SOCIAL COSTS OF UNTREATED OPIOID DEPENDENCE

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ABSTRACT Using cost-of-illness methodology applied to a comprehensive survey of 114 daily opiate users not currently in or seeking treatment for their addiction, we estimated the 1996 social costs of untreated opioid dependence in Toronto (Ontario, Canada). The survey collected data on social and demographic characteristics, drug use history, physical and mental health status, the use of health care and substance treatment services, drug use modality and sex-related risks of infectious diseases, sources of income, as well as criminality and involvement with the law enforcement system. The annual social cost generated by this sample, calculated at Canadian $5.086 million, is explained mostly by crime victimization (44.6%) and law enforcement (42.4%), followed by productivity losses (7.0%) and the utilization of health care (6.1%). Applying the $13,100 cost to the estimated 8,000 to 13,000 users and 2.456 million residents living in Toronto yields a range of social cost between $43 and $69 per capita.

KEY WORDS Cost of illness, Illicit drugs, Opioid dependence.

INTRODUCTION

Illicit drug use imposes a substantial burden on Canadian society from the utilization of scarce public sector and personal resources, from the effect of crime

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on its victims (i.e., crime victimization), from productivity losses, and from drug-related morbidity and premature mortality, which impairs the well-being of users and affected individuals.[1-3] Cost-of-illness methodology applied to epidemiologic and administrative data (i.e., top-down analysis[4]) estimates the 1992 social cost of all illicit drug use in Canada at $1.4 billion ($48 per capita or 0.20% of the gross domestic product [GDP])[5] and at $489 million in Ontario ($46 per capita or 0.17% of gross domestic product).[6]

While providing valuable insight into the overall economic burden of illicit drug use, top-down analyses typically

- include only costs compiled by clinical and administrative information systems (e.g., law enforcement expenditures, but not the broader social costs of crime victimization)
- cannot distinguish the harm of specific psychoactive substances (e.g., opioids)
- have limited relevance to the subpopulations generating the greatest social harm (e.g., those dependent on vs. all users of opioids)
- include both the hidden population of untreated users and those in treatment

Similarly, bottom-up estimates of the social costs reported by clients entering treatment (and especially those in therapy) may underestimate the economic burden generated by the hidden population of untreated opioid users to the extent that these diverted or self-selected individuals are healthier, avoid risky drug injection and sex practices, and are better integrated into mainstream society (i.e., stable housing, greater support, more paid work, less criminal activity).

Although the prevalence of lifetime heroin use in the Province of Ontario (Canada) remains low (1.1% during 1996),[7] it is associated with disproportionately high health and social problems. In Vancouver (British Columbia, Canada), over-dosing on narcotics has become the leading cause of death among young adults, while the injection of drugs is a leading risk factor of new cases of human immunodeficiency virus (HIV) and viral hepatitis infections.[8] In Toronto (Ontario, Canada), the percentage of drug-related deaths involving heroin has stabilized at 37%.[9] Heroin-related mortality of 2 per 100,000 residents is comparable to the rate in Minneapolis/St. Paul, Minnesota, but is less than that in Detroit, Michigan, and Philadelphia, Pennsylvania. Through its interrelationship with crime, home-lessness, and concurrent mental disorders, dependence on opioids (i.e., natural opiates and substances of synthetic origin) generates substantial social harm.[8-10]

To inform better the debate on the social harm of untreated opioid dependence, we estimated the economic burden for Toronto using cost-of-illness methodology

applied to data derived from a recent survey of a sample of daily users of natural (opiates) and synthetic origin opioids who were not receiving or seeking treatment. Although cost-of-illness estimates inform policymaking that is concerned with the allocation of health care resources across competing needs and they are used in decision-analysis modeling the cost-effectiveness of alternative interventions, the unique contribution of this bottom-up analysis is the understanding gained about the distribution of the economic burden across health care, law enforcement, and other components of the social harm of opioid dependence.

An assessment of the social harm of untreated opioid dependence needs to consider four dimensions: harm to physical health, harm to mental health, intermediate-level harm to personal and social relationships, and broader harm determined by societal and cultural reaction to drug use.[23] These dimensions identify key sources and components of the social cost of illicit substance use. In considering substance abuse as a chronic health condition, it is important to distinguish between the harm of single-occasion use versus the progressive damage derived from chronic untreated dependence. An effective intervention reduces harm in one or more domains.

Direct physical harm mostly arises from isolated events of opioid overdoses, with minimal damage occurring from long-term use. Social costs are generated from the use of health care services, impaired quality of life, and loss of economic productivity. Over the longer term, however, treatment for opioid dependence (and concurrent addictions) may be obtained from public or private agencies.

Hazardous behaviors that impair mental functioning place users and others at risk of harm from accidents in the home, workplace, roadway, and places of recreation. Such events may require health care and law enforcement interventions, impair quality of life, cause death, and reduce economic productivity.

Substantial personal and social harm occurs from infections (HIV, viral hepatitis) from sharing needles and unsafe sex practices. Aside from the high cost of health care and social services, impaired quality of life, and the loss of economic activity, substantial out-of-pocket expenses and support from volunteer agencies may be incurred. Intermediate-level harm from isolated disruption of family and workplace disruptions and longer term impairment of social and economic relationships place users and their victims at risk of injury and social isolation. The user's lifestyle stresses personal relationships. Aside from mental health effects on users and their families (e.g., depression) from living within the illegal drug culture, the breakdown of personal relationships from these stresses imposes financial and other hardships that may require help from relatives and public agencies. These wider harms may have substantial implications for the use of

health and social services, law enforcement, impaired quality of life, and loss of economic activity.

Finally, wider social- and cultural-level harm is incurred from criminal and informal sanctions for drug-related infractions. Depending on the degree that use is criminalized, the costs to the legal system (police, court, and corrections) can be high. Moreover, loss of time from productive activities during periods of incarceration may be high. Also, welfare, public housing, and other social support resources are employed to compensate for the loss of family income. Substantial social harm is caused by the social and cultural response to opioid use. For single-occasion use, criminal controls and sanctions are potentially strong responses to charges for drug-related crimes. Continuing opioid use increases the risk of arrest and, for repeat offenders, the severity of punishment. Engaging in criminal careers diverts users from engaging in productive (legal) economic activities. Convicted users face stigmatization and discrimination that limits their ability to (re)enter the formal economy. To the extent that opioid use and possession are prosecuted strongly and crimes are committed to purchase drugs, the stigma of being labeled a user and the implications of a criminal record ensure a continuing cycle of social harm.

