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Dynamics in the costs of criminality among opioid dependent individuals

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Abstract

Background—Research into the avoided crime-related costs associated with methadone maintenance treatment (MMT) is sparse. Our objective was to characterize the dynamics in crime-related costs associated with MMT effectiveness among opioid dependent individuals in Vancouver, Canada.

Methods—We considered individuals enrolled in a prospective study between December, 2011 and May, 2013. Monthly crime-related costs (2013 CAD) were derived from self-reported criminal activity. On the basis of MMT receipt and illicit opioid use, individuals were classified in mutually exclusive health states: (i) MMT high effectiveness; (ii) MMT low effectiveness; (iii) opioid abstinence; or (iv) relapse. We classified individuals as daily, non-daily or non-stimulant users and controlled for demographic and socio-economic characteristics. A two-part multiple regression model was constructed; the first part modeled non-zero cost probability, the second estimated the level of costs. Avoided costs were estimated for each health state and stratified by stimulant use intensity.

Results—Our study included 982 individuals (median age 47, 38% female) for 2232 observations. Individuals on MMT with high effectiveness incurred lower monthly costs of criminality (avoided costs of \$6298; 95% C.I. (\$1578, \$11,017)), as did opioid abstinent individuals (\$6563 (\$1564, \$11,561)). Avoided costs for daily stimulant users were greater than for non-daily users, both for individuals on MMT with high effectiveness (\$12,975 vs. \$4125) and opioid abstinent (\$12,640 vs. \$4814).

Conclusion—Using longitudinal data on individuals with a history of MMT, we found substantially lower costs of criminality associated with high effect to MMT. Avoided costs were

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Contributors

BN designed the study. EK managed the literature searches, summaries of previous related work, undertook the statistical analysis, and wrote the first draft of the manuscript. TK, JM and EW led the studies on which the analysis was based and provided critical input into the design and interpretation of results. All authors have approved the final manuscript.

Conflict of interest statement

Dr. Julio Montaner has received grants from Abbott, Biolytical, Boehringer Ingelheim, Bristol-Myers Squibb, Gilead Sciences, Janssen, Merck and ViiV Healthcare.

highest among daily stimulant users that were on MMT with high effectiveness or those opioid abstinent.

Keywords

Methadone maintenance treatment; Opioid use; Stimulant use; Treatment outcomes; Relapse; Costs of criminality

1. Introduction

Illicit drugs have been estimated to impose a \$10.2 billion annual societal cost in Canada (\$291 per capita), with law-enforcement costs representing the largest share (\$2.9 billion; \$83 per capita) of the direct burden (Rehm et al, 2007). In the US, the annual societal costs are estimated to be \$223 billion (\$707 per capita), with criminal justice costs representing the largest share (\$71.0 billion; \$225 per capita) of the direct societal costs of illicit drug use (National Drug Intelligence Center, 2011). In 2012, the US Federal government enacted drug control spending of \$26.3 billion with more than 51% (\$13.5 billion) for domestic law enforcement and interdiction of illegal drug use (ONDCP, 2013).

Substance abuse treatment (SAT) has been identified as a direct method of reducing crime-related costs of substance use disorders (SUD; Prendergast et al., 2002). Opioid substitution treatment (OST) with methadone is the most common treatment modality for opioid dependence and methadone maintenance treatment (MMT) has a long history of associated decline in criminal activity (Marsch, 1998; Prendergast et al., 2002). Comprehensive literature reviews of cost-benefit and cost-effectiveness analyses for opioid dependence treatment by Schwartz et al. (2014) as well as Doran (2008) find that studies which include criminal activity consistently find benefits outweighing the costs. Estimates of the economic benefits of avoided crime, i.e., costs that would have otherwise been incurred if the crimes had taken place, are essential to inform optimal use of scarce resources.

Nevertheless, research into the crime-related cost dynamics associated with MMT effectiveness and illicit opioid abstinence is sparse (Chisholm et al, 2006; Doran, 2008). Using a cost-of-illness methodology with 114 illicit opioid users not in treatment, Wall et al. (2000) estimated an average annual law enforcement and victimization societal burden of \$53,054 for untreated opioid dependence. Crime-related costs have also been accounted for in cost-effectiveness analyses of different forms of OST. Dijkgraaf et al. (2005) found a 12-month cost of criminality reduction of \$51,303 per individual receiving medical co-prescription of heroin compared to MMT, and Nosyk et al. (2012) found a 12-month cost of criminality reduction of \$29,902 per individual receiving diacetylmorphine versus methadone, with both studies being conducted in a limited duration randomized control trial setting. All costs presented in 2013 CAD.

