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BENEFITS AND COSTS OF SUBSTANCE ABUSE TREATMENT PROGRAMS FOR STATE PRISON INMATES: RESULTS FROM A LIFETIME SIMULATION MODEL

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SUMMARY

Reflecting drug use patterns and criminal justice policies throughout the 1990s and 2000s, prisons hold a disproportionate number of society's drug abusers. Approximately 50% of state prisoners meet the criteria for a diagnosis of drug abuse or dependence, but only 10% receive medically based drug treatment. Because of the link between substance abuse and crime, treating substance abusing and dependent state prisoners while incarcerated has the potential to yield substantial economic benefits. In this paper, we simulate the lifetime costs and benefits of improving prison-based substance abuse treatment and post-release aftercare for a cohort of state prisoners. Our model captures the dynamics of substance abuse as a chronic disease; estimates the benefits of substance abuse treatment over individuals' lifetimes; and tracks the costs of crime and criminal justice costs related to policing, adjudication, and incarceration. We estimate net societal benefits and cost savings to the criminal justice system of the current treatment system and five policy scenarios. We find that four of the five policy scenarios provide positive net societal benefits and cost savings to the criminal justice system relative to the current treatment system. Our study demonstrates the societal gains to improving the drug treatment system for state prisoners.

Keywords

benefits; costs; substance abuse treatment; inmates; simulation

1. INTRODUCTION

Reflecting in part drug use and arrest and incarceration policies in the 1990s and 2000s, a large proportion of state prison inmates abuse substances. In 2004, 32% of prison inmates had used illegal drugs at the time of the offense for which they were incarcerated, 56% had used in the month before the offense, and 53% met diagnostic criteria for recent drug dependence or abuse (Mumola and Karberg, 2006).

Treating substance abuse of incarcerated individuals is important from a societal perspective because inmates who regularly use drugs have higher criminal recidivism rates (Belenko and Peugh, 2005). However, no more than 10% of state inmates report receiving any clinically or medically based substance abuse treatment while incarcerated (Belenko, 2002). Given the high cost of incarceration, the high probability of criminal recidivism following release, and the relatively modest cost of prison-based treatment, investing in effective and targeted substance abuse treatment may make economic sense.

This paper evaluates the costs and benefits of policies that may be directed to a cohort of substance abusing individuals in the state prison system. We focus on state prison inmates for four reasons. First, state correctional systems house about 60% of the nation's inmate population and 88% of the prison population (Harrison and Beck, 2005). Second, relatively little substance abuse treatment is delivered in local jails, where inmates are typically detained for short periods of time with unpredictable release dates (Wilson, 2000; Belenko, 2002). Third, most of the research on correctional treatment and substance abuse-related recidivism has been conducted in state prisons. Thus, most of the available data for model parameters are generated from studies on state prisons. Fourth, the federal prison population includes inmates convicted of federal crimes who are more likely to be non-abusing traffickers than substance abusers and to have very different demographic characteristics than state inmates (Belenko, 2002; Mumola and Karberg, 2006). Focusing on state inmates is thus more relevant for substance abuse and substance abuse treatment policy analyses.

Building on a related study (Zarkin *et al.*, 2005), we develop a lifetime simulation model that captures the episodic and recurrent nature of substance abuse and the multiple episodes of substance abuse treatment, crime commission, and re-incarceration in jail or prison. By modeling the course of individuals over their remaining lifetime, the model accounts for the costs and benefits of substance abuse treatment received in prison and in community-based programs after release compared with an approach based on a static model or using data gathered over only a few years of individuals' lifetimes (e.g., Daley *et al.*, 2004; McCollister *et al.*, 2003a, 2003b, 2004).

Recently, dynamic simulation modeling has been applied to assess criminal justice policies (Auerhahn, 2004, 2008a, 2008b). For example, Auerhahn (2004) applied a dynamic simulation model of the California criminal justice system to assess the impact of a 2000 law that was intended to reduce the number of drug offenders entering prison. The results suggest that the law would not change the proportion of drug offenders in the population. In this paper, we use dynamic simulation methods to assess the degree to which the long-term benefits of providing treatment to incarcerated offenders outweigh the costs of additional treatment. We also show the implications of potential policies that change access to prison treatment and to prison aftercare and that improve the effectiveness of prison treatment.

2. METHODS

2.1. The dynamic simulation model

We developed a discrete event simulation model, a type of Monte Carlo simulation, that follows a nationally representative cohort of individuals who are initially incarcerated in the state prison system in the United States. The model tracks individuals' substance abuse, criminal activity, employment, and health care utilization until death or age 61, whichever comes first, as they move in and out of incarceration and substance abuse treatment programs. Its advantages over alternatives, such as a Markov model, are its flexibility in modeling dynamics, the ability to allow for stochastic variation in behavior and outcomes across people, the functionality of individuals' progression to be affected by their attributes

and history, and the ability to perform individual-level analyses on cumulative lifetime activities.

2.2. Model states

States and transitions between states are structured to allow the model to capture important features of substance abuse, treatment, crime, employment, and health care, while also simplifying reality so that estimates can be computed and validated. All individuals begin the model in state prison. At any given time, individuals in our model are in one of seven mutually exclusive states (Figure 1). Three of the states are for individuals incarcerated in prison or jail: non-abuser, substance abuser not in treatment, and in treatment; the latter state applies only to those in prison because the model assumes that treatment occurs only in prison, and not in jail. The remaining four model states are in the community: non-abuser; substance abuser not in treatment; in aftercare, defined as community-based treatment immediately following prison release; and in community-based treatment but not immediately after prison release. In the model, aftercare treatment is defined as participating in community-based treatment within 1 month following release from prison. It is recognized separately because the literature suggests that it is particularly successful for an offender population (Butzin *et al.*, 2005; Martin *et al.*, 1999; Wexler *et al.*, 1999).