Although the effect on others and the wider social and cultural harm bearing on users are important, we lack the data to measure, to value, and to attribute these costs to opioid use. Therefore, in this analysis, we focused more narrowly on the social costs of the health care, criminality, and productivity implications of untreated dependence.

There are a number of methodological issues that analysts must consider when estimating the social costs of untreated opioid dependence. These include identifying, measuring, and valuing health care and other resources consumed by drug users, assigning monetary value to foregone economic production from drug-related morbidity and premature mortality, and quantifying the link between drug use and social costs. In our analysis, the recommendations of the international guidelines for estimating the social costs of substance abuse[11] and the national standards for calculating the cost of health care services[12] were followed.

Although the identification, measurement, and valuation of the consumption of social resources are straightforward conceptually, the accuracy and comprehensiveness of analysis are limited to the data used. Population-based data sources are convenient, but important items are omitted, and the findings may not generalize to certain subgroups (e.g., dependent opioid users). Of particular importance for illicit substance use is that the cost of criminal activity compiled

by law enforcement information system is underestimated by the omission of the costs of crime victimization.[13-15] Secondary analysis of survey data, however comprehensive, must also consider methodological issues and data limitations.

The controversy over the inclusion of out-of-pocket expenditures made by the victims of crime and the human capital estimate of productivity losses is particularly important, but the continuing debate offers little concrete guidance to analysts. The handling of stolen property in economic analysis is controversial, with methods and empirical publications taking opposing positions.[15-25] For example, the recent bottom-up National Treatment Outcome Research Study (NTORS) excluded productivity losses, but used the net (i.e., uncompensated) out-of-pocket expense to households and gross losses to retailers to estimate the lower bound of the victim costs of property crime.[25] Similarly, the recent publication of *The Economic Costs of Alcohol and Drug Abuse in the United States, 1992,*[16] continues the debate on the merits of human capital.[15,26-29]

As for most cost-of-illness studies, the traditional human capital approach[4] was used to estimate productivity losses from opioid-related morbidity and premature mortality. As the human capital assumes labor market equilibrium, full employment, and nonreplacement of individuals lost to the labor force—a situation typically not describing the circumstances of most opioid users[15]—the more recent friction-cost method provides a more conservative estimate.[30] However, to the extent that the labor market conditions and social interventions enhance the employability (participation, retention, wage) of the disadvantaged, both of these methods may understate the potential productivity loss.

Finally, calculating the proportion of social costs attributable to opioid dependence can be problematic. In contrast to top-down cost-of-illness studies, which use global attributable fractions estimated from epidemiological data, these comprehensive survey data support a more precise analysis. The low participation rate of opioid users in the formal economy, however, raises concerns about the estimation of the time lost to productive activity. In particular, what proportion of these respondents (and the target population) likely will enter into and remain in the formal economy? Similarly, uncertainty exists about the expected reduction in the days that psychoactive substances are used.

METHODS

A recent survey[31] provides a rare opportunity to estimate the economic burden to society of untreated opioid dependence. By the very nature of trying to track individuals engaging in this illegal activity, no formal sampling frame exits for contacting all untreated illicit opioid users in Toronto. Thus, an advertising

campaign using flyers posted at needle exchanges and social service agencies was used to recruit subjects. Participants were asked to tell other users about the survey. Given the context of this population, the flyer/snowball recruitment method is the best possible approach that, in spite of its limitation, has demonstrated a high degree of representativeness for hidden populations.[32–34]

The sample (n = 114) was interviewed between June 1996 and March 1997. Eligibility criteria were that subjects had to be daily opiate users currently not in or seeking treatment. Qualified subjects were invited to participate in a one-on-one anonymous and confidential interview after providing informed consent. Subjects were paid for partaking in the interview of closed- and open-ended questions.

The survey collected data on demographic and socioeconomic characteristics, drug use history, physical and mental health status, use of health care and drug treatment services, modality of drug use, risks of infectious diseases, sources of income, as well as criminality and involvement with the law enforcement system (see Table I for overview and Table II for selected characteristics). Most subjects had a fairly long history of opiate use, had been unemployed or underemployed, and did not have stable living arrangements. The main sources of income were illegal activities and social benefits. Subjects typically used different forms of natural and synthetic opioids, as well as a wide variety of other licit and illicit drugs daily, most of which were purchased from illegal markets. Most respondents injected their drugs and did so multiple times per day. Many subjects reported both physical and mental health problems, as well as frequent utilization of the health care system for these and other drug-related problems. Although few HIV infections were reported, a considerable number of subjects recounted engaging in unsafe sex and hazardous injection techniques over the past year. The majority of subjects had been in drug treatment before, many of them more than once. Finally, about half of the sample had been arrested for criminal offenses, half had spent some time in prison, and half were under some form of criminal justice supervision in the past year.

Analysis was concerned with estimating the total economic burden of the study sample of untreated (dependent) opioid users. As such, the sum of the economic activities reported by the respondents was used to estimate social cost (see Activity in Table I). Cost was calculated as the product of reported activity over 12 months multiplied by the corresponding unit cost and adjusted for the proportion attributable to opioid dependence. Table I summarizes the survey data used to estimate the social costs. Economic data are reported by component and source (cost-item). Data derived from a 30-day recall period were deemed

TABLE I Summary of Survey Responses by Cost Component and Source

	Recall Period/Measure	n	Activity	Median	Mean	SD	T$_{MEAN}$	LL	UL	Active, %
Health Care										
Inpatient care	12 months:									
Physical health										
admissions		114	99	0	0.87	2.91	0.32	0.15	0.53	33
days		114	677	0	5.94	18.62	1.65	0.72	2.88	33
Mental health										
admissions		114	21	0	0.18	0.56	0.04	0.01	0.09	14
days		114	60	0	0.53	2.27	0.11	0.02	0.23	14
Emergency care	12 months:									
Physical health										
visits		114	301	1	2.64	6.74	1.39	0.90	1.97	62
Mental health										
visits		114	22	0	0.19	1.24	0.02	0.00	0.06	4
Outpatient care	12 months:									
Physical health										
visits		114	120	0	1.05	4.84	0.24	0.07	0.48	18
Mental health										
visits		114	0	0	0.00	0.00	0.00	0.00	0.00	0
Substance abuse treatment	12 months:									
Institution treatment days	Annualized days	106	358	0	3.38	10.40	0.86	0.31	1.60	21
Residential treatment days	Annualized events	110	233	0	2.12	6.27	0.58	0.22	1.05	22
Outpatient counselling days	Annualized days	110	58	0	0.52	3.10	0.07	0.00	0.19	9
Methadone treatment days	Annualized days	110	224	0	2.04	16.39	0.21	0.00	0.61	14
Medical care	12 months:									
Inpatient (see inpatient care)	Assumed initial/follow-up visits	114	Imputed							
Emergency (see emergency care)	Assumed visits	114	Imputed							
Outpatient (see outpatient care)	Assumed visits	114	Imputed							
Substance abuse (see treatment)	Assumed visits	114	Imputed							
Physician office										
All physical health visits	Visits	114	2,136	5	18.74	51.04	9.60	6.39	13.44	79
Initial consultations for physical health	Assumed initial contacts	114	90							79
All follow-up visits for physical health	Calculated follow-up visits	114	2,046.							73

