were missing at least one out of four assessments (Novak et. al., 2022). The usual care group was missing 4.7% of assessments (8 out of 172 assessments), and the ACWS group was missing 5.6% of assessments (9 out of 160 assessments).

Missing outcome data were assigned as the adverse outcome: a drug-positive test or unemployment (Holtyn et al., 2020b). Missing healthcare utilization data (hospital nights, behavioral health hospitalization nights, ED visits, behavioral health outpatient treatment days and medical outpatient doctor visits) were imputed using multiple imputation with chained equations and a Poisson distribution. Our model covariates included healthcare utilization and baseline randomization stratification variables. Missing healthcare data were replaced by the mean imputed value from 15 imputation iterations.

2.5. Cost Estimation

We estimated intervention costs from both the provider perspective and the healthcare sector perspective. We did not include a broader societal perspective, such as patient time costs and all non-healthcare sector costs, due to limited usable data (Neumann et al., 2016). The provider perspective includes all intervention costs over the 12-month intervention period; these costs include the costs of the therapeutic workplace, employment specialists and financial incentives. We define the provider perspective as what it cost an organization to implement the intervention. In this study the organization is the Center for Learning and Health; however, in a real-world implementation, the organization might be a social services organization with local government funding. We also examined a healthcare sector perspective, capturing the healthcare costs related to substance use disorders, to provide useful information to social services agencies and government policy makers who may implement ACWS interventions.

To estimate the ongoing intervention costs, we used a micro-costing, or activity-based approach, which entailed estimating the resource use and associated cost of each intervention component, and then multiplying that cost by the amount of the resource used. The hourly per-participant cost of the therapeutic workplace included the loaded hourly wage (including fringe benefits and taxes) of the employment specialist, building space, and computer equipment. Based on study team input, we assumed 20 people (from ACWS and other interventions) attended the therapeutic workplace per day. Our calculated hourly cost per participant (\$9.73) was then multiplied by the hours each participant attended during the intervention period.

The cost of ACWS drug tests included time spent by a research assistant and supervisor collecting and managing urine tests and results and the non-labor cost of tests and building space. We multiplied the unit cost of the drug test itself (\$7.02) and the additional ACWS management cost (\$7.00) by the number of drug tests received so that participants with higher engagement would have higher intervention costs. To better capture the cost of implementing ACWS outside of research setting we did not include research costs. By

excluding research costs and since wage supplements are the largest portion of ACWS costs, our cost estimates are expected to be comparable to a real-world setting.

The total per-participant costs of the intervention included the therapeutic workplace costs, drug test costs, and ACWS management costs. For healthcare utilization, we multiplied patients' self-reported healthcare utilization by unit costs from McCollister et al. (2017). All prices and unit costs were inflated to 2020 dollars using the consumer price index (https://www.bls.gov/data/inflation_calculator.htm). Lastly, all participant costs were summed and averaged by group for the intervention and post-intervention periods. Total costs equal the sum of the intervention costs plus healthcare costs.

2.6. Cost and Outcome Analysis

We based our cost and outcome analysis approach on the methods used in Holtyn et al. (2020a) and Novak et al. (2022) and calculated model-adjusted predicted values for the average per-participant costs, negative drug tests, and employment. For our cost analysis, we used generalized linear models (GLM) as the kurtosis of the residuals was less than 3 supporting the use of GLM (Manning and Mullahy, 2001). We then conducted a modified Park test to determine gamma as the appropriate family function and used the log link function (Glick et al., 2014). Our independent variables in the models included a group variable (ACWS or usual care), the baseline randomization stratification variables and baseline healthcare costs reported over the 90-day period prior to study involvement. For our outcome analysis, we used generalized estimating equations for longitudinal data with repeated measures, and the independent variables (group and baseline stratification variables) described in Holtyn et al. (2020a) and Novak et al. (2022). We added a time variable (e.g., year or month indicator variable) to allow our model-adjusted predicted values to vary over time.

We obtained predicted values for costs and outcomes at both the end of the intervention period and post-intervention period. We used predicted values for all participants including those who did not provide any assessment data. To help account for uncertainty of our predicted values, we used bootstrapping with replacement ($N=91$) and 1,000 draws. For each bootstrapped draw we re-ran all analysis models and calculated predicted values for participant costs and outcomes and calculated the bootstrapped standard errors by group. We repeated this process for each draw. We used the significance of the estimated coefficient on the group variable to determine if differences between usual care and ACWS were statistically significant.

2.7. Cost-Effectiveness Analysis

Our cost-effectiveness methodology follows the standard approach described in the literature (Drummond et al., 2015; Glick et al., 2014). We ordered the usual care and ACWS groups by increasing total participant costs. We calculated the incremental cost effectiveness ratios (ICERs) for the intervention and post-intervention period using our model-adjusted average costs and outcomes. To calculate the number of participants with a negative drug test, we multiplied the percentage of participants with a negative drug test by the number of participants in each group. We followed a similar method using the employment outcome

to calculate the number of participants employed. Using this approach allows us to present the ICERs as the incremental cost for an additional participant with a negative drug test or employed.