Substance abuse has four categories: alcohol dependence, other drug use excluding infrequent marijuana use, both alcohol dependence and other drug use, and neither alcohol dependence nor drug use. Infrequent marijuana use is excluded because it is associated with fewer negative social consequences than other drugs. The model also separately tracks whether a substance abuser is using opiates. Opiate use is associated with particularly increased health risks, and its treatment options commonly include pharmacological treatments, such as methadone, that are not as readily available for other substances. Because reliable evidence is limited on rates of substance abuse while incarcerated, the dynamics of substance abuse in prison and jail is not modeled. Instead, incarcerated individuals' substance abuse status is based on their substance abuse status in the month before entry into prison or jail. Treatment in prison has two modalities: outpatient drug-free and residential. Community-based treatment has three modalities: outpatient drug free, residential, and methadone maintenance therapy. Individuals are assumed to be non-abusing while in substance abuse treatment.

2.3. Transitions between states

The model simulates life paths based on transitions between the seven states described above and to the terminating death state or age 61. At the end of each month, individuals either remain in the same state or move to another. The likelihood of moving to another state depends either on a transition probability or, in the case of release from prison or exit from treatment, whether the individual has completed a specific length of stay. Many of the model's transition probabilities and lengths of stay are dependent on individual attributes. Primary attributes are age (21–25, 26–35, 36–45, and 46–60 years), race/ethnicity (black, Hispanic, and white/other), and gender. Most transition probabilities are estimated by either logistic (binary parameters) or linear (continuous parameters) regression controlling for age, race/ethnicity, and gender. Predicted values from those logistic and linear regressions were used as parameter inputs for the model; these values varied by age, race/ethnicity, and gender if parameter estimates were significant at the 0.05 level. Other attributes and factors (e.g., substance abuse treatment history) are also included in several parameters, as discussed below.

Key transitions in the model are the initiation and cessation of substance abuse, entry into treatment, length of stay in treatment, and incarceration and release from prison. Table I

summarizes the transitions that occur in the model and the attributes that affect these transitions.

All individuals begin the model in state prison, having already served some portion of their sentence, and they may be reincarcerated to prison or jail after release based on criminal activity. The length of stay of subsequent prison or jail spells depends on the length of the sentence and the percentage of that sentence that the individual will serve, both of which depend on the type of offense for which the individual is incarcerated. The length of stay in jail is typically much shorter than the length of stay in prison.

Although incarcerated, individuals are characterized by their substance abuse status in the last month in the community before incarceration. They may change their substance abuse status starting in the month they are released from prison into the community. The model has separate probabilities of initiating substance abuse for individuals entering the community from incarceration and individuals already in the community. Substance abusers re-entering the community from incarceration without having received treatment in prison have relatively high rates of re-initiation in the first month after release (Butzin *et al.*, 2005). Re-initiation of substance abuse is stratified by age, with younger people being more likely to initiate abuse. Once individuals are abusing substances, the model allows them to stop either with or without treatment. The probability of cessation is higher if a substance abuser receives treatment.

The treatment process in prison and in the community is governed by parameters for the probability of entry into treatment, treatment modality, length of stay, and probability of success. The probability of entry into treatment in prison depends on gender, substance abuse status, and opiate use status; entry into treatment in the community depends solely on treatment history. Modality of prison treatment (outpatient or residential) depends on age, gender, and opiate use status; modality of community treatment (outpatient, residential, or methadone maintenance therapy) depends on age, race/ethnicity, gender, substance abuse status, and opiate use status. Methadone maintenance therapy is intended solely for opiate addiction; thus, the model allows opiate users only to use methadone maintenance therapy.

Treatment is successful if the individual does not resume substance abuse the first month after exiting treatment. Because substance abuse in prison is not explicitly modeled, success of prison treatment is determined only once the individual is released to the community. Because there is little evidence on the relation between length of stay in prison-based treatment and treatment success, treatment success in prison depends only on modality and not on length of stay. However, treatment success in the community depends in part on whether length of stay reaches a specific completion threshold that varies by treatment modality. For example, in outpatient treatment in the community, the threshold is 3 months, based on findings from Hubbard *et al.* (1997) and Simpson (1979).

Crime has three exclusive categories: violent, drug, and non-drug nonviolent ('nonviolent'). Individuals in the community have the opportunity to commit one or more crimes each month. The probability of committing crimes depends on whether a crime was committed in the previous month, the time since last release from prison or jail, substance abuse status, and gender; it is higher for those who committed a crime in the previous month, substance abusers, and men. Our model incorporates different probabilities for committing violent and nonviolent crimes, with a lower probability of committing violent crime. In addition, the propensity to commit either type of crime varies by age as suggested by an extensive criminological literature: crime rates fall as individuals move across the age groups 21–25, 26–35, 36–45, and 46–60 years.

The number of crimes committed depends only on the type of crime being committed and does not vary by individual attributes. With each of these crime types, the model assumes a probability of arrest per crime. The probability of arrest is highest for violent crimes. The probability of arrest for a drug offense depends on time since last release from prison and substance abuse status. With each arrest, there is a probability of incarceration. A percentage of those incarcerated go to jail and the rest go to prison. For simplification, we assumed that the crime, arrest, and incarceration occur in the same month.

The probability of being employed in the community depends on employment in the previous month, substance abuse status, age, gender, and race/ethnicity. For the month that individuals enter the community from prison, the employment probability depends on employment status before incarceration. The probability of employment is higher for men, whites or other races, and those who were working in the previous month. The probability of employment post-release from prison or jail is calibrated to rise smoothly with time and then level out after the first year post-release (Mallik-Kane and Visser, 2008).

For health care other than substance abuse treatment, we modeled the probability of using each of three modalities of care while individuals are in the community: inpatient, outpatient, and emergency department. The probability of health care use depends on gender and substance abuse status. Within each modality, substance abusers have an equal or higher probability of utilization than non-abusers. We also modeled the probabilities of acquiring HIV and then developing AIDS. The probability of acquiring HIV is dependent on race/ethnicity and history of injection drug use.

2.4. Model validation

Internal and external validation are essential for simulation models (Winston, 1994; Law and Kelton, 2000). We internally validated the model by verifying that the programmed model functioned correctly and accurately represented the desired dynamics (Gold *et al.*, 1996).