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Follow-up to obtain prescriptions (drug diversion)	30-days visit projected 12 months	68	973	0	1.18	2.20	0.54	0.27	0.89	41
Follow-up visits for physical health	Calculated visits	114	1,073		24.80					73
All visits for mental health	Sessions	100	234	0	2.34	9.21	0.41	0.07	0.93	13
Ambulance services	12 months:									
Physical health (for drug overdoses)	imputed annualized services	96	9	0	0.09	0.22	0.03	0.01	0.06	32
Mental health (for attempted suicides)	imputed annualized services	109	6	0	0.06	0.14	0.02	0.01	0.03	28
Prescribed pharmaceuticals	Prescriptions:									
Follow-up to attempted suicides	12 months	109	Imputed							
Mental health prescriptions	30 days	114	9	0	0.08	0.27	0.01	0.00	0.03	8
Diverted prescriptions	30 days	76	93	0	1.22	1.98	0.58	0.29	0.94	42
Criminal code infractions:	Infractions:									
Illicit drug possession or use	30 days	81	7,004	90	86.47	47.92	80.33	70.87	90.39	100
Illicit drug sale, distribution, or manufacture	30 days	92	2,800	8	30.43	55.34	14.75	9.08	21.74	60
Income-related property crimes	30 days	99	1,021	0	10.31	22.52	3.77	1.96	6.08	38
Shoplifting or minor theft	30 days	102	749	0	7.34	18.69	2.19	0.97	3.79	28
Forgery or fraud	30 days	109	96	0	0.88	3.70	0.15	0.02	0.35	10
Burglary, theft, breaking and entering, auto theft	30 days	111	240	0	2.16	10.59	0.34	0.05	0.79	14
Robbery (involving a weapon)	30 days	114	7	0	0.06	0.57	0.00	0.00	0.00	2
Income-related other illegal activities	30 days	105	288	0	2.74	12.94	0.37	0.04	0.93	10
Tax evasion or defrauding social assistance	30 days	110	70	0	0.64	4.04	0.06	0.00	0.20	6
Pimping	30 days	114	10	0	0.09	0.67	0.00	0.00	0.02	2
Prostitution-related offenses	30 days	108	208	0	1.93	10.18	0.18	0.00	0.55	5
Driving-related violations	30 days	106	624	0	5.89	31.98	0.68	0.06	1.73	11
Driving while under the influence	30 days	108	354	0	3.28	26.24	0.27	0.00	0.86	8
Major driving violations	30 days	111	270	0	2.43	17.50	0.25	0.01	0.71	9

TABLE 1 Continued

Recall Period/Measure	n	Activity	Median	Mean	SD	T_{MEAN}	LL	UL	Active, %
Vandalism/loitering/vagrancy	30 days	107	185	0	1.73	9.73	0.20	0.01	0.55	7
Law enforcement offenses	30 days	109	69	0	0.63	4.18	0.06	0.00	0.20	7
Parole or probation violations	30 days	110	64	0	0.58	4.03	0.00	0.00	0.16	5
Contempt of court	30 days	113	5	0	0.04	0.25	0.00	0.00	0.01	4
Other offenses	30 days	114	14	0	0.12	1.01	0.01	0.00	0.03	2
Capital offenses	12 months	112	309	0	2.76	24.11	0.29	0.01	0.80	18
Arson	12 months	114	1	0	0.01	0.09	0.00	0.00	0.00	1
Weapons offense	12 months	113	276	0	2.44	24.00	0.12	0.02	0.52	5
Assault	12 months	113	30	0	0.27	0.81	0.06	0.02	0.13	15
Rape or sexual assault	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Homicide or manslaughter	12 months	114	2	0	0.02	0.13	0.00	0.00	0.00	0
Other	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	2
Law enforcement: police arrests:	Arrests:									
Illicit drug possession or use	12 months	114	22	0	0.19	0.66	0.04	0.01	0.08	11
Illicit drug sale, distribution or manufacture	12 months	114	1	0	0.01	0.09	0.00	0.00	0.00	1
Income-related property crimes	12 months	114	92	0	0.81	1.54	0.37	0.21	0.56	36
Shoplifting or minor theft	12 months	114	64	0	0.56	1.26	0.21	0.10	0.35	27
Forgery or fraud	12 months	114	6	0	0.05	0.26	0.00	0.00	0.01	4
Burglary, theft, breaking and entering, auto theft	12 months	114	20	0	0.18	0.77	0.02	0.00	0.06	8
Robbery (involving some weapon)	12 months	114	2	0	0.02	0.13	0.00	0.00	0.00	2
Income-related other illegal activities	12 months	114	3	0	0.03	0.28	0.00	0.00	0.00	1
Tax evasion or defrauding social assistance	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Pimping	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Prostitution-related offenses	12 months	114	3	0	0.03	0.29	0.00	0.00	0.00	1