Perhaps more importantly, however, none of the reviewed studies provided estimates of crime-related costs associated with the cyclical longitudinal patterns of chronic continued drug use, treatment, relapse and full abstinence (Bell et al., 2006; Bovasso and Cacciola, 2003; Dobler-Mikola et al., 2005; Galai et al., 2003; Hser et al., 2007; Nosyk et al., 2013, 2009; Termorshuizen et al., 2005). Furthermore, while self-reported crime is common,

opioid dependent individuals are infrequently arrested (French et al., 2000; Nurco, 1998; Schwartz et al., 2006, 2007); therefore estimates of the costs of criminality must be based on criminal acts perpetrated rather than only on those recorded by police services. While deriving costs from every incident committed will accurately capture the societal benefit of avoided crime, these immediate benefits will not be realized as reductions in law enforcement expenditures in the short-term. However, these cost reductions could result in a medium to long-term decrease of the proportion of public funding allocated to law enforcement due to illicit drugs.

Therefore, our objective was to characterize from a societal perspective the avoided crime-related costs associated with opioid abstinence and MMT effectiveness among opioid dependent individuals with varying degrees of concurrent use of other illicit substances (e.g., crack, powder cocaine).

2. Methods

2.1. Study design and subjects

Data for this analysis were derived from a series of ongoing open prospective cohort studies involving illicit drug users, including the At-Risk Youth Study (ARYS), the AIDS Care Cohort to evaluate Exposure to Survival Services (ACCESS), and the Vancouver Injection Drug Users Study (VIDUS). The VIDUS study began enrollment in May 1996 and recruits individuals through word of mouth, street out-reach, and referrals. The original VIDUS cohort was divided into two separate studies in 2005: VIDUS now follows HIV-negative individuals and its sister study ACCESS follows HIV-positive drug users (Strathdee et al., 1997; Wood et al., 2009). ARYS began in late 2005 and is made up of street-involved youth who report use of drugs other than or in addition to cannabis and are aged 14–26 (Wood et al., 2006a,b).

Sampling and follow-up methodologies have been described in detail previously and were identical to allow for merged analyses (Strathdee et al., 1997; Tyndall et al., 2003; Wood et al., 2006a,b). At baseline, individuals complete an interviewer-administered questionnaire and individuals received \$20 CAD for each visit. All studies have been approved by the University of British Columbia/Providence Health Care Research Ethics Board.

Items assessing self-reported criminal activity, arrests and charges in the past month were first added to the follow-up study instrument for the cohort studies in November, 2011. We considered baseline data captured between March 2005 and December, 2012, with a maximum of three assessments conducted at six month intervals between December, 2011 and May, 2013. All individuals who completed at least one follow-up interview during this period and had ever accessed MMT at baseline or during follow-up assessments were eligible for inclusion. Individuals were excluded if their baseline assessment was missing.

2.2. The costs of criminal activity

The primary dependent variable considered in this analysis is composed of direct and indirect costs of criminal activity incurred during the previous 30 days. Costs were calculated from a societal perspective, which include costs for the criminal justice system as

well as for victimization but did not include crime career opportunity costs or intangible costs. We adhered to best practice guidelines for the conduct of economic analysis (Garrison et al., 2010) and included costs regardless of who incurred them or whether they corresponded to budgetary expenditures. We used a comprehensive methodology motivated by McCollister et al. (2010), which uses most current costs to build on Rajkumar and French (1997). A set of eight categories of self-reported criminal activity was multiplied by unit costs and all costs are adjusted for inflation and presented in 2013 CAD (see Supplementary material for details).

Justice system costs—Justice costs are composed of resources dedicated to policing, court proceedings as well as the correctional system. Total policing expenditures include arrest as well as incident-based unit costs. Only the cost of arrest is included for drug dealing and sex work involvement, consistent with the methodology used by Dijkgraaf et al. (2005). Crime category specific costs for arrest cases and court cases were used. Corrections costs are composed of a per-case processing cost as well as daily costs for days spent incarcerated. We updated unit costs of arrests, court proceedings and incarceration presented by Wall et al. (2000).