We externally validated the model by comparing model outputs and estimates to data from sources outside the model. To validate the crime data, we compared re-arrest and re-incarceration rates of the cohort after initial release from prison to recidivism data from the Bureau of Justice Statistics (BJS) on the recidivism of prisoners released in 1994. To validate substance abuse data, we compared the percentage of inmates in our model who were substance abusers before incarceration and who then abused in the first year after release to similar rates predicted from logistic regression outputs in Butzin *et al.* (2002). We also validated substance abuse rates after community treatment by comparing the percentage of community treatment participants using 1 year after treatment in our model to similar rates from the Drug Abuse Treatment Outcomes Study (DATOS) (Simpson *et al.*, 1997). Any deviation between an initial model estimate and its validation data counterpart was incorporated into the model so that the final model estimates closely matched the estimates in the validation data.

2.5. Policy analysis

We conducted five policy scenarios to assess the conditions under which the net benefit is greatest. These scenarios were selected to examine how the model responded to substantive and policy-relevant changes in selected parameters. In Scenario 1, we tripled the probability of receiving prison treatment. In Scenario 2, we increased the effectiveness of prison treatment (and the associated costs) to equal the effectiveness and costs of community-based treatment. In Scenario 3, we quadrupled the probability of receiving aftercare treatment. In Scenario 4, we increased the probability and effectiveness of prison treatment. Scenario 5 builds on Scenario 4 by also increasing the probability of receiving aftercare treatment.

2.6. Computing benefits and costs

We defined lifetime economic benefits as the sum of the present value (PV) of earnings minus the sum of the PV of crime victimization costs, arrest, court, incarceration costs, and health care costs (Zarkin *et al.*, 2005): Lifetime economic benefits = PV of lifetime earnings – (PV of crime victimization costs + PV of arrest, court, and incarceration costs + PV of health care costs). A discount rate of 3% was used for all PV calculations (Gold *et al.*, 1996).

We likewise defined lifetime treatment costs as the sum of the PV of substance abuse treatment costs. These include costs incurred both in prison and in the community. Societal net benefits equal lifetime economic benefits minus lifetime treatment costs. We compared the societal net benefits for each scenario to baseline to identify the most beneficial policy scenario.

We also performed our analysis from the criminal justice system perspective. In this perspective, we included only the costs of prison treatment, aftercare, arrest, court, and incarceration, and we excluded crime victimization costs and individuals' lifetime earnings and lifetime health care costs. We compared the cost savings (relative to baseline) for each scenario to identify the most beneficial policy.

Outcomes with the same parameter settings vary because of the stochastic nature of the model. To ensure that our conclusions on the benefits and costs of treatment are not driven by this randomness, we ran the model with 30 000 individuals. To ensure stability, we report the means from 10 replications of the model for each scenario. We used paired *t*-tests to assess statistical significance between scenarios. We also performed a two-way sensitivity analysis that simultaneously varied in equal steps from baseline the values of two key parameters: the probability of receiving aftercare and the probability of prison treatment success (and its associated costs). We then assessed the degree to which net benefits changed relative to baseline at each step.

2.7. Sensitivity analysis

We conducted sensitivity analyses to assess the robustness of study conclusions to changes in the model parameters. We performed a series of one-way sensitivity analyses of 17 of the most critical model parameters, each at plus and minus 20% of the base value, which is common in the modeling literature (e.g., Hamby, 1995; Earnshaw *et al.*, 2006). The parameters describe substance abuse initiation, cessation, and continued abuse; treatment receipt, success, and cost; and the occurrence and cost of crime, arrest, and incarceration. For each of the alternative values of these parameters, we re-ran the models, re-estimated the incremental net benefits and cost savings of each policy relative to baseline, and paid particular attention to whether the ranking of scenarios as measured by net benefits and cost savings changed.

3. DATA

The model has approximately 2000 parameter values, many of which vary by individual characteristics. The vast majority of parameters were estimated from regression runs or were available from the literature. Several parameter values were not available. In those cases, we hypothesized values for them and calibrated those assumptions to match other data. The parameters are (1) the probability that an individual who uses before an incarceration and does not receive prison treatment resumes use immediately after release (calibrated to match the percentage using 12 months after release from prison from Butzin *et al.* (2002)); (2) the probability of community treatment success (calibrated to match the prevalence of use 12 months after release from community treatment from DATOS (1994)); (3) the monthly

probability of committing a crime (calibrated to match arrest rates from the Recidivism database (1994)); and (4) the probability of employed individuals continuing employment and the probability of unemployed individuals becoming employed in a month (calibrated to match employment rates of inmates just before incarceration from the Survey of Inmates in State Correctional Facilities [SISCF] (2004)).

Table II describes the characteristics of the initial cohort, which is the population of U.S. state prisoners in 2004 aged 21–60 years ($N = 1.14$ million). The weighted estimates are derived from SISCF. The most recent SISCF was conducted by the Bureau of the Census for BJS and comprises surveys of state inmates in 2004 (Mumola and Karberg, 2006).

3.1. Transitions and outcomes

Transition and outcome parameters determine how individuals change states from month to month and determine the outcomes of these transitions when they occur. Table III summarizes the key parameters and their data sources.

Substance abuse data are from SISCF and the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). NESARC is a longitudinal survey with its first wave in 2001–2002 and second wave of the same respondents 3 years later. The survey was conducted by the Bureau of the Census for the National Institute on Alcohol Abuse and Alcoholism. The parameters on initiating substance abuse in the community are from NESARC (we do not explicitly model initiating substance abuse in prison).

The probability of treatment in prison was derived from the proportion of inmates in SISCF who had received treatment while incarcerated. The length of time spent in prison treatment was derived from information on time to complete treatment and the proportion of treatment participants who complete treatment (Florida Department of Corrections, 2005).

Butzin *et al.* (2002) estimate the probability of success of in-prison treatment and the probability of stopping substance abuse among those who entered prison as substance abusers but did not go to treatment. Butzin *et al.* assessed participants for substance abuse 1 year after release. Because we model transitions on a monthly basis, we calibrated Butzin *et al.*'s 1-year estimate to its monthly equivalent.