To gauge the sampling uncertainty of the estimated ICERs, we followed standard methods to calculate cost-effectiveness acceptability curves (CEACs) (Fenwick et al., 2001; Fenwick et al., 2006; Glick et al., 2014). The CEACs incorporate the inherent joint variability of the cost and outcome estimates and show the probability that a policy maker's intrinsic valuation or willingness to pay for the outcome is greater than the ICER (and is therefore cost-effective) for alternative possible values of the willingness to pay. We used the bootstrapped costs and outcome means described previously to calculate the CEACs and graphed the resulting probabilities.

2.8. Sensitivity Analysis

To better understand the impact of using model-adjusted costs and outcomes we conducted our analysis using data without model-adjusted costs and outcomes. To better understand how intervention costs impact our results, we adjusted intervention costs, holding incentive costs constant by plus or minus twenty-five percent. We also conducted a whole case analysis, which dropped any participant with missing data.

3. Results

Table 1 shows the average participant utilization and intervention cost by group without model adjustments. Participants in the ACWS group spent, on average, significantly more time in the therapeutic workplace compared to usual care. This difference was approximately 50 times as much as in the therapeutic workplace and is described in more detail in Holtyn et al. (2020b). ACWS participants averaged 81 drug tests (approximately 1.5 tests per week) and received an average of \$6,619 in stipends and supplements over the 12-month intervention period. On average, the observed cost is \$11,310 per participant in the ACWS group and \$77 for participants in the usual care group.

Table 2 shows self-reported healthcare utilization by group during the intervention period (months 1–12) and post-intervention period (months 13–24) with imputed missing values. In both periods, we observed a few minor differences between the two groups, although none of these differences were statistically significant. During the intervention period, participants in the usual care group reported spending more days in the hospital, more days in behavioral health outpatient treatment, and fewer medical outpatient visits than participants in the ACWS group. During the post-intervention period, participants in the ACWS group spent more nights in the hospital, but fewer days of behavioral health outpatient treatment and fewer medical outpatient visits than participants in usual care.

Table 3 summarizes the model-adjusted intervention and healthcare costs. Model-adjusted intervention costs of \$73 per participant in usual care and \$11,851 per participant in ACWS are similar to observed costs shown in Table 1. During the intervention period, participants in the usual care group averaged \$20,553 in healthcare costs, whereas participants in the ACWS group averaged \$18,836. Total participant costs for the intervention period were

\$20,625 for usual care compared with \$30,686 for ACWS. This difference is driven by the difference in intervention costs and is statistically significant. During the post-intervention period, participants in the usual care group had \$11,014 in healthcare costs, whereas participants in the ACWS group had \$12,252. In total across the two-year period (intervention and post-intervention), participants in the usual care group had \$31,639 in costs, whereas participants in the ACWS group had \$42,938. This cost difference is also statistically significant.

Our base case results for the intervention and post-intervention periods are summarized in Table 4, which shows the number of participants with a negative drug test and the number of participants with employment at the end of both the intervention (12 months) and post intervention period (24 months). At the end of the intervention period, 21 participants in the usual care group (44.7% of N=47, rounded to the nearest participant) and 28 participants in the ACWS group (64.8% of N=44) had a negative drug test. For the employment outcome, nine participants in the usual care group (18.2% of N=47) and 20 participants in the intervention group (44.7% of N=44) were employed. At the end of the post-intervention period, 22 participants in the usual care group (46.6% of N=47, rounded to the nearest participant) and 20 participants in the ACWS group (46% of N=44) had negative drug tests. Nine participants in the usual care group (19.8% of N=47) and 14 participants in the ACWS group (32.9% of N=44) were employed. For both outcomes these differences were not statistically significant.

The ICER for intervention costs alone shows that ACWS costs \$1,683 per additional participant with a negative drug test and \$1,071 for an additional participant employed relative to usual care. When healthcare costs are included, ACWS costs \$1,437 and \$915 per additional participant with a negative drug test or employed, respectively, relative to usual care. Including healthcare costs reduced the cost per additional participant because participants in the ACWS group incurred fewer healthcare costs. For the post-intervention drug use outcome, the ACWS group had fewer participants with a negative drug test (not statistically significant) and higher per-participant costs, meaning usual care is the better choice based on this outcome measure (i.e., the ACWS group is “economically dominated”). For the employment outcome, the ICERs show that ACWS costs \$2,356 per additional employed participant without including healthcare costs and \$2,278 with healthcare costs.

Incorporating the joint variability in our cost and outcome measures, the CEACs in Figures 1a and 1b show the probability that ACWS is the optimal choice depending on the value a decision maker places on the outcome measures. In Figure 1a, there is an 80% probability that ACWS is the optimal choice if society is willing to pay over \$2,100 per additional participant with negative drug test. For employment (Figure 1b), there is an 80% probability that ACWS is the optimal choice if the willingness to pay is over \$1,800 per additional participant employed.