Victimization costs—Unit costs of victimization from McCollister et al. (2010) were used and take into account medical expenses, cash losses, property theft and victimization-related consequences. Our data does not allow us details as to the specific nature of the capital offense being self-reported and we therefore assumed victimization costs for those reports as if they were assaults. It is argued that drug dealing and sex work can be viewed as a transfer with no direct victimization costs (Rajkumar and French, 1997; Zarkin et al., 2012), therefore, most of the criminal incidents in our study with victimization costs are income-related property crimes (99.2%). Our survey does not allow us to distinguish between incidents within this category; consequently we assign victimization costs probabilistically combining Vancouver Police Department (VPD) and Statistics Canada's General Social Survey (GSS) on victimization data.

To ensure representativeness of our results, and to correct for potentially incorrect responses, we choose an appropriately conservative approach excluding the top 2% of non-zero derived cost observations from our analysis.

2.3. Independent variables

We were primarily interested in assessing the benefits associated with MMT effectiveness on the costs of criminal activity. An effective maintenance dose will block the euphoric effects of opioids so we defined health states according to the intended benefit of reduction or cessation of opioids use (College of Physicians and Surgeons of British Columbia, 2014). Consequently, on the basis of both self-reported MMT receipt at assessment and illicit opioid use in the past six months, participants were classified as being in one of four mutually exclusive health states: (i) on MMT with high effectiveness (defined as current MMT receipt and no illicit opioid use in the last six months); (ii) on MMT with low effectiveness (defined as current MMT receipt with illicit opioid use in the last six months); (iii) opioid abstinence (defined as no current MMT receipt and no illicit opioid use in the

last six months); or (iv) in relapse (defined as no current MMT receipt with illicit opioid use in the last six months).

We hypothesized that other individual-specific fixed and time-varying effects were potentially associated with both intensity of criminal activity and MMT receipt (Bukten et al., 2013; DeBeck et al., 2007). Aside from vital demographic characteristics and socio-economic characteristics, we accounted for the intensity of concurrent stimulant use in the last six months and classified individuals as daily users, non-daily users or non-users. As path-dependence of criminal careers are likely to be strong predictors of current criminal activity (Bayer et al., 2009; Glaeser et al., 1996; Nurco, 1998), we also included baseline indicators of criminality.

Time-varying covariates included current unstable housing situation, as well as indicators of a recent episode of homelessness or of recent employment, both in the previous six months.

2.4. Statistical analysis

A two-part multiple regression model, or hurdle model, estimated using generalized linear modeling (GLM), was constructed to account for excess zeroes and skewness in criminal cost data. The first part modeled the probability of having a non-zero cost using a logit model specification while the second part estimated the level of non-zero costs that occurred, using a Gamma distribution and log link. In the second stage, modified Park tests were executed to determine the appropriateness of the distributional family used. We accounted for within-individual correlation of the error terms and estimated robust (Huber–White) standard errors.

Finally, average marginal effects (AME) for both stages of the models were derived for each health state compared to the referent category, which in our case are individuals classified as in relapse. It is important to note that the predicted AME are for the entire sample, as opposed to being based on the conditional sample of individuals with non-zero costs and that effects are averaged across all individuals. We subsequently estimated AME on crime-related costs associated with each health state stratified by stimulant use intensity.

2.5. Sensitivity analysis

We considered three modifications to determine the robustness of our results. First, we executed the analysis according to a third-party payer perspective, whereby only costs borne by the criminal justice system are considered. Second, we used a more conservative approach disregarding incident-based costs and conducted the analysis considering only costs imposed by arrests and court proceedings. Third, we conducted the analysis with the sub-population who had completed all three follow-up surveys for which they were eligible to determine if our results were robust to the potential confounding effects associated with missing a follow-up assessment.

Statistical analyses were executed in SAS version 9.3 and Stata version 13.1.

3. Results

3.1. Summary statistics

1568 individuals were considered and the 982 individuals that met the study inclusion criteria of having a history of MMT had a median age of 47, 37.7% were female and 76.5% had baseline assessments prior to 2007. Further characteristics are presented in Table 1. Our study was comprised of 2232 observations and prevalence of drugs use at time of follow-up is provided in Fig. 1.