Driving-related offenses	12 months	114	5	0	0.04	0.21	0.00	0.00	0.01	4
Driving while under the influence	12 months	114	2	0	0.02	0.13	0.00	0.00	0.00	2
Major driving violations	12 months	114	3	0	0.03	0.16	0.00	0.00	0.01	3
Vandalism/loitering/vagrancy	12 months	114	3	0	0.03	0.16	0.00	0.00	0.01	3
Law enforcement offenses	12 months	114	18	0	0.16	0.74	0.02	0.00	0.06	9
Parole or probation violations	12 months	114	8	0	0.07	0.12	0.01	0.00	0.02	5
Contempt of court	12 months	114	10	0	0.09	0.47	0.01	0.00	0.03	4
Other offenses	12 months	114	12	0	0.11	0.43	0.01	0.00	0.04	7
Capital offenses	12 months	114	16	0	0.14	0.40	0.03	0.01	0.06	12
Arson	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Weapons offense	12 months	114	3	0	0.03	0.16	0.00	0.00	0.01	3
Assault	12 months	114	13	0	0.11	0.35	0.02	0.00	0.05	11
Rape or sexual assault	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Homicide or manslaughter	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Other	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Law enforcement: Court charges	Charges:									
Illicit drug possession or use	12 months	114	22	0	0.19	0.65	0.04	0.01	0.09	11
Illicit drug sale, distribution, or manufacture	12 months	114	1	0	0.01	0.09	0.00	0.00	0.00	1
Income-related property crimes	12 months	114	94	0	0.82	1.55	0.38	0.22	0.57	38
Shoplifting or minor theft	12 months	114	65	0	0.57	1.24	0.22	0.11	0.36	28
Forgery or fraud	12 months	114	6	0	0.05	0.26	0.00	0.00	0.01	4
Burglary, theft, breaking and entering, auto theft	12 months	114	21	0	0.18	0.78	0.03	0.00	0.07	8
Robbery (involving some weapon)	12 months	114	2	0	0.02	0.13	0.00	0.00	0.00	2
Income-related other illegal activities	12 months	114	4	0	0.04	0.30	0.00	0.00	0.01	2
Tax evasion or defrauding social assistance	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Pimping	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Prostitution-related offenses	12 months	114	4	0	0.18	0.30	0.00	0.00	0.01	2

TABLE I Continued

Recall Period/Measure		n	Activity	Median	Mean	SD	T_{MEAN}	LL	UL	Active, %
Driving-related offenses	12 months	114	5	0	0.04	0.21	0.00	0.00	0.01	4
Driving while under the influence	12 months	114	2	0	0.02	0.13	0.00	0.00	0.00	2
Major driving violations	12 months	114	3	0	0.03	0.16	0.00	0.00	0.01	3
Vandalism/loitering/vagrancy	12 months	114	3	0	0.03	0.16	0.00	0.00	0.01	3
Law enforcement infractions	12 months	114	19	0	0.17	0.74	0.03	0.00	0.07	10
Parole or probation violations	12 months	114	9	0	0.08	0.36	0.01	0.00	0.03	6
Contempt of court	12 months	114	10	0	0.09	0.47	0.01	0.00	0.03	4
Other offenses	12 months	114	22	0	0.19	0.73	0.03	0.01	0.08	10
Capital offenses	12 months	114	18	0.	0.16	0.41	0.04	0.01	0.07	14
Arson	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Weapons offense	12 months	114	3	0	0.03	0.16	0.00	0.00	0.01	3
Assault	12 months	114	13	0	0.11	0.35	0.02	0.00	0.05	11
Rape or sexual assault	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Homicide or manslaughter	12 months	114	0	0	0.00	0.00	0.00	0.00	0.00	0
Law enforcement: corrections										
Prison	12 months prison-days	114	4,012	0	35.19	66.65	12.75	7.17	19.84	42
Parole	12 months cases	114	1	0	0.01	0.09	0.00	0.00	0.00	1
Probation	12 months cases	114	26	0	0.23	0.42	0.08	0.04	0.14	23
Economic productivity										
Paid work	12 months paid days	114	6,407	12	56.20	78.57	28.14	18.66	39.53	55
Volunteer activity	12 months volunteer-days	77	317	0	4.12	13.34	0.24	0.09	0.45	25

TABLE II Selected Characteristics of Survey Respondents, n = 114

Demographic characteristics		
Sex		
Male	81.6% (93)	
Female	18.4% (21)	
Age, years (n = 104)		
<20	0 (0)	
21–30	14.9% (7)	
31–40	55.3% (63)	
41–50	27.2% (31)	
51+	2.6% (3)	
Socioeconomic characteristics		
Living conditions		
Living in permanent housing		48.2% (55)
Living in temporary housing (shelter, rooming house, street)		51.8% (59)
Income sources: subjects who had monetary income from the following sources in past 30 days		
Social/welfare benefits		75.4% (86)
Illegal activities/crime		67.5% (77)
Gifts/loans		49.1% (56)
Work/employment		30.7% (35)
Sex work		9.6% (11)
Drug use characteristics		
Prevalence of drugs used (in last 30 days)		
Heroin		92.1% (105)
Other opiates		72.8% (83)
Alcohol		70.2% (80)
Cannabis		64.0% (73)
Benzodiazepines		60.5% (69)
Cocaine		57.9% (66)
Crack		33.3% (38)
Barbiturates		13.2% (15)
Length of heroin use among regular heroin users		
<1 year		2.2% (2)
1–5 years		36.2% (33)
6–10 years		27.5% (25)
11–15 years		11.0% (10)
16–20 years		9.9% (9)
21+ years		13.2% (12)
Injection drug use		
Subjects who injected a drug in the past 12 months		93.0% (106)
Subjects who injected a drug in the last 30 days		84.2% (96)
Subjects who on average injected a drug at least once a day in last month (n = 106)		75.5% (80)

Source: Reference 31.

to represent typical (average) activity and were extrapolated to estimate cost for the full year. Economic data reported for other periods were adjusted to 1996 using the consumer price index (for Canada, Ontario, or Toronto, as required). Analysis was adjusted for missing data using mean (proxy) values calculated from the responding sample (see Activity in Tables III–VI).

Projecting these findings to the Toronto population, however, should account for the effects of the sample size (see n in Table I) and response distribution on the precision of point estimates (i.e., mean, median). As the distribution of reported activities is skewed positively, count data with a high proportion of zero responses (i.e., few active respondents; see Active in Table I), the $\sqrt{\text{activity}} + \sqrt{\text{activity} + 1}$ transformation[35,36] was employed to estimate the mean point estimate (T_{MEAN}) and its 95% confidence interval (LL, UL) for the cost-items.[37] The means and confidence intervals displayed in the Table I have been converted back from the transformed scale.

RESULTS

To facilitate interpretation of study findings, estimated social costs are reported in Tables III to VII by component and source: health care (inpatient, emergency, outpatient, substance abuse treatment, medical, ambulance, pharmaceutical), law enforcement (police, courts, corrections), crime victimization (out-of-pocket expenses, compensation for pain and suffering, productivity losses, health care), and productivity losses (morbidity, mortality). For the baseline analysis, the cost of each component was estimated as the arithmetic sum of the constituent sources (see Tables III–VI). Social cost is the arithmetic sum of these components (see Table VII). All costs are in 1996 Canadian dollars.