The post-intervention period CEACs are shown in Figures 2a and 2b. In Figure 2a, ACWS is never the better choice over willingness-to-pay values ranging from \$0 to \$8,000. Figure 2b shows that ACWS has about an 80% probability of being the optimal choice even when willingness to pay values are over \$5,100 per additional participant employed.

3.1 Sensitivity Analysis

Our results based on actual observed data were similar to the model-adjusted results. As shown in Table 5, using observed data with missing data imputed as the negative outcome, we reach the same conclusions. The resulting ICER for the intervention period is \$738 for an additional negative drug test and \$400 for an additional participant employed based on the 12-month assessment. These lower ICER values are largely driven by differences in the outcome measures, as our model-adjusted data included all time points. The ICER for the combined intervention and post-intervention period is economically dominated for additional negative drug tests and \$3,337 for an additional participant employed. In both cases, these ICERs do not change our overall base case conclusions, and our base case results present a more conservative estimate of ACWS effectiveness. Decreasing and increasing intervention costs, holding incentives constant, did not change overall results as shown in Table 6. However, since the usual care arm did not include incentives, both decreasing and increasing intervention costs slightly raised the point estimate of our ICERs for both outcome measures. This highlights how incentive cost drives the overall cost of the ACWS interventions. Our whole case analysis, which dropped participants with any missing assessment, reduces the number of participants by about 20% in the intervention period and almost 40% in the post-intervention period. We found that total costs under this condition were similar to our base case.

4. Discussion

This cost-effectiveness study of the ACWS intervention found that the addition of the ACWS intervention raised per-participant costs while increasing the number of participants with a negative drug test and employment at the end of the intervention period. Our ICER results (including healthcare costs) show that at the end of the intervention period, an additional participant with an opiate- and cocaine-negative drug test costs \$1,437, and an additional participant employed costs \$915. At the end of the post-intervention follow-up, the ACWS group had lower healthcare costs, but the difference was not large or statistically significant compared to the usual care group. As expected, differences in outcome measures between ACWS and usual care participants decreased in the post-intervention period. Effectiveness studies of similar interventions (e.g., Benishek et al., 2014; DeFulio and Silverman, 2011; Silverman et al., 2021) have found that the positive effects on outcomes are not maintained after the intervention ends, and our post-intervention results fit this pattern as well.

The ACWS intervention aims to reduce drug use for both opiates and cocaine and increase employment and, ultimately, reduce poverty. Ideally, these intended impacts should be considered jointly yet we found no prior cost and cost-effectiveness literature that does that. The critical question is whether decision makers (e.g., providers, local governments) are willing to pay the incremental cost associated with the intervention but this valuation is not known a priori and likely varies by decision maker. Despite the lack of direct comparison cost-effectiveness studies, we can still contextualize our findings and discuss the broader implications of our findings. While ACWS is designed as an adjunct to traditional substance

use treatment, we can still compare the cost of ACWS to common substance use disorder treatments to help interpret our cost estimates.

Common substance use disorder treatments, such as methadone maintenance, standard outpatient, intensive outpatient, and adult residential treatments cost an average of \$26, \$34, \$90, and \$193 per day respectively (in 2020 dollars; McCollister et al., 2016; French et al. 2008). Comparatively, this study found that ACWS costs \$31 per day (\$11,310 per patient/365 days). Thus, the cost of ACWS is well within the range of substance use disorder treatments that society has supported.

Interpreting our cost-effectiveness employment result is also challenging as we did not find any existing cost or cost-effectiveness studies of employment interventions for people with substance use disorders. Cost and cost-effectiveness studies of employment interventions focus on people with serious mental illness and are not comparable to this intervention or to the participants in this population (e.g., Hoffmann et al., 2014; Knapp et al., 2013; Yamaguchi et al., 2017). Without study comparisons, we can compare our ICER results to the potential earnings a participant may gain from increased employment. This comparison is only to better understand our cost-effectiveness results and determine if the cost of an additional person employed may generate a reasonable return as measured by private employment earnings. We calculated that it costs \$915 for an additional participant employed, which is about 72% of a monthly full-time salary at the Federal minimum wage (\$1,260 assuming 168 hours at \$7.50). Although higher local wages would improve this comparison, many participants in the ACWS program obtained part-time employment (Holtyn et al., 2021). Overall, the cost of additional employment gains derived from ACWS may be a good value, but it depends on local wages and hours worked.

Our cost-effectiveness results indicate that broader adoption of ACWS would be most valuable to a decision maker that values both increased abstinence from drugs and employment. Local governments may find ACWS cost-effective as a program to augment existing substance use treatment programs while increasing employment. Previously, state and local governments in Minnesota, Connecticut, Milwaukee, New York and, internationally, in Canada, have implemented wage supplements to increase employment among welfare recipient populations (e.g., Berlin, 2007; Michalopoulos, 2005; Riccio et al., 2016). Recently, basic income programs, without contingency management, have been piloted in the United States in locations such as Stockton, CA (West et al., n.d.), and Washington, D.C. (Boyle et. al. 2022). These interventions did not include drug abstinence contingencies but targeted people with low-income or without regular employment. As the ACWS wage supplements are conditional on abstinence and employment the intervention may also reduce the negative perceptions of giving people money just to do the “right thing” and improve employment-related outcomes. These efforts suggest there could be support for the wider use of wage supplements and income support among decision makers, but further study is needed to determine the value that potential decision makers place on reduced substance use and increased employment.