The crime-related total cost outcome was most frequently equal to zero (84.7%), while no criminal activity was reported in 80.0% of all observations (details of unit costs and self-reported incidents are provided in the Supplementary material). Among non-zero crime-related cost observations the mean was \$19,535 (standard deviation (SD): \$56,813) with the criminal justice system portion representing \$17,682 (90.2% of mean total derived costs). In comparison the median total costs among non-zero observations was \$1364 (Interquartile range (IQR): \$1364–\$6228) and the 99th percentile was \$295,281.

3.2. Two-part regression analysis

The estimated crime-related costs of current health states are presented in Table 2 and Fig. 2, as are the avoided costs amounts and percentages when compared to relapse (full regression results are provided in the Supplementary material). Reductions in monthly costs of criminality were associated with both periods of MMT with high effectiveness (avoided costs of \$6298; 95% confidence interval (\$1578, \$11,017)) and opioid abstinence (\$6563 (\$1564, \$11,561)) when compared to individuals in relapse. Individuals on MMT with low effectiveness incurred criminal costs that were not statistically different compared to individuals in relapse.

When stratified by stimulant use intensity, estimated avoided costs for daily users were greater than for non-daily users, both during periods of MMT with high effectiveness (\$12,975 [–\$1446, \$27,396] vs. \$4125 [\$698, \$7553]) and opioid abstinence (\$12,640 [–\$1476, \$26,755] vs. \$4184 [\$1247, \$8382]). For individuals reporting no stimulant use, costs of criminality were not statistically different between periods of opioid abstinence or episodes in MMT with either high or low effectiveness, and relapse. Additionally, criminal costs for individuals in MMT with low effectiveness were not statistically different from individuals in relapse regardless of stimulant use intensity.

Perhaps more importantly, given the context-dependence of crime-related cost levels and stimulant use intensity, is the fact that avoided costs in percentage terms are fairly stable within the health states of MMT with high effectiveness and opioid abstinence, regardless of the variation in amounts across stimulant users. Periods of MMT with high effectiveness for all individuals are associated with 83.4% avoided costs and daily and non-daily stimulant users are, respectively, associated with 86.7% and 84.6% avoided costs. Results were comparable for opioid abstinent individuals. While avoided costs for stimulant non-users were not statistically different from zero, avoided costs in percentage terms differed substantially within health states.

3.3. Sensitivity analysis

Results of the sensitivity analyses are presented in Table 3. First, in the third-party payer scenario, both MMT with high effectiveness and opioid abstinence remained associated with statistically significant cost reductions. Second, when using our more conservative costing approach with arrests only as well as court proceedings, again both MMT with high effectiveness and opioid abstinence remained associated with statistically significant cost reductions. Lastly, when we conducted our analysis with a balanced panel our findings remained robust.

4. Discussion

4.1. Findings

Using data based on individuals with a history of MMT from ongoing open prospective cohort studies involving illicit drug users, we found crime-related cost reductions associated with periods of MMT with high effectiveness or opioid abstinence whereas MMT with low effectiveness was not associated with any difference in costs compared to relapse. When stratified by stimulant use intensity, avoided crime-related costs were greater for daily stimulant users than for non-daily stimulant users both for MMT with high effectiveness or opioid abstinence, while cost reductions for individuals reporting no stimulant use were not statistically different from relapse regardless of the health state.

4.2. Implications

Evidence on longitudinal patterns of MMT utilization suggests that recovery from illicit opioid abuse is characterized by recurrent periods of OST use, relapse and abstinence (Bell et al, 2006; Nosyk et al., 2009). Consequently, characterizing crime-related cost reductions associated with each of these mutually exclusive health states is critical for future economic modeling efforts in OST. Relapse has been characterized as a regularly observed step that does not preclude later sustained abstinence, and subsequent periods of abstinence are found to be successively longer (Nosyk et al., 2013); therefore while crime-related costs associated with low effectiveness were not statistically different from relapse, a finding confirmed elsewhere (Oliver et al., 2010), continued access to MMT for individuals with an episode of low effectiveness can be crucial for long-term avoided costs. As an example, for an existing program with similar MMT treatment policies and distribution of outcomes as in our study, using a hypothetical baseline of \$5000 in monthly crime-related costs for relapsed individuals, our results suggest associated criminal cost avoidance of \$3.5 million (2013 CAD) per 100 treated individuals annually.