Five data sets provide parameters for community-based treatment: NESARC, the Treatment Episode Data Set (TEDS), DATOS, the National Treatment Improvement Evaluation Study (NTIES), and the National Survey on Drug Use and Health (NSDUH). TEDS contains data on substance abuse treatment admissions, mostly to publicly funded treatment providers. DATOS collected data from 1991 to 1993 on typical community-based treatment programs to examine treatment effectiveness and included interviews with clients at 96 treatment programs in 11 mid-size and large cities. NTIES includes data from 1992 to 1997 on 78 treatment programs. The mid-1990s was the last time that large-scale data collection occurred in community-based substance abuse treatment programs. NSDUH is an annual national survey sponsored by the Substance Abuse and Mental Health Services Administration that serves as one of the primary sources of information on illicit drug and alcohol use among the civilian, noninstitutionalized U.S. population.

We used NESARC to obtain the monthly probability of entering treatment in the community by converting treatment transitions between waves 1 and 2 into monthly treatment transition probabilities. Conditional upon entering community treatment, we used TEDS to estimate the probability of entering each treatment modality. DATOS gives distributions of lengths of stay in each modality of community treatment. We derived a minimum length of stay that would be considered completion of treatment from Hubbard *et al.* (1997) and Simpson *et al.*

(1997). The probability of restarting substance abuse following community treatment is calibrated so that the proportion of treatment participants using substances 1 year after release matches the rate observed in DATOS.

The majority of criminal justice-related parameters come from SISCF and the Recidivism of Prisoners released in 1994 (the Recidivism database), both from BJS. The Recidivism database comprises the officially recorded criminal history of 38 624 prisoners in 15 states. Since the states included represent two-thirds of released prisoners in 1994, the Recidivism sample is the largest source of such data for released prisoners.

The number of crimes committed depends on (1) the probability of committing a crime and (2) the number of crimes committed conditional on committing a crime. The monthly probability of committing a crime cannot be calculated directly. We derive it indirectly from the probability of rearrest by month since release from prison, the clearance rate from the Uniform Crime Report (FBI, 2005) and the offense frequency from the second RAND inmate survey (Chaiken and Chaiken, 1982). The number of crimes committed conditional on committing a crime is determined by a distribution based on the RAND inmate survey. The probability of arrest after release from prison is based on analyses using the Recidivism database. Employment probabilities used SISCF data; employment transitions were based on findings from Mallik-Kane and Visser (2008).

3.2. Unit costs

Most of our unit costs are available directly from the literature (Table IV). All economic inputs were updated to 2009 dollars using the Consumer Price Index. Treatment costs are from a number of sources that depend on modality and setting; for example, the cost of in-prison residential treatment is from McCollister and French (2002).

Crime costs are from Miller *et al.* (1996). The cost of crime from the societal perspective is estimated separately by crime type. Violent crime is the most expensive, followed by nonviolent crime. The cost of a violent crime is the weighted average of victimization costs for fatal crimes, child abuse, rape/sexual assault, other assault, and robbery. The cost of a nonviolent crime is the weighted average of victimization costs for drunk driving, arson, larceny, burglary, and motor vehicle theft. The cost per victimization includes medical care, mental health care, police and fire response to crime, social services and victim services, property loss or damage, and lost victim productivity. Our victimization costs are very conservative because they do not include any value for pain and suffering. Drug crime is assumed to have zero social cost; it is viewed as a transfer in society with no direct victim costs.

Arrest costs are calculated from Cohen *et al.* (1994) and Durose and Langan (2004). Cohen *et al.* provide the costs of the various components associated with an arrest: investigation and arrest, booking, pretrial jail, arraignment, sentencing, and trial. Each of these components of the criminal justice process following an arrest are weighted by the probability that they occur for a given crime type. For example, fewer nonviolent and drug arrests go to trial, so trial costs are weighted less heavily in these arrest costs than in arrest costs for violent crimes. The most expensive type of arrest is for violent crime, followed by drug and nonviolent.

The monthly costs of incarceration come from BJS sources. The monthly operating cost of prisons comes from Stephan (2004). The average monthly cost of jail is derived by combining total corrections costs at the local level from Justice Expenditures and Employment Extract Series (BJS, 2006) and the number of persons in the jail system from Harrison and Beck (2005).

Health care costs in prison or jail are included in the monthly prison or jail costs. People with HIV/AIDS have higher health care costs than people without HIV/AIDS. Legal monthly earnings are the median wage for the month prior to incarceration in SISCf. Earnings depend on being employed, are stratified by substance abuse status, and are higher for non-abusers.

4. RESULTS

Table V presents the results of the lifetime outcomes for the baseline model and the five policy scenarios. The first four rows show how the key model settings – probability of prison treatment, probability of aftercare, cost per month of prison treatment, and probability of prison treatment success – change across the five scenarios. The first column of those settings shows the baseline values of these parameters; the probability of success (and associated cost) of prison treatment in Scenarios 2, 4, and 5 are higher than in the baseline and are similar to the success (and costs) of community-based treatment.

The percentage and the total number of the 1.14 million state prison cohort that goes to prison and community-based treatment change as expected in response to policies designed to improve treatment utilization and outcomes. For example, Scenario 1 (greater access to prison treatment) increases the percentage of substance abusers who go to treatment in prison over the course of a lifetime from 19 to 44%, which corresponds to an almost fourfold increase in the total years of prison treatment for the prison cohort. Because an increase in the number of prison treatment participants increases the number of individuals who go into aftercare upon release, Scenario 1 also leads to a 5% increase in total years of community-based treatment. Scenarios 3 (greater access to aftercare) and 5 (greater access to more effective prison treatment and greater access to aftercare) likewise increase the number of years in a lifetime spent in aftercare and community treatment. Compared with the baseline, years in community treatment increase by 31 and 94%, respectively.

Of the prisoners in our nationally representative state prison cohort, 85% abuse substances at least once in their lifetimes in the baseline and other scenarios (not presented in the table). The percentage of months in the community that individuals abuse substances decreases from 38% in the baseline to 31% in Scenario 5, a 19% decrease (see Table V).