4.1. Limitations

Our study focuses on intervention and healthcare costs, and future studies should look to include additional costs and benefits that may be affected by increased employment (e.g., Neumann et al., 2016). Although we collected data on criminal justice involvement of the participants, we did not have enough criminal justice system involvement to make meaningful comparisons. Additionally, we used participant self-report to collect data on healthcare utilization, justice system involvement, and employment. Self-report may be biased because of recall and recency effects; verifiable criminal justice system involvement and employment data would have improved the study. Future economic studies may also consider additional outcome measures such as days abstinent or quality adjusted life years, which would allow greater comparability of results to other substance use and employment interventions.

4.2. Conclusion

To our knowledge, this study is the only cost and cost-effectiveness study of an intervention that jointly targets increases in drug abstinence and employment. Considering total participant intervention period costs, ACWS costs about \$1,437 per additional participant with a negative drug test and about \$915 for an additional employed participant. Like other substance use disorder interventions, the ACWS effects were not maintained for the drug use outcome after the intervention ended. For employment in the post-intervention period, the cost for an additional participant employed increases to over \$2,300, and we did not find longer term reductions in healthcare costs that might offset the cost of ACWS.

ACWS is cost-effective compared to usual care if decision makers (e.g., providers, local governments) are willing to pay the incremental cost associated with the intervention. Further study is needed to determine if ACWS offers additional benefits beyond healthcare costs and to better understand what decision makers may be willing to spend.

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Highlights

- The ACWS intervention cost \$11,310 per participant over one year
- An additional participant with a negative drug test cost \$1,437 at 12 months
- An additional participant employed cost \$915 at 12 months
- Decision makers who value both outcomes may find ACWS cost-effective