Furthermore, our results highlight the importance of accounting for concurrent stimulant use to accurately characterize the avoided crime-related costs associated with OST. Our results of greater avoided costs given higher intensity of stimulant use are consistent with findings of increased criminal activity being associated with the intensity of illicit drug use as well as polydrug use (Best et al., 2001; Collins et al., 1985; Miller and Gold, 1994; Stewart et al., 2000). Dual cocaine-opioid use can be effectively treated with OST (Castells et al., 2009) and our result emphasize the importance of taking into consideration concurrent stimulant use intensity for accurate avoided cost estimates associated with MMT.

The importance of accurately recognizing all OST costs and benefits is further heightened by the changing U.S. policy landscape. In 2011, more than 50% of the 465,467 opioid-related treatment admissions reported no health insurance (Substance Abuse and Mental Health Services Administration, 2013); and the number of admissions into treatment should increase under the Affordable Care Act (ACA), which now requires insurers to treat substance use disorders (SUDs) in the same way they would any other chronic disease. A Canadian perspective may provide a degree of insight into the possible influence of these changes. While costing methodologies differed, Canadian direct health care costs of illicit drug use were said to be \$40 per capita (Rehm et al, 2007; 2013 CAD) while in the US, in an era preceding the ACA, they were \$34 per capita (National Drug Intelligence Center, 2011; 2013 CAD). With direct health care costs related to illicit drug use likely to increase under the ACA, there would be an additional \$1.8 billion (2013 CAD) of illicit drug use related health resource utilization if the per capita burden in the US was to reach Canadian levels. Notwithstanding that treatment escalation will increase direct health resource utilization, it has already been shown in California under Proposition 36 that offering SAT to nonviolent drug offenders rather than incarcerating them is cost-saving; additional drug treatment costs are more than offset by the avoided costs of incarceration (Anglin et al., 2013). Moreover, cost reductions associated with crime avoidance have the potential in the medium to long-term to reduce the share of public funds enacted for drug control, consequently alleviating the total societal burden of SUDs. Simulation models that include multiple episodes of treatment have shown considerably higher health and economic benefits than costs (Nosyket al., 2012; Zarkin et al., 2005).

4.3. Limitations

This analysis has several limitations. First, while our analysis was based on cohort studies involving illicit drug users, given the characteristics of our study population, the nature of the health-care and MMT delivery policies in BC, caution must be exercised in applying these estimates to other settings. Second, our health state classifications relied on relatively coarse measures of current exposure to MMT and concurrent illicit opioid use in the past six months. While assessments classified as MMT with high effectiveness, opioid abstinence and relapse were unlikely to be misclassified, we could not adequately characterize the influence of varying degrees of adherence for MMT with low effectiveness and concurrent illicit opioid use associated with criminal activity. Third, we attempted to address potential treatment selectivity issues by using an inclusion criterion based on a history of MMT, as opposed to being treatment naïve, to control for the possible correlation between seeking treatment and the pro-social behavior of committing fewer crimes. While we may not have controlled for all selection bias, the magnitudes of our results are comparable to those found in limited duration randomized control trial settings (Dijkgraaf et al., 2005; Nosyk et al., 2012). To our knowledge, given the characteristics of our data and the nature of our estimation specification, controlling for unmeasured confounding by using each individual as their own control (i.e., a fixed effects specification for the two-part model) is not currently accessible given standard statistical packages. We therefore conducted an alternative sensitivity analysis for only the second part of our model using the log of non-zero crime-related costs in a linear specification that allowed us to control for individual fixed effects. Details are provided as Supplementary material¹. Results were robust in

direction and statistical significance, and although the absolute magnitude of crime-related costs was smaller, the estimated percentages of avoided crime-related costs were similar to the findings we report. This additional analysis suggests that while the individual-level heterogeneity present in our findings influences the magnitude of our estimates, the relative effects appear to be robust. Fourth, given the 2% outlier cutoff being arbitrary, we conducted sensitivity analysis on the full sample. The results from the first part of the model were robust to the inclusion of outliers but the estimates for the level of non-zero costs are no longer significant when outliers are included.