Turning to the crime results, the baseline percentages of the cohort that commit a crime (73%), are arrested (68%), and are re-incarcerated (61%) are substantial. Although these percentages change very little across the scenarios, we do find important differences in the per-person number of crimes committed (conditional on committing crimes), number of arrests (conditional on being arrested), and number of re-incarcerations (conditional on being re-incarcerated). The net effect of these changes is that substantial differences arise in total arrests, crimes, and re-incarcerations for the entire cohort. For example, comparing Scenario 5 to baseline shows a 17% reduction in the number of crimes committed, a 16% reduction in the number of arrests, and a 16% reduction in the number of re-incarcerations. Although the per-person employment outcomes in Table V change relatively little across the scenarios, compared with the baseline, total years of employment in Scenario 5 are 10% higher.

Table VI presents the benefits and costs of the baseline and the five policy scenarios for the U.S. state prison cohort. Total lifetime earnings (discounted) at baseline are \$114 billion (approximately \$100 471 per person in the state prison cohort). Crime victimization costs are \$66 billion (\$58 023 per person in the cohort), and arrest, court, and incarceration costs are substantially larger, with a baseline mean of \$257 billion (\$226 008 per person); total baseline health care costs in the community are approximately \$30 billion (\$25 988 per

person). Recall that earnings and health care costs only accrue while individuals are in the community and that the majority of the initial cohort is re-incarcerated in their lifetime.

Total lifetime treatment costs for the U.S. state prison cohort at baseline are \$1.1 billion (\$2694 per participant), which includes \$0.6 billion for aftercare treatment (\$2061 per participant), \$0.2 billion for other community-based treatment (\$2102 per participant), and \$0.3 billion for prison-based treatment (\$1502 per participant). Health care, crime victimization, arrest, court, and incarceration costs are larger than earnings. Therefore, the net economic benefits per person are negative for all scenarios, including baseline.

With the exception of greater access to prison treatment (Scenario 1), earnings increase and the costs of crime victimizations and arrests, courts, and incarcerations decrease for all the scenarios, which leads to increased total lifetime economic benefits for the U.S. state prison cohort. At the same time, the total costs of treatment increase. Overall, the increase in benefits across the scenarios relative to baseline outweighs the increase in costs, which leads to an increase in societal net benefits for all scenarios. The increase in net benefits in Scenario 5 relative to baseline is the largest, at \$38.7 billion. This increase is statistically significant from baseline and Scenarios 1 through 3 ($p < 0.01$), but it is not significantly different from the net benefits increase in Scenario 4.

Table VI also shows the cost savings of the policies from the criminal justice system perspective, which includes arrest, court, incarceration costs, prison treatment costs, and aftercare costs. The increased treatment costs of greater access to prison treatment alone (Scenario 1) outweigh the resulting reductions in costs to the criminal justice system, although the change in criminal justice system costs relative to baseline is not statistically significant. All other policies result in cost savings to the criminal justice system. More effective prison treatment (Scenario 2) and greater access to aftercare (Scenario 3) provide roughly similar cost savings to the criminal justice system (\$5 to \$6 billion) and are both significantly different from baseline ($p < 0.01$). From the criminal justice system perspective, the savings over baseline are the greatest for Scenarios 4 and 5 (\$16 to \$17 billion). As with societal net benefits, the cost savings for Scenario 5 are also significantly greater than for all other policies, except for Scenario 4.

The one-way sensitivity analyses showed that our conclusions were robust over the tested ranges. Specifically, for all tested values of the 17 parameters that were varied, Scenarios 4 and 5 had the highest net benefits, followed by 2 and 3, then Scenario 1 and baseline. In about one-third of the analyses, the ranking within each of those three groupings (Scenarios 4/5, 2/3, and 1/baseline) was switched from what was observed in the base case. This is not surprising given that the net benefits within those groupings were not statistically different. In addition, analyses that varied cost parameters resulted in the largest differences in incremental net benefits versus baseline, yet the rankings between policies were unchanged. Similar robustness was found for the cost savings sensitivity analyses for the criminal justice system.

The results of the two-way sensitivity analysis are shown in Table VII. The table describes the increase in net benefits relative to baseline under each of 20 combinations of the probability of receiving aftercare (columns) and the probability of prison treatment success (rows). The maximum value of the prison treatment success is the success rate for community-based treatment, and the maximum value for the probability of aftercare is the value assumed in Scenarios 3 and 5. Because improved treatment success requires additional treatment resources, treatment costs increase proportionately with the probability of treatment success. Moving across a row or down a column shows the change in net benefits as one parameter changes, holding the other parameter constant; moving diagonally in the

table shows the change in net benefits as the two parameters change. Jointly increasing the probabilities of success and aftercare receipt yields gains in net benefits, with the increase in net benefits reaching an asymptote of about \$.30 billion at approximately 75% of the maximum values of each parameter.

5. DISCUSSION

In 2004, the state prison system held approximately 1.32 million people, and this number rose slightly to 1.41 million in 2008 (Sabol *et al.*, 2009). Approximately 50% of state prisoners meet the criteria for a diagnosis of drug abuse or dependence (Chandler *et al.*, 2009), but only 10% receive clinically or medically based substance abuse treatment while incarcerated (Belenko and Peugh, 2005). Treating substance abusing state prisoners while incarcerated has the potential to yield substantial public health and economic benefits (Chandler *et al.*, 2009).

This paper simulates the lifetime costs and benefits of various programs to enhance substance abuse treatment for a cohort of 1.14 million state prisoners (those of the 1.32 million who are between age 21 and 60). Our model captures the dynamics of substance abuse as a chronic disease; estimates the benefits of treatment over individuals' lifetimes; tracks the costs of crime and criminal justice costs related to policing, adjudication, and incarceration; and accounts for differences in age, gender, race/ethnicity, drug use history, treatment history, and criminal history. The model thus serves as a powerful tool to help guide decision making.