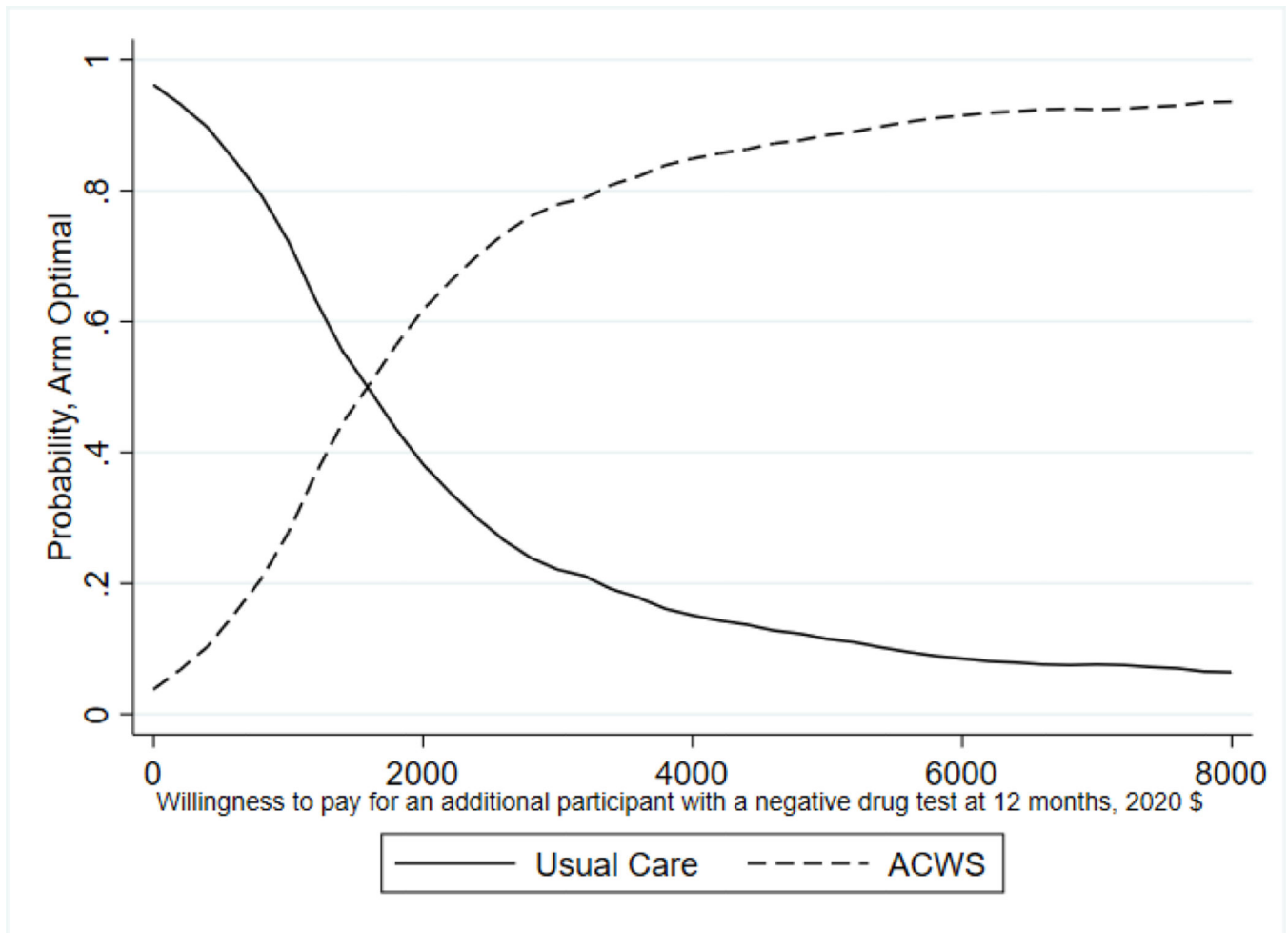


Fig 1a.
Cost-Effectiveness Acceptability Curves (CEACs) for Negative Drug Test and Total Participant Cost at End the Intervention Period.

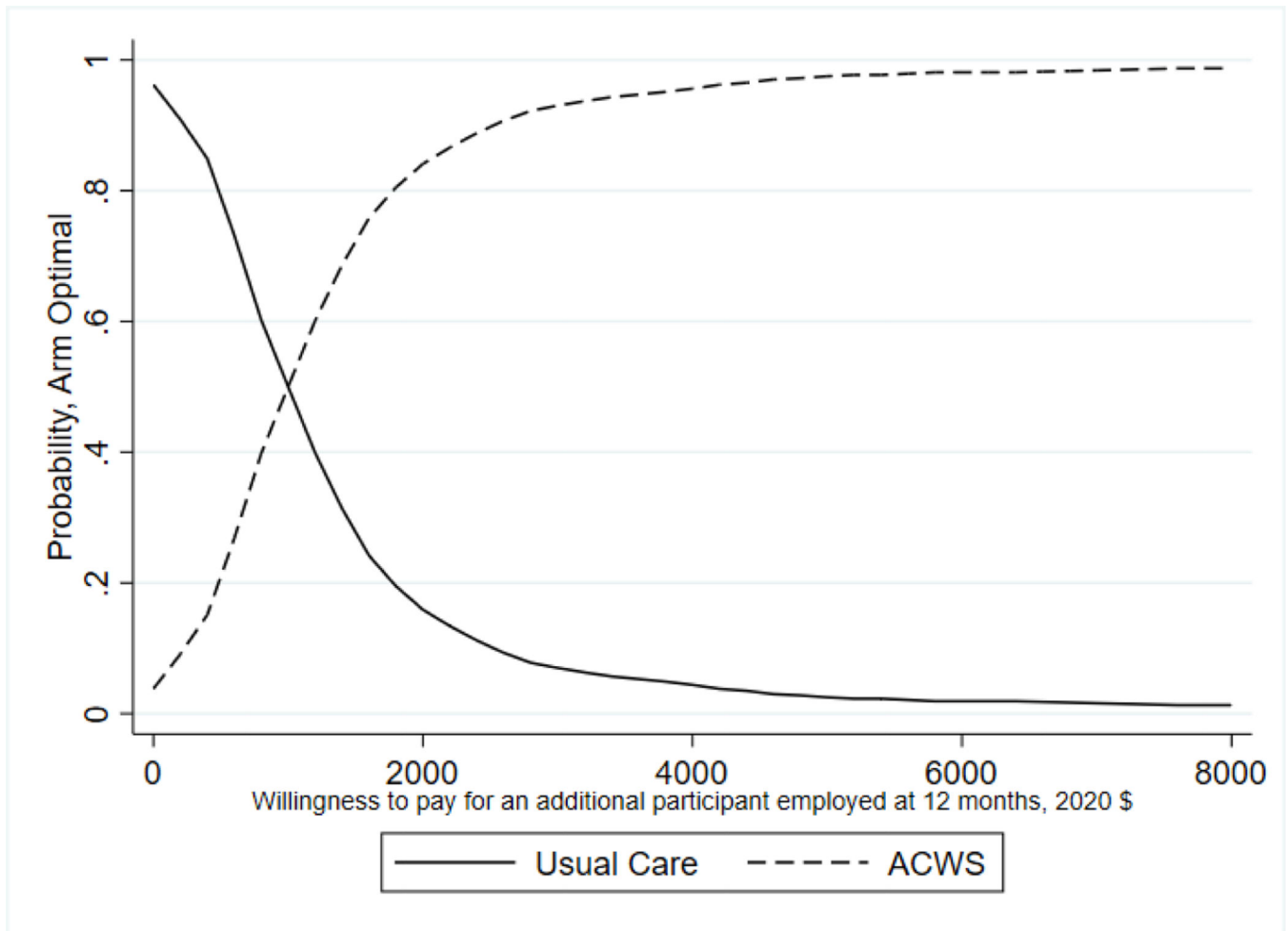


Fig. 1b.
Cost-Effectiveness Acceptability Curves (CEACs) for Employment and Total Participant Cost at End of Intervention Period.