COST OF HEALTH CARE

The $311,000 cost of health care (Table III) derived from opioid dependence arises from the use of hospitals, emergency departments, outpatient departments, medical care, ambulance services, substance abuse treatment, and prescription pharmaceuticals.

The $62,300 cost of inpatient care was estimated from 120 hospital admissions and 737 hospital days. Standard unit costs of inpatient care for opioid abuse/ dependence ($323 per day) and for depressive neuroses ($344 per day) estimated for the Province of Alberta[38] were used (see also the comparable figures for the Province of Manitoba[39]). As these figures were derived from urban tertiary care settings, they represent the cost of inpatient care provided to the respondents.

TABLE III   Health Care Cost by Component and Source

Component and Source		Activity	Unit Cost	Cost	Attributed	Opioid Cost	% Total
Inpatient Care	Admissions	Days	$/Day	$/Year	Proportion	$/Year	
Physical health	99	677	323	218,395	0.26	57,558	
Mental health	21	60	344	20,642	0.23	4,760	
Total				239,037		62,318	1.2
Emergency Care	Patients	Visits	$/Use	$/Year	Proportion	$/Year	
Physical health	71	301					
Drug overdose		10	213	2,207	0.82	1,818	
Attempted suicide		6	213	1,339	0.82	1,103	
Other care (including drug diversion)		284	85	24,030	0.34	8,066	
Mental health	5	22	85	1,859	0.48	888	
Total				29,435		11,875	0.2
Outpatient Care	Patients	Visits	$/Visit	$/Year	Proportion	$/Year	
Physical health	21	120	47	5,640	0.26	1,486	
Mental health	0	0	47	0	0.23	0	
Total				5,640		1,486	0.0
Substance Abuse Treatment	Clients	Contacts	$/Contact	$/Year	Proportion	$/Year	
Institutional treatment days	2	385	323	124,208	0.82	102,297	
Residential treatment days	2	241	116	27,981	0.82	23,045	
Outpatient counselling sessions	1	60	66	3,948	0.82	3,252	
Methadone treatment sessions	1	233	10	2,326	0.82	1,915	
Total				158,463		130,509	2.6
Medical Care	Patients	Visits	$/Visit	$/Year	Proportion	$/Year	
Inpatient							
Full consultations physical health	99	38	105.40	10,435	0.26	2,750	
Follow-up visits physical health	99	578	17.10	9,884	0.26	2,605	
Initial consultations mental health	21	21	114.55	2,406	0.23	555	
Follow-up visits mental health	21	39	17.10	667	0.23	154	
Emergency							
Drug overdose		10	78.50	815	0.82	671	
Attempted suicide		6	78.50	494	0.82	407	
Other contacts (including drug diversion)		284	78.50	22,320	0.34	7,492	
Psychiatric consultation (overdose, suicide)		17	78.50	1,309	0.82	1,078	
Mental health		5	78.50	393	0.23	91	

TABLE III   Continued

Medical Care	Patients	Visits	$/Visit	$/Year	Proportion	$/Year	% Total
Outpatient							
General assessments physical health	21	21	53.60	1,126	0.26	297	
Partial assessments physical health	21	99	23.10	2,287	0.26	603	
All mental health	0	0				0	
Treatment (annual)	6	6	48.20	299	0.82	246	
Primary							
Physician-office							
General assessment physical health	90	90	48.20	4,338	0.00	0	
Intermediate assessments	83	2,046					
Diverted prescriptions	47	1,632	24.80	40,468	0.72	29,201	
Physical health	83	414	24.80	26,602	0.00	0	
All mental health sessions	13	267	111.60	29,770	0.48	14,221	
Total				137,282		60,369	1.2

Ambulance Services	Annual Events	$/Event	$/Year	Proportion	$/Year	
Treated overdoses	10	313	3,251	0.82	2,678	
Drug-related attempted suicide	6	313	1,972	0.82	1,624	
Total		5,223		4,302		0.1

Pharmaceuticals	Patients	Prescriptions	Charge	$/Year	Proportion	$/Year	
Follow-up after attempted suicide	6	6	21.33	134	0.23	31	
Drug-related mental health conditions	9	108	42.99	4,643	0.48	2,218	
Diverted prescriptions	48	1,697	30.81	52,286	0.72	37,729	
Total				57,063		39,978	0.8
Total health care				632,143		310,837	6.1

These per diem unit costs, which exclude emergency, outpatient, and long-term care, as well as education and research activities (and corresponding shares of ancillary and overhead expenses),[40] were adjusted for the intensity of resource utilization.[12,38,39] The respective 26% and 23% of inpatient care for physical and mental health attributable to opioid dependence were determined from the predicted annual rates of treated drug overdoses and drug-related attempted suicides, both adjusted for the expected 82% expected reduction in days of drug use (see Cost of Law Enforcement, below). The predicted 10 overdoses and 6 attempted suicides were calculated as reported lifetime incidences standardized for the period of opioid use.

The $11,900 cost of emergency care was estimated from 323 visits for physical

TABLE IV Law Enforcement Cost by Component and Source

Component and Source	Activity	Unit Cost	Cost	Attributed	Opioid Cost	% Total
Police	Arrests	Incidents	$/Incident	$/Year	Proportion	$/Year	
Illicit drug possession or use	22	169	2,613	442,181	0.82	364,178	
Illicit drug sale, distribution, or manufacture	1	8	2,613	20,099	0.72	14,503	
Income-related property crimes	92	696	2,613	1,818,254	0.48	871,268	
Income-related other illegal activities	3	23	2,613	60,297	0.21	12,946	
Driving-related violations	5	38	2,613	100,496	0.82	82,768	
Vandalism/loitering/vagrancy	3	23	2,613	60,297	0.82	49,661	
Law enforcement infractions	18	18	2,613	47,032	0.77	36,419	
Other offenses	12	92	2,613	241,190	0.22	53,950	
Capital offenses	16	29	2,613	74,654	0.72	53,870	
Total				2,864,500		1,539,563	30.3

Court		Charges	$/Case	$/Year	Proportion	$/Year	
Drug possession/use		22	1,305	28,710	0.82	23,645	
Income-related drug business		1	1,305	1,305	0.72	942	
Income-related property		94	1,472	138,344	0.48	66,291	
Income-related other illegal activities		4	1,305	5,220	0.21	1,121	
Driving-related violations		5	2,873	14,364	0.29	4,104	
Vandalism/loitering/vagrancy		3	1,305	3,915	0.29	1,119	
Legal status violations		19	1,305	24,795	0.77	19,200	
Other offenses		22	1,305	28,710	0.29	8,202	
Capital offenses		18	4,467	80,406	0.72	58,020	
Total				325,769		182,644	3.6