Our results clearly demonstrate positive net benefits to society and the criminal justice system (as measured by cost-savings) of enhancing in-prison substance abuse treatment and community-based prison treatment aftercare. Except for greater access to the current prison treatment system, all other scenarios yield significant societal incremental net benefits relative to baseline (which captures the status quo). As noted in the literature (Knight *et al.*, 1996; Inciardi *et al.*, 1997), the current prison treatment system has only limited success for reducing substance abuse without the addition of aftercare following release from prison, which is also captured in our analysis. The largest increments to net benefits from baseline are for two scenarios: (1) greater access to more effective prison treatment and (2) greater access to more effective prison treatment and greater access to aftercare. Note that the latter scenario yields only a small positive incremental effect relative to the former scenario because greater treatment success associated with more effective prison treatment means less of an opportunity for aftercare to have a beneficial effect. As noted above, there is no statistically significant difference between these scenarios, and neither model dominates the other as a preferred choice.

Our results from the criminal justice system perspective mirror those from the societal perspective. All scenarios except increasing access to current prison treatment yield cost savings relative to baseline. Greater access to more effective prison treatment, and greater access to more effective prison treatment and greater access to aftercare yield the largest cost savings. The criminal justice system results are particularly noteworthy because they show that increased spending on more effective treatment and greater access to aftercare result in cost-savings overall to the criminal justice system. These savings are driven by reductions in crimes committed, which translate into lower policing, adjudication, and incarceration costs. Importantly, these are conservative estimates of the cost savings to the criminal justice system (although perhaps politically more realistic) because they assume that aftercare costs are paid by the criminal justice system.

Our approach also demonstrates the value of following individuals over a lifetime rather than over a shorter period of time. For example, we re-ran our model and the five scenarios assuming that we tracked individuals for only 1-year post-release from their initial incarceration. We compared the net benefits in the truncated model to those obtained from our lifetime model. We found that the incremental net benefits of the policy scenarios (relative to baseline) were 14 to 50 times larger in the lifetime simulation model than in the truncated model.

Our paper has two limitations that are common to simulation models. First, the structure of the model represents a simplified version of reality. For example, the specific process of how incarcerated individuals get into prison treatment and aftercare is not included in our model. Although this detail is needed in practice to move individuals in and out of treatment, it is not required for our core purpose of estimating the costs and benefits of treatment interventions for incarcerated individuals. We made other simplifications that future work may want to address, including stopping at age 60, not including the possibility of an increased overdose risk among newly released prison inmates (e.g., Binswanger *et al.*, 2007), and not including unobserved heterogeneity that may exist once we control for observed differences across people, such as potential unobserved heterogeneity of the propensity to respond to treatment.

Second, even with a simplified model structure, several parameter values are not available in the literature or in existing databases, or, if they were available, the data sources were not current. In those cases, we assumed values for model parameters and then validated selected model outcomes with values available in the literature or in databases.

Despite these limitations, our model demonstrates the benefits and costs of enhancing prison treatment and aftercare for a cohort of individuals incarcerated in state prison. Future work should seek to refine our policy scenarios and evaluate scenarios that are the most policy-relevant to decision makers. In addition, our model can and should be implemented for specific states and other locales. To be the most useful for policymakers, this effort will draw on location-specific information, such as costs, the prison treatment and aftercare system, and criminal behavior. A challenge for the corrections and treatment fields will be expanding access to more effective treatment using consensus principles of effective treatment for offenders during and after incarceration (NIDA, 2006).

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Figure 1.

States of the dynamic model. *Individuals in our model do not abuse drugs or abuse alcohol while incarcerated. They are instead attributed Substance Abuser or Non-abuser status the month before entry into prison or jail. That status is updated on release into the community. **State is only relevant for individuals in prison and not for individuals in jail, as the model assumes that treatment is not offered in jail. [†]Aftercare is treatment in the community that begins immediately after release from incarceration.

Table I

Transitions that determine substance abuse, incarceration, and treatment

Time point at which transition occurs	Model transition	Attributes by which transition varies	Transition result	Next state
Incarceration start	How long will the individual be incarcerated?	Type of offense	(Incarceration sentence)×(% of sentence to serve)	Incarcerated (until end of incarceration period)
	[Substance abusers only] Receive treatment during prison?	Gender, opiate use status	Yes	Incarcerated (same state; treatment occurs at the end of prison stay)
			No	Incarcerated (same state)
Prison treatment start	How long will the individual stay in treatment?	Modality of treatment	Treatment length of stay	Incarcerated (same state)
End of incarceration	[Substance abusers only] Start treatment upon entering community?	Whether treatment received in prison	Yes	In treatment (aftercare)
			No	Non-abuser or substance abuser (in community)
	Start or resume substance abuse upon entering community?	No stratification	Yes	Substance abuser (in community)
Monthly in community			No	Non-abuser (in community)
	[Non-abusers only] Start or resume substance abuse?	Age	Yes	Substance abuser
			No	Non-abuser (same state)
	Incarcerated? (after committing crime and arrest)	Substance abuse, gender, age, and race/ethnicity	Yes	Incarcerated, same substance abuse status
			No	Same state
	[Substance abusers only] Stop substance abuse?	Age	Yes	Non-abuser
	[Substance abusers only] Start treatment?	Treatment initiation depends on treatment history. Modality depends on age, gender, race/ethnicity and opiate status	Yes	In treatment
End of community treatment episode			No	Substance abuser (same state)
	Was treatment successful?	Treatment completion status	Yes	Non-abuser
Start of community treatment episode	How long will the individual stay in treatment?	Modality of treatment	Treatment length of stay	In treatment (same state)

Table IIInitial characteristics of state prison cohort, ages 21–60 ($N = 1.14$ million)

Characteristics	Value
Demographics (%)	
Age 21–25	18.5
Age 26–35	34.1
Age 36–45	31.9
Age 46–60	15.5
Black, non-Hispanic	40.7
Hispanic	18.2
Non-Black, non-Hispanic	41.1
Female	6.9
Male	93.1
Criminal history	
Ever incarcerated for a drug offense (%)	13.0
Ever incarcerated for nonviolent offense (%)	29.6
Ever incarcerated for a violent offense (%)	15.0
Mean number of arrests prior to start of model	5.1
Recent substance abuse before initial incarceration (%; exclusive categories) ^a	
Only used drugs	39.9
Only alcohol dependent	6.7
Both used drugs and alcohol dependent	15.4
Neither used drugs nor alcohol dependent	38.0
Recent opiate and injection drug use before incarceration (%; exclusive categories)	
Injected drugs in period prior to initial incarceration (for drug users)	22.4
Used opiates in period prior to initial incarceration (for drug users)	15.2
Treatment (%)	
Ever had substance abuse treatment	29.6

Source: These represent weighted estimates from the Survey of Inmates in State Correctional Facilities (U.S. Department of Justice, 2004).