Moreover, assessing individual levels of criminal activity must rely on self-reported measures as these are only observed by the individuals in question. Self-reports can be affected by a range of response biases, including those specific to impression management and recall. Research has shown that recall of justice history over the prior six months is relatively accurate and that the magnitude of underreporting is roughly equal to that of over-reporting for several measures (Johnson et al., 2005). Finally, one of the most frequently raised issues of self-reported data is the reliability of disclosure given the ad hoc nature of data collection (Johnson and Golub, 2007), a concern mitigated by the fact that the average length of involvement with these ongoing cohort studies is 5.4 years.

4.4. Conclusions

Our results demonstrate that characterizing the avoided crime-related costs associated with the different OST states of opioid abstinence, MMT receipt with either high or low effectiveness and relapse periods is essential, and how controlling for concurrent stimulant use can benefit economic modeling efforts to inform policy and resource allocation decisions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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¹Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi:....

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.drugalcdep.2014.09.007>.

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Fig. 1.

Observed health states at time of follow-up assessment for the 982 individuals included in our study, as well as the prevalence of drug use in each respective health state. Mutually exclusive health states are: (i) MMT with high effectiveness (current MMT receipt and no illicit opioid use in the last six months); (ii) MMT with low effectiveness (defined as current MMT receipt with illicit opioid use in the last six months); (iii) opioid abstinence (defined as no current MMT receipt and no illicit opioid use in the last six months); or (iv) relapse (defined as no current MMT receipt with illicit opioid use in the last six months). [†]Drugs

considered for polydrug use categorization were hard drugs only, defined for our purposes as heroin, crack, cocaine, crystal methamphetamine or combination of. ‡ Heavy alcohol use is defined as consuming more than 4 drinks each day.

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Fig. 2.

Monthly crime-related costs (top panel), monthly avoided costs when compared to relapse (middle panel) and monthly avoided cost percentages when compared to relapse (bottom panel) were estimated from average marginal effects (AME) derived from a two-part multiple regression model. Results presented are for each mutually exclusive health state for all individuals (2232 observations) as well as stratified by stimulant use intensity (672 observations for daily stimulant users; 887 observations for non-daily stimulant users; 673 observations for stimulant non-users). Each point (middle panel) represents the estimated avoided costs and the error bars represent the 95% confidence interval for each point. Points where the confidence interval does not include \$0 reflect statistically significant amounts equivalent to those associated with a p -value < 0.05 . Mutually exclusive health states are: (i) MMT with high effectiveness (current MMT receipt and no illicit opioid use in the last six months); (ii) MMT with low effectiveness (defined as current MMT receipt with illicit opioid use in the last six months); (iii) opioid abstinence (defined as no current MMT receipt and no illicit opioid use in the last six months); or (iv) relapse (defined as no current MMT receipt with illicit opioid use in the last six months).

Table 1Individual characteristics at baseline assessment ($N = 982$).

	<i>N</i>	(%)
Female gender	370	(37.7)
Age		
<25	98	(10.0)
25–35	183	(18.6)
35–45	372	(37.9)
>45	329	(33.5)
Completed high school	470	(47.9)
Aboriginal	302	(30.8)
White	635	(64.7)
Born in Canada	355	(36.2)
Ever been homeless	834	(84.9)
Ever overdosed	541	(55.1)
Ever been in any treatment	841	(85.6)
Ever been in MMT	737	(75.1)
In MMT at baseline assessment	492	(50.1)
Length of MMT history		
<1 Year	134	(13.6)
1–5 Years	187	(19.0)
>5 Years	165	(16.8)
Have been in MMT more than once	257	(26.1)
Ever had mental illness diagnosed	471	(48.0)
Ever been in jail	842	(85.7)
Have been in jail and/or prison >5 times	512	(52.1)
Have served a sentence >5 years	105	(10.7)
HIV Positive	332	(33.8)
Ever been on ART	311	(31.7)
Cohort		
ACCESS	332	(33.8)
VIDUS	571	(58.2)
ARYS	79	(8.0)
Year of baseline assessment		
2005	55	(5.6)
2006	556	(56.6)
2007	131	(13.3)
2008	72	(7.3)
2009 or later	168	(17.1)
Follow-up surveys completed during study period		
1	198	(20.2)
2	254	(25.9)

	<i>N</i>	(%)
3	530	(54.0)
Missed a scheduled survey during study period	435	(44.3)

ART: antiretroviral therapy. ACCESS: AIDS Care Cohort to evaluate Exposure to Survival Services. VIDUS: Vancouver Injection Drug Users Study. ARYS: At-Risk Youth Study.