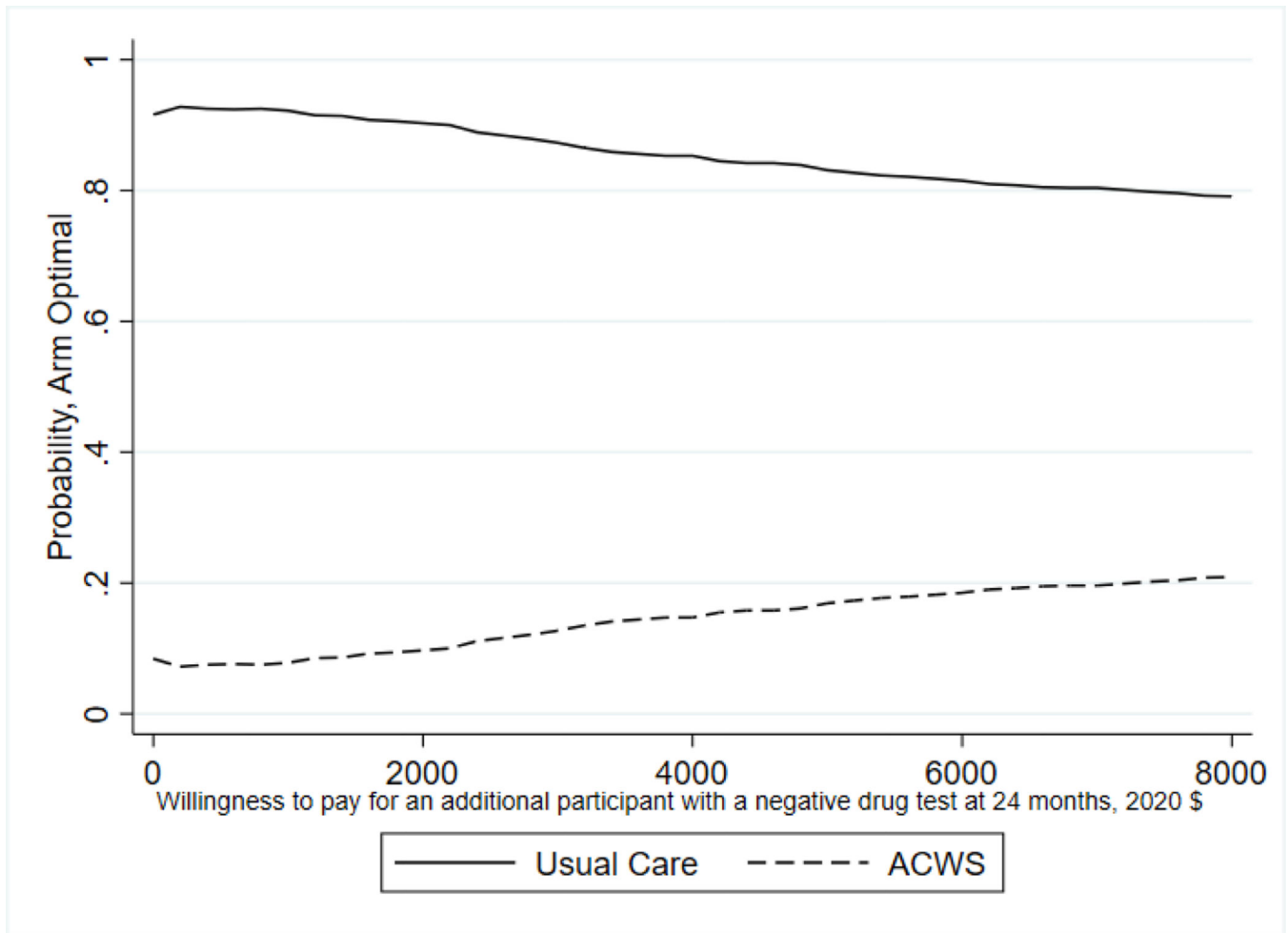


Fig. 2a.
Cost-Effectiveness Acceptability Curves (CEACs) for Negative Drug Test and Total Participant Cost at the End of Post-Intervention Period.