Corrections	Cases	Case Days	$/Day; $/Case	$/Year	Proportion	$/Year	
Prison	48	4,012	127	509,026	0.80	409,361	
Parole	1		3,973	3,973	0.80	3,195	
Probation	26		997	25,917	0.78	20,114	
Total				538,916		432,670	8.5

| Total law enforcement | | | | 3,729,185 | | 2,154,877 | 42.4 |

and mental health concerns. For physical health visits, analysis distinguished among contacts for drug overdose, drug-related attempted suicide, and other concerns (including obtaining prescription drugs for illicit purposes and as a source of primary care). Selected Ontario hospitals report the unit cost of emergency care (i.e., operating expenses, equipment depreciation, and a share of

TABLE V Crime Victimization Cost by Component and Source

Component and Source	Activity	Unit Cost	Cost	Attributed	Opioid Cost	% Total
Out-of-Pocket Expenses	Incidents	$/Infraction	$/Year	Proportion	$/Year	
Household victimization	2,999	664	1,991,547	0.81	1,622,742	
Vandalism	799	383	306,012	0.82	252,030	
Personal victimization	115	48	5,508	0.80	4,429	
Total			2,303,067		1,879,201	36.9
Pain and Suffering	Incidents	$/Incident	$/Year	Proportion	$/Year	
Personal victimization	115	3,728	430,304	0.80	345,980	
Total			430,304		345,980	6.8
Productivity Losses	Victims	Days/Victim	$/Day	$/Year	Proportion	$/Year
Household victimization	2,999	0.27	51.38	41,599	0.81	33,895	
Personal victimization	115	0.61	51.38	3,617	0.80	2,909	
Total				45,216		36,804	0.7
Health Care	Emergency	Inpatient	Primary	$/Year	Proportion	$/Year
Unit cost ($/event)	369.69	560.35	48.20			
Robbery (85 victims)	8%	2%	12%	3,966	0.83	3,305
Assault (30 victims)	11%	2%	16%	1,788	0.72	1,290
Total				5,754		4,595	0.1
Total victimization				2,784,341		2,266,580	44.5

TABLE VI Productivity Loss by Component and Source

Component and Source	Activity	Unit Cost	Cost	Attributed	Opioid Cost	% Total
Morbidity	Participants	Lost Days	$/Day	$/Year	Proportion	$/Year
Paid work	63	5,518	51.38	283,494	0.82	233,484	
Volunteer activities	28	−165	51.38	−8,477	0.82	−6,982	
Total				275,017		226,502	4.5
Mortality	Expected Deaths	$/Death	$/Year	Proportion	$/Year	
Opioid overdoses	0.63	213,349	134,410	0.82	110,699	
AIDS from contaminated needles	0.09	213,349	20,161	0.82	16,605	
Total			154,571		127,304	2.5
Total productivity			429,588		353,807	7.0

TABLE VII Social Cost by Component

Component	Reported	%	Opioid	% Total
Health care	$632,143	8.3	$310,837	6.1
Law enforcement	$3,729,185	49.2	$2,154,875	42.4
Crime victimization	$2,784,341	36.8	$2,266,579	44.6
Productivity losses	$429,589	5.7	$353,807	7.0
Social cost	$7,575,258	100.0	$5,086,099	100.0

overhead expenses) by the intensity of care (five levels).* The predicted 10 over-doses and 6 attempted suicides annually were valued as Level 4 care ($213 per visit). The expected reduction of this cost was predicated on the expected 82% decrease in days of drug use. Of the 284 nonoverdose visits, 34% were attributable to opioid use as inappropriate utilization by frequent users of emergency services[41] adjusted for the expected reduction in drug use. Of the remaining contacts, no decrease was anticipated as these visits arise from perceived need for medical care and the use of emergency services as the usual point of entry into the health care system. For mental health visits, 48% were attributable to opioid dependence on the basis of the prevalence of drug-related disorders and the expected reduc-tion in drug use. For these less-urgent physical/mental health contacts, we as-sumed Level 2 care at $85 per visit.

The $1,490 cost of hospital outpatient follow-up care was estimated from 120 visits for physical health concerns. No mental health visits were reported. As accounting (financial and statistical) data were not reported for nonemergency ambulatory care and standard costs either were not estimated or were not ad-justed for type of hospital, we used the unit cost reported by the Hamilton (Ontario) McMaster University Medical Centre ($48 per visit).[42] This figure, which reflects the average use of outpatient resources (operating, equipment, and a share of overhead expenses[43]), is derived from recommended methodology,[12] and it has been used elsewhere.[44] We assumed that these visits were follow-up to inpatient care and, hence, were attributed to the physical health effects of opioid dependence (26%), as above.

The $131,000 cost of substance abuse treatment was estimated from lifetime use of institutional, residential, outpatient counseling, and methadone maintenance

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*R. Welch, London Health Sciences Centre standard unit-costs for emergency care by level of care, personal communication, July 4, 2000.

interventions adjusted for the respondent's duration of regular opioid use (a
mean of 12.0 years). On average, a total of 385 days of institutional care, 241
days of residential care, 60 sessions of outpatient counseling, and 233 sessions
of methadone maintenance were used annually. The per diem cost of institutional
care was estimated as above for inpatient care.[38] The unit costs (i.e., operating,
equipment, and a share of overhead expenses) of treatment in the remaining
settings were reported by the Ontario Drug and Alcohol Treatment Information
System[45] as $116 per day for residential care (excluding intake assessment), $68 per
session for one-on-one outpatient counseling, and $10 per session for methadone
maintenance (adjusted for decreasing cost over time). These services were attrib-
uted fully to opioid use, but were adjusted for the expected reduction in drug
use.