^aRecent drug use is in the month before incarceration; recent alcohol dependence is in the year before incarceration.

Table III

Parameter sources

Parameter	Source
Substance abuse	
Probability inmate is a substance abuser at start of model (%)	SISCF (U.S. Department of Justice, 2004)
Probability non-abuser initiates substance abuse (%/month)	NESARC (Grant <i>et al.</i> , 2003; Grant and Kaplan, 2005)
Probability substance abuser ceases abuse without treatment (%/month)	NESARC (Grant <i>et al.</i> , 2003; Grant and Kaplan, 2005)
Probability substance abuser starts opiates/starts injecting (%/month)	NESARC (Grant <i>et al.</i> , 2003; Grant and Kaplan, 2005)
Treatment	
Prison treatment	
Probability substance abuser enters prison treatment (%)	SISCF (U.S. Department of Justice, 2004)
Probability prison treatment is successful (%)	Butzin <i>et al.</i> , 2002
Community treatment	
Probability substance abuser enters community treatment (%/month)	NESARC (Grant <i>et al.</i> , 2003; Grant and Kaplan, 2005), TEDS (U.S. Department of Health and Human Services, 2005)
Probability substance abuser enters community treatment immediately after release from prison	NSDUH (U.S. Department of Health and Human Services, 2002–2007)
Probability substance abuser completes community treatment	DATOS (Hubbard <i>et al.</i> , 1997; Simpson <i>et al.</i> , 1997)
Probability community treatment is successful	NTIES (U.S. Department of Health and Human Services, 1992–1997)
Crime and criminal justice	
Probability individual commits crime after release from prison	RPR94 (U.S. Department of Justice, 1994)
Number of crimes committed per month	RAND inmate survey (Chaiken and Chaiken 1982)
Probability individual is arrested for crimes committed	UCR (FBI, 2005) and RPR94 (U.S. Department of Justice, 1994)
Probability individual is incarcerated following arrest	RPR94 (U.S. Department of Justice, 1994)
Probability incarceration is to prison or to jail	RPR94 (U.S. Department of Justice, 1994)
Distribution of length of jail sentences	RPR94 (U.S. Department of Justice, 1994)
Distribution of length of prison sentences	SISCF (U.S. Department of Justice, 2004)
Employment	
Probability individual is employed (%/month)	Returning home (Mallik-Kane and Visser, 2008); SISCF (U.S. Department of Justice, 2004)
Health and health care	
Probability individual uses health care services (%/month)	NTIES (U.S. Department of Health and Human Services, 1992–1997)
Probability individual acquires HIV (%/month)	Hall <i>et al.</i> (2008); Brady <i>et al.</i> (2008)
Probability HIV-positive individual develops AIDS (%/month)	CDC (2008)

SISCF, Survey of Inmates in State Correctional Facilities, 2004; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; TEDS, Treatment Episode Data Set; NSDUH, National Survey on Drug Use and Health (2002, 2003, 2004, 2005, 2006, 2007); NTIES, National Treatment Improvement Evaluation Study; RPR94, Recidivism of Prisoners Released in 1994; UCR, Uniform Crime Report.

Table IV

Unit costs (January 2009\$)

	Value	Source
Treatment		
Treatment in prison (per month)		
Outpatient drug free	117	Michigan Department of Corrections (2001)
Residential/therapeutic community	300	McCollister and French (2002)
Treatment in community (per month)		
Methadone maintenance therapy	406	ADSS Cost Study (SAMHSA, 2003)
Outpatient drug free	361	ADSS Cost Study (SAMHSA, 2003)
Residential/therapeutic community	2446	ADSS Cost Study (SAMHSA, 2003)
Crime and criminal justice		
Crime (per crime)		
Nonviolent offense	1598	Miller <i>et al.</i> (1996)
Violent offense	7029	Miller <i>et al.</i> (1996)
Arrest (per arrest)		
Drug offense	7136	Cohen <i>et al.</i> (1994); Durose and Langan (2004)
Nonviolent offense	7043	Cohen <i>et al.</i> (1994); Durose and Langan (2004)
Violent offense	10 114	Cohen <i>et al.</i> (1994); Durose and Langan (2004)
Jail (per month incarcerated)	2395	Bureau of Justice Statistics (2006)
Prison (per month incarcerated)	1989	Stephan (2004)
Employment		
Earnings (per month employed)		
Non-abuser	1509	SISCF (U.S. Department of Justice, 2004)
Substance abuser	1229	SISCF (U.S. Department of Justice, 2004)
Health and health care		
Use of inpatient services (per visit)		
Non-abuser	9131	French and Martin (1996)
Substance abuser	12 254	French and Martin (1996)
Use of outpatient services (per visit)	117	French and Martin (1996)
Use of emergency department (per visit)	316	Williams (1996)
Use of health care in prison (per month)	261	Stephan (2004)
Treating individual with HIV (not AIDS) (per month)	2576	Schackman <i>et al.</i> (2006)
Treating individual with AIDS (per month)	3695	Schackman <i>et al.</i> (2006)

Table V

Model settings and lifetime outcomes from baseline and policy scenarios for the 2004 state prison cohort^a