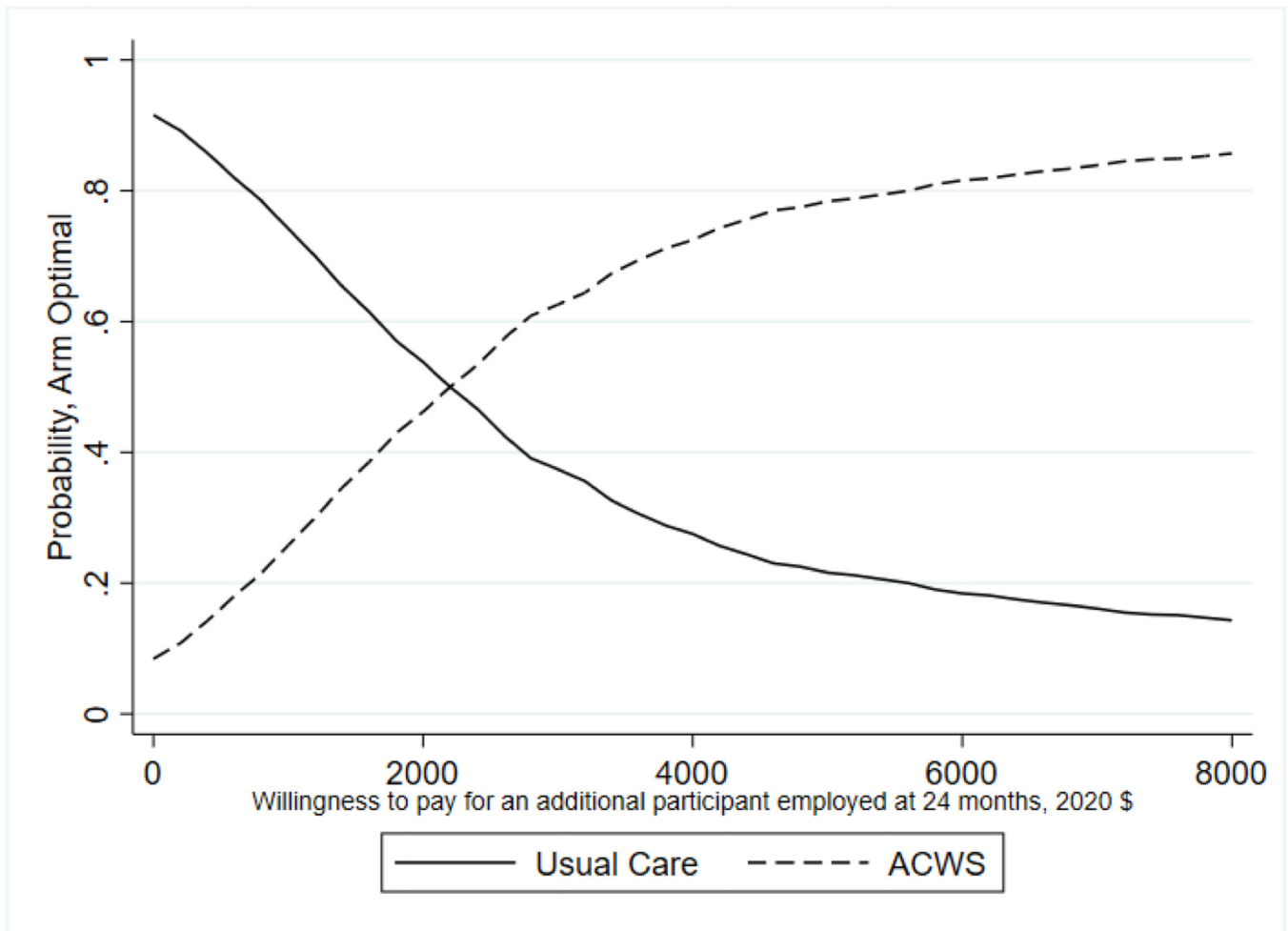


Fig. 2b.
Cost-Effectiveness Acceptability Curves (CEACs) for Employment and Total Participant Cost at the End of Post-Intervention Period.

Table 1

Intervention Utilization and Costs

Therapeutic Workplace Employment Specialist		Abstinence-Contingent Wage Supplements (ACWS)						
Group	N	Average hours per participant	Average costs per participant ^a	Average drug tests per participant	Average drug test costs per participant	Average ACWS management costs per participant ^b	Average wage supplements per participant	Average intervention cost per participant
Usual Care	47	8	\$77	—	—	—	—	\$77
ACWS	44	359	\$3,553	81	\$569	\$568	\$6,619	\$11,310

^a Includes labor and non-labor therapeutic workplace costs.

^b Includes labor and non-labor ACWS management costs.

Table 2.

Healthcare Utilization

Group	N ^a	General Hospitalization Nights	Behavioral Health Hospitalization Nights	Emergency Department Visits	Behavioral Health Outpatient Treatment Days	Outpatient Doctor Visits
Healthcare Utilization during the Intervention Period						
Usual Care	47	4.4	2.2	1.2	102.3	6.9
ACWS	44	3.0	2.2	1.2	99.9	9.0
Healthcare Utilization during the Post-Intervention Period						
Usual Care	47	1.5	0.7	0.3	88.2	13.3
ACWS	44	2.5	1.3	0.3	70.5	10.3
Unit Costs ^b		\$2,376	\$1,077	\$3,230	\$34	\$124

Note: The intervention period was 12 months, and the post-intervention period was 12 months. No statistically significant differences were found between Usual Care and ACWS using a two-sided t-test with a *p*-value < 0.05. All data were collected using the modified Economic Form 90.

ACWS = Abstinence Contingent Wage Supplements.

^aIncludes imputed data: all participants included.

^bUnit costs are reported in McCollister et al. (2017) and inflated to 2020 dollars using the consumer price index. The same unit costs were applied healthcare utilization during the intervention and post-intervention periods.

Table 3.