The $60,400 cost of medical care includes reported office visits for primary
care, as well as imputed physician services that would have been provided
in inpatient, emergency, outpatient, and substance abuse treatment settings.
Following the Ontario Schedule of Benefits for Medical Services,[46] analysis distin-
guishes between the tariffs paid for initial and follow-up care by medical specialty.
Hospital admissions for physical health concerns generated 99 initial consulta-
tions by attending internists ($105.40 per consultation), followed by 578 visits
($17.10 per visit) to monitor patient progress. Similarly, admissions for mental
health care generated 21 psychiatric consultations ($114.55 per admission), fol-
lowed by 39 visits ($17.10 per visit). Each of the 323 emergency visits involved
an examination by the attending physician ($78.50 per examination). For the 6
attempted suicides and 10 drug overdoses (see ambulance services discussion,
below), patients were also seen by a psychiatrist while in the emergency room
($78.50 per consultation). The 120 physical health outpatient visits required the
attending clinic internist to perform 21 general assessments ($53.60 per assess-
ment), one for each of the 21 respondents reporting care, followed by 99 partial
assessments to monitor patient progress ($23.10 per assessment). No visits were
reported for mental health disorders. Finally, the 6 subjects in substance abuse
treatment annually were assumed to have been examined by a general prac-
titioner ($48.20 per assessment). These imputed costs were attributed respectively
to the health effects of opioid dependence as above for inpatient, emergency,
outpatient, and treatment services.

The 2,139 office visits to general practitioners for physical health concerns
were interpreted as 90 initial visits ($48.20 per general assessment), one for each
of the 90 respondents reporting care, and 2,046 visits thereafter ($24.80 per
intermediate assessment). For the follow-up visits, 1,632 were explained as con-

tacts made to obtain prescriptions for illicit purposes.* To the extent that the 72% decrease in drug trafficking following the switch from opioid dependence to irregular use (see law enforcement discussion, below) reduced the diversion of prescriptions, 1,175 visits would be eliminated. Analysis assumed that, as the 90 initial contacts and the remaining follow-up visits were for the treatment of chronic physical health conditions arising from historical physiological and life-style circumstances (including the use of psychoactive substances), no reduction in this cost was anticipated. The 267 visits for mental health care consisted of 1-hour sessions with a psychiatrist ($111.60 per hour). As above, 48% of the reported cost was attributable to opioid dependence.

The $4,300 cost of ambulance services was estimated from the reported number of lifetime overdoses for which medical treatment was sought and for drug-related attempted suicides. The average unit cost of emergency ambulance ser-vices ($313 per event) was calculated from unpublished Ontario Ministry of Health data.[44] Of the reported cost, 82% is attributable to opioid dependence on the basis of the predicted reduction in days of drug use (i.e., the period in which users are at risk of drug overdose and drug-related attempted suicide).

Finally, the $40,000 cost of pharmaceuticals includes prescriptions issued to patients discharged from the hospital following treatment for attempted suicide, drugs prescribed to treat mental health conditions (mostly depression), and prescription drugs diverted for illicit purposes. Costs were estimated using On-tario Drug Formulary prices[47] adjusted for the customary $10.50 pharmacy dis-pensing fee. Treatment of the 6 attempted suicides (emergency, inpatient, follow-up care by a psychiatrist) included a small supply of antidepressants (e.g., 10 tablets of Prozac at $1.083 per tablet) provided to cover the period between hospital discharge and psychiatric office care. Also, the 9 respondents who re-ported chronic drug-related mental health concerns were assumed to take Prozac for the full year (30 tablets per prescription and 12 refills). As above, 23% and 48% of the cost of antidepressants were attributable, respectively, to opioid dependence. Diverted prescriptions (e.g., morphine, oxycodone) are used to finance the purchase of illicit drugs and as a substitute when preferred psychoac-tive substances are not available.[48–50] The $38,800 cost was estimated from the responses of 76 subjects questioned about this activity.* An average cost of $30.80 per prescription (including dispensing fee) was calculated from the reported mix

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*R. Wall, B. Brands, and J. Blake, The diversion of prescription opioids by a cohort of untreated opiate users, unpublished memo, 1999.

of diverted analgesics. Of the cost, 72% was attributed to opioid dependence on the basis of the expected reduction in drug trafficking (see law enforcement discussion below).

COST OF LAW ENFORCEMENT

The $2,155,000 cost of law enforcement (Table IV) for opioid-related crimes consists of

- the police costs of investigating incidents, making arrests, and laying charges
- the court costs of processing charges
- the correction costs of enforcing sentences

These costs were estimated using operating expenses and statistics reported by the Canadian Centre for Justice Statistics.

To distinguish better between drug-related and other criminal activity, reported infractions, arrests, and charges were grouped as follows:

- possession or use of illicit drugs
- sale, distribution, or manufacture of illicit drugs (i.e., trafficking)
- income-related property crimes (shoplifting, minor theft, burglary, theft, breaking and entering, auto theft, robbery, forgery, fraud)
- other income-related activity (tax evasion, defrauding social assistance, pimping, sex trade)
- driving-related offenses (driving while under the influence, major driving violations)
- vandalism, loitering, vagrancy
- legal status violations (violations of parole or probation, contempt of court), other illegal activities
- capital offenses (arson, weapons charges, assaults, rape and sexual assaults, homicide, murder, other)

Typical of opioid use behavior,[17,51] most reported criminal activity was for illicit drug possession/use (59%) and income-generating trafficking, property, and other crimes (35%). For arrests, however, while possession/use and income-related crimes still accounted for the majority of arrests (13% and 57%, respectively) and charges (12% and 54%, respectively), income-generating property crimes were of particular importance—that is, 9% of the criminal activity was responsible for 54% of the arrests and 51% of the charges.

Among the 94% of survey respondents reporting lifetime arrests, 81% were for infractions committed while using drugs or to obtain money to purchase drugs. Estimating the proportion of criminal activity attributable to opioid-related

crime was problematic. Although criminal activity was related to heavy drug use,[52-54] reduction in criminality was determined by the effectiveness of treatment and was limited by prior criminal history (especially that before the onset of drug use).[55,56] Moreover, sustained change in criminality is mitigated by users' generally poorer health, lower educational attainment, fewer resources, and social stigma that limits their (re)integration into mainstream society.[53]

Findings by scientific studies of reduced criminal activity among opioid users in methadone maintenance are encouraging (e.g., the 84% reduction in trafficking and property-related crime[56]), but may be overstated for estimating untreated social costs from the self-selection of subjects into treatment, confounding by rigorous monitoring and sanctions, and the potential for information bias. The study by Johnson and colleagues[51] of the economics of crime among New York City heroin users provides a more conservative estimate of excess criminal infractions attributable to untreated opioid dependence. As criminal activity is reported by degree of heroin use (daily, regular, irregular), the attributable proportion was estimated as the difference in rates of criminal activity between daily (6 to 7 days per week) and irregular (0 to 2 days per week) users. This calculation assumes that dependent users are unlikely to withdraw completely from using opioids for the rest of their lives (i.e., the chronic disease model), and that in remaining socially disadvantaged, they will continue to engage in income-generating crime.