Monthly costs estimated from average marginal effects (AME)¹ derived from a two-part multiple regression model² using participants from the ACCESS, VIDUS and ARYS cohort studies (2013 CAD).

Table 2

Crime-related costs			Avoided costs		%
	Amount	[95% C.I.] ³	Amount	[95% C.I.] ³	
All Individuals (2232 observations)					
Health state:					
Relapse	\$7552***		Referent health state		
Opioid abstinence	\$989*			\$6563**	\$1564, \$11,561
MMT high effectiveness	\$1254***			\$6298**	\$1578, \$11,017
MMT low effectiveness	\$3985***			\$3566	[-\$1118, \$8250]
Daily stimulant users (672 observations)					
Health state:					
Relapse	\$14,970***		Referent health state		
Opioid abstinence	\$2330			\$12,640*	[-\$1476, \$26,755]
MMT high effectiveness	\$1995**			\$12,975*	[-\$1446, \$27,396]
MMT low effectiveness	\$6607***			\$8363	[-\$5399, \$22,126]
Non-daily stimulant users (887 observations)					
Health state:					
Relapse	\$4877***		Referent health state		
Opioid abstinence	\$62			\$4814***	\$1247, \$8382
MMT high effectiveness	\$751***			\$4125**	\$698, \$7553
MMT low effectiveness	\$3995***			\$882	[-\$2934, \$4697]
Stimulant non-users (673 observations)					
Health state:					
Relapse	\$802*		Referent health state		
Opioid abstinence	\$689			\$113	[-\$948, \$1175]
MMT high effectiveness	\$533**			\$269	[-\$563, \$1101]

Crime-related costs		Avoided costs	
	Amount [95% C.I.] ³	Amount [95% C.I.] ³	%
MMT low effectiveness	\$560	[-\$127, \$1247]	30.2
			[-\$659, \$1144]

ACCESS: AIDS Care Cohort to evaluate Exposure to Survival Services. VIDUS: Vancouver Injection Drug Users Study. ARYS: At-Risk Youth Study.

¹ AME are the average of the estimated marginal effect for each participant in the respective sample.

² First part of the model included covariates for stimulant use intensity, gender, age, recent homelessness, chronic incarceration and juvenile detention. Second part of the model included covariates for stimulant use intensity, gender, recent housing instability, recent employment and whether the participant had skipped a scheduled survey. Stratified estimations did not include stimulant use intensity indicators.

³ Confidence intervals were derived using the delta method which relies on a first-order Taylor series expansion.

* *p*-Value <0.10
** *p*-value <0.05
*** *p*-value<0.01.

Table 3

Sensitivity analysis for estimated avoided costs when compared to the referent health state of relapse (2013 CAD)[‡].

Health state	Monthly avoided costs [95% C.I.]			
	(1) Baseline [‡]	(2) Third party	(3) Arrests & charges	(4) Balanced panel
Full sample (2232 observations)				
Health state:				
Relapse	Referent health state			
Opioid abstinence	\$6563 ^{**}	[\$1564, \$11,561]	\$5859 ^{****}	[\$1539, \$10,178]
			\$312 ^{**}	[\$6, \$618]
MMT high effectiveness	\$6298 ^{***}	[\$1578, \$11,017]	\$5551 ^{****}	[\$1449, \$9654]
			\$386 ^{****}	[\$178, \$595]
MMT low effectiveness	\$3566	[-\$1118, \$8250]	\$3223	[-\$902, \$7347]
			\$19	[-\$242, \$280]
Incident-based costs	Yes	Yes	No	Yes
Criminal justice system costs	Yes	Yes	Yes	Yes
Arrest costs only	No	No	Yes	No
Victimization costs	Yes	No	No	Yes

* p -Value <0.10

** p -value <0.05

*** p -value <0.01.

[‡] All costs estimated from average marginal effects derived from a two-part multiple regression model.

[‡] Refers to estimates presented in Table 2.