Intervention and Post-Intervention Period Costs

Group	N	Total intervention costs per participant ^a	Intervention period healthcare costs per participant ^b	Total intervention period participant costs ^c	Post-intervention healthcare costs per participant ^b	Total intervention period and post-intervention period costs ^d
Usual Care	47	\$73	\$20,553	\$20,625	\$11,014	\$31,639
ACWS	44	\$11,851 *	\$18,836	\$30,686 *	\$12,252	\$42,938 *

Note: The intervention period was 12 months, and the post-intervention period was 12 months. All costs are based on model-adjusted, predicted values.

ACWS = Abstinence Contingent Wage Supplements

^aIncludes Therapeutic Workplace and, for the ACWS group, ACWS drug testing, management and supplement wage costs presented in Table 1 without model adjustment.

^bTotal healthcare costs are calculated by multiplying healthcare utilization by its corresponding unit cost presented in Table 2.

^cSum of Total intervention costs per participant and Intervention period healthcare costs per participant.

^dSum of Total intervention period participant costs and post-intervention healthcare costs per participant.

* Statistically significant difference between Usual Care and ACWS at z-values < 0.01.

Table 4.

Cost-Effectiveness

Cost-Effectiveness at the End of the Intervention Period (12 Months)

					Intervention costs			Total costs (intervention + healthcare costs over 12 months)		
Group	N	Intervention costs per participant	Participants with a negative drug test ^a	Participants employed ^a	ICER Participants with a negative drug test	ICER Participants employed	Total participant costs	ICER Participants with a negative drug test	ICER Participants employed	ICER
Usual Care	47	\$73	21	9	—	—	\$20,625	—	—	—
ACWS	44	\$11,851**	28	20*	\$1,683	\$1,071	\$30,686**	\$1,437	\$915	\$2,278
Cost-Effectiveness at the End of the Post-Intervention Period (24 Months)										
Usual Care	47	\$73	22	9	—	—	\$31,265	—	—	—
ACWS	44	\$11,851**	20	14	Economically dominated	\$2,356	\$42,654*	Economically dominated		

Note: All costs and outcomes are based on model-adjusted, predicted values.

ACWS = Abstinence Contingent Wage Supplement

ICER = Incremental Cost Effectiveness Ratio

^aNumber of participants are calculated by multiplying the percentage of opiate- and cocaine-negative drug tests or percentage employed by the N for each group.

* Statistically significant difference between Usual Care and ACWS at z-values < 0.05.

** Statistically significant difference between Usual Care and ACWS at z-values < 0.01.

Table 5.

Sensitivity Analysis: Costs and Outcomes without Model-Adjusted Predicted Values

Total Costs (Intervention + Healthcare Costs Over 12 Months)						
Arm	N^a	Total intervention participant costs	Participants with a negative drug test at 12 months	Participants employed at 12 months	ICER participants with a negative drug test at 12 months	ICER participants employed at 12 months
Usual Care	45	\$19,704	18	4	—	—
ACWS	44	\$27,359	29	23	\$738	\$400
Total Costs (Intervention + Healthcare Costs Over 24 Months)						
Arm	N	Total intervention and post-intervention	Participants with a negative drug test at 24 months	Participants employed at 24 months	ICER Participants with a negative drug test at 24 months	ICER Participants employed at 24 months
Usual Care	43	\$28,422	17	9	—	—
ACWS	40	\$40,755	16	13	Economically dominated	\$3,337

Notes:

ACWS = Abstinence Contingent Wage Supplement

ICER = Incremental Cost Effectiveness Ratio

^a Missing assessments are assumed to be zero; participants with no assessments completed in the period are dropped from the analysis.

Table 6.**Intervention Costs Sensitivity Analysis**

Twenty-five percent decrease in intervention costs									
Cost-Effectiveness at the End of the Intervention Period (12 Months)									
					Intervention costs		Total costs (intervention + healthcare costs over 12 months)		
Arm	N	Intervention costs per participant	Participants with a negative drug test^a	Participants employed^a	ICER Participants with a negative drug test	ICER Participants employed	Total participant costs	ICER Participants with a negative drug test	ICER Participants employed
Usual Care	47	\$55	21	9	—	—	\$20,607	—	—
ACWS	44	\$10,622	28	20	\$1,510	\$961	\$29,457	\$1,264	\$805
Cost-Effectiveness at the End of the Post-Intervention Period (24 Months)									
Usual Care	47	\$55	22	9	—	—	\$31,247	—	—
ACWS	44	\$10,622	20	14	Economically dominated	\$2,113	\$41,425	Economically dominated	\$2,036
Twenty-five percent increase in intervention costs									
Cost-Effectiveness at the End of the Intervention Period (12 Months)									
Usual Care	47	\$91	21	9	—	—	\$20,643	—	—
ACWS	44	\$13,080	28	20	\$1,856	\$1,181	\$31,915	\$1,610	\$1,025
Cost-Effectiveness at the End of the Post-Intervention Period (24 Months)									
Usual Care	47	\$91	22	9	—	—	\$31,283	—	—
ACWS	44	\$13,080	20	14	Economically dominated	\$2,598	\$43,883	Economically dominated	\$2,520