	Baseline	Greater access to prison treatment Scenario 1	More effective prison treatment Scenario 2	Greater access to aftercare Scenario 3	Greater access to more effective prison treatment Scenario 4	Greater access to more effective prison treatment and greater access to aftercare Scenario 5
Model settings						
Probability of treatment in prison (%) ^b	12–31	35–93			35–93	35–93
Probability of aftercare for prison treatment participants (%)	20.9			80		80
Cost per month of prison treatment (outpatient/residential)	\$117/\$300		\$361/\$2446		\$361/\$2446	\$361/\$2446
Probability of success of prison treatment (outpatient/residential) (%)	8.6/11.0		40/50		40/50	40/50
Prison treatment						
Percentage of substance abusers who receive prison treatment	18.6	43.9	18.6	18.6	44.1	43.8
Total years spent in prison treatment per prison treatment participant	0.6	0.8	0.6	0.6	0.7	0.7
Total years spent in prison treatment (1000s)	44.0	162.3	39.4	40.3	129.8	126.7
Community treatment						
Percentage of substance abusers who receive community treatment including aftercare	33.6	35.3	32.4	40.5	32.4	52.0
Total years spent in community treatment per community treatment participant	0.5	0.5	0.5	0.5	0.5	0.5
Total years spent in community treatment (1000s)	40.9	42.9	39.6	53.6	38.5	79.5
Substance abuse						
Percentage of months in the community as a substance abuser	38.2	37.8	36.1	36.5	31.7	31.1
Crime and criminal justice system						
Percentage committed a crime	73.4	73.3	73.0	73.3	71.5	71.9
Percentage arrested	67.5	67.4	67.0	67.3	65.1	65.4
Percentage re-incarcerated	61.0	60.8	60.3	60.7	58.0	58.4
Number of crimes per person, if committed crimes	61.5	61.7	58.6	58.8	53.2	52.2
Number of arrests per person, if arrested	5.8	5.8	5.6	5.6	5.1	5.0
Number of re-incarcerations per person, if re-incarcerated	3.6	3.7	3.5	3.5	3.3	3.2
Total number of crimes committed (1 000 000s)	51.4	51.4	48.7	49.0	43.3	42.7
Total number of arrests (1 000 000s)	4.5	4.5	4.3	4.3	3.8	3.8

	Baseline	Greater access to prison treatment Scenario 1	More effective prison treatment Scenario 2	Greater access to aftercare Scenario 3	Greater access to more effective prison treatment Scenario 4	Greater access to more effective prison treatment and greater access to aftercare Scenario 5
Total number of re-incarcerations (1 000 000s)	2.5	2.5	2.4	2.4	2.2	2.1
Employment						
Total years of employment per person	8.8	8.9	9.1	9.1	9.7	9.7
Total years of employment (1 000 000s)	9.6	9.6	9.9	9.8	10.5	10.6

^aReported outcomes are means across 10 replications; each replication includes 30 000 individuals weighted to represent the 2004 state prison population ages 21–60.

^bSpecific probabilities of treatment in prison vary by gender, substance abuse status, and use of opiates. Numbers in table represent the range of these probabilities.

Table VI

Benefits and costs of treatment (in \$ billions)

	Baseline	Greater access to prison treatment Scenario 1	More effective prison treatment Scenario 2	Greater access to aftercare Scenario 3	Greater access to more effective prison treatment Scenario 4	Greater access to more effective prison treatment and greater access to aftercare Scenario 5
Earnings	\$114.3	\$115.1	\$118.1	\$117.4	\$125.5	\$126.4
Crime victimization costs ^a	\$66.0	\$66.0	\$62.9	\$63.2	\$56.4	\$55.8
Arrest, court, and incarceration costs	\$257.2	\$256.9	\$250.0	\$250.9	\$235.9	\$234.2
Health care costs	\$29.6	\$29.8	\$30.0	\$30.0	\$30.1	\$30.2
Total lifetime economic benefits ^b	\$238.8	\$237.8	\$225.2	\$227.0	\$197.3	\$194.2
Community treatment						
Aftercare	\$0.6	\$0.6	\$0.6	\$0.8	\$0.6	\$1.3
Other community treatment	\$0.2	\$0.3	\$0.2	\$0.2	\$0.2	\$0.3
Prison treatment	\$0.3	\$0.8	\$1.9	\$0.3	\$5.5	\$5.4
Total lifetime treatment costs	\$1.1	\$1.7	\$2.8	\$1.3	\$6.3	\$6.9
Societal perspective						
Net benefits ^c	\$239.9	\$239.5	\$227.9*	\$228.4*	\$203.6*	\$201.1*
Net benefits vs baseline ^d	—	\$0.4	\$11.9	\$11.5	\$36.3	\$38.7
Criminal justice system perspective						
Total criminal justice system costs ^e	\$258.1	\$258.3	\$252.6*	\$252.0*	\$241.9*	\$240.9*
Total criminal justice system cost savings vs baseline ^f	—	\$0.2	\$5.5	\$6.0	\$16.1	\$17.1

* Significantly different from baseline at the 0.01 level.

^a Crime victimization costs exclude costs of pain and suffering.

^b Total lifetime economic benefits = PV of earnings - PV of crime victimization costs - PV of arrest, court, incarceration costs - PV of health care costs.

^c Societal Net benefits = Total lifetime economic benefits - Total lifetime treatment costs.

^d Net benefits vs baseline = Net benefits for each scenario - Baseline net benefits.

^e Total criminal justice system costs = Arrest, court, and incarceration costs + Prison treatment costs + Aftercare costs.

^f Total criminal justice system cost savings vs baseline = Baseline total criminal justice system costs - Total criminal justice system costs for each scenario.

Table VII

Two-way sensitivity analysis

Change in net benefits (absolute difference vs baseline, billions)				
Probability of receiving aftercare (%)^a (Outpatient/inpatient)	Probability of prison treatment success (%)			
	20.9^b	40.0	60.0	80.0
8.6/11.0 ^b	\$0.00	\$0.12	\$0.27	\$0.29
16.5/20.8	\$0.09	\$0.21	\$0.26	\$0.31
24.3/30.5	\$0.18	\$0.25	\$0.30	\$0.31
32.2/40.3	\$0.32	\$0.29	\$0.30	\$0.31
40.0/50.0	\$0.33	\$0.34	\$0.32	\$0.34

^a As probability of success increases, cost per month also increases accordingly.

^b Parameter values used in baseline.