Using the New York data, the 82% between-group (daily vs. irregular) difference in the number of use-days in which psychoactive substances were used is a proxy measure for the reduction in the risk of being arrested and charged for drug possession/use. Similarly, reductions in the rates of income-related crimes (trafficking, property, other) were calculated as between-group differences in self-reported offenses (72%, 48%, 21%, respectively). The risks of committing driving-related and vandalism/loitering/vagrancy infractions were also deemed to diminish with the expected decrease in drug use. The reduction in capital offenses (mostly weapons) was assumed to correspond to the predicted decrease in drug trafficking. In assuming equal risk of violating the terms of probation/parole, the proportion of law enforcement offenses attributed to opioid dependence was calculated as the weighted average of the above rates. Finally, the proportions of prison, parole, and probation sentences assigned to opioid dependence account for the distribution of charges and patterns of sentencing in Canada.[57]

The $1.54 million police cost was calculated using the $2,613 average cost of the Toronto Metropolitan Police to investigate criminal code incidents during

1996 and the imputed number of cases investigated, that is, the reported arrests adjusted for the prevailing clearance rate for property (13%), violent (56%), and other (13%) crimes.[58] The $183,000 cost of prosecuting, defending, and sentencing cases was estimated from average court, prosecution, and legal aid operating expenses and statistics reported for the Province of Ontario and adjusted for the expected duration of trial.[42] Finally, the $433,000 cost of enforcing convictions served in prison and under supervision in the community was estimated from operating expenses[59] and statistics[60] reported for Ontario.

COST OF CRIME VICTIMIZATION

The $2,267,000 cost of crime victimization (Table V) includes the cost to the victims of

- out-of-pocket expenses
- pain and suffering
- productivity losses
- use of health care

The cost attributed to opioid dependence was estimated as between-group differences in income-related infractions recounted by daily and irregular heroin users in New York City[51] and data on assaults reported by Ball and Ross.[56]

The $1,879,000 out-of-pocket expenses of the victims of household (i.e., breaking and entering, motor vehicle theft, theft), vandalism, and personal (i.e., sexual assault, robbery, assault) crimes were estimated from data reported by the 1993 General Social Survey, which reported the value of stolen/damaged property, the compensation paid by third parties, and the proportion of stolen goods recovered.[61] The $346,000 compensation awarded by the Ontario Criminal Injuries Compensation Board[62] was a proxy for the value placed by society on the pain and suffering of the victims of personal incidents. The Province of Ontario data distinguishes compensation to redress pain and suffering from other compensation (e.g., lost wages, legal expenses). To the extent that victims' valuations of their loss of well-being are understated, however, this estimate is conservative. The $36,800 productivity loss stemming from household and personal infractions was calculated as the expected number of days away from work[61] valued at the minimum wage ($51.63 per day, see below). As the victims of opioid-related crimes are disadvantaged disproportionally,[63] calculation was adjusted for the rate of employment of this population.[42] Finally, the $4,595 cost of health care used by the victims of violent crimes was calculated as their predicted utilization of services[64] valued as the per diem cost of hospitalization for injury ($438)[38]

and the above unit costs of emergency, outpatient, and primary care, including applicable physician fees.

COST OF PRODUCTIVITY LOSSES

Untreated opioid dependence is estimated to generate productivity losses of $354,000 (Table VI). First, respondents' performance of economically valuable paid and volunteered activities is impaired by opioid-related physical and mental health morbidities. Second, periods spent in hospitals, institutions, residential facilities, and prisons reduce the time available for performing such activities. Third, preoccupation with financing the opioid-related lifestyle detracts many users from meaningful participation in the formal economy. Finally, premature mortality (i.e., before age 65 years) reduces the duration of life in which these activities can be performed. The Ontario minimum wage of $6.85 per hour and a standard working day of 7.5 hours was used to assign monetary value to these losses of productive activities ($51.38 per day). The cost attributable to opioid dependence accounts for the expected 82% reduction in the days of drug use.

The $227,000 cost of opioid-related morbidity was estimated from respondents' report of 6,407 days worked and 469 days volunteered over the past 12 months. Days worked were compared to the 21,579 potential workdays reported by a comparable sample of Ontario residents[42] and reduced by 55% to correspond to the proportion of untreated (dependent) opioid users most likely to participate in the formal economy, that is, those respondents reporting at least some paid work. This comparator was standardized for demographic (age, sex) structure and adjusted for rates of unemployment and workforce participation. For volunteer activities, more time was provided by the respondents.[42]

The $127,000 cost of premature mortality among intravenous drug users was estimated as the earnings generated by the 114 survey respondents as they advance through a series of stages (defined by seven age groupings and two genders) until retiring at the age of 65.[42] Earnings were calculated using prevailing rates of unemployment and labor force participation in these groupings adjusted for a 1% annual growth in productivity and discounted to the present using the 3% rate of time preference.[65] Cost was estimated as the average lifetime earnings foregone due to opioid-related mortality (1% lower rate[66]) and mortality related to AIDS (acquired immunodeficiency syndrome) (0.15% among Toronto injection drug users [IDUs]*) reduced by 55% to adjust for the number of respondents most likely to engage in paid work.

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*R. S. Remis, M. Millson, and C. Major, The HIV epidemic among injection drug users in Ontario: the situation in 1997, unpublished study, University of Toronto Department of Public Health Sciences, Toronto, Ontario, Canada, 1997.

SAMPLE SOCIAL COST

Of the $5.086 million annual social cost (Table VI) of untreated opioid dependence during 1996 that was estimated for this sample of 114 residents of Toronto, crime victimization explains the largest amount (44.6%), followed by law enforcement (42.4%), productivity losses (7.0%), and, finally, the use of health care (6.1%). This amount expressed in US currency is $3.730 million. In 1999 Canadian dollars, this cost is $5.307 million ($3.572 million in US dollars).

Consistent with findings of the recent bottom-up British NTORS,[25] sample variation estimated as standard deviation (see SD in Table I) was high for most cost-items. Although our smaller sample (n = 114) may explain some variation, comparison to the larger NTORS (n = 1075) suggests that response heterogeneity is characteristic of dependent illicit drug users, with implications for generalizing sample findings to populations. The distributions of survey responses for the cost-items are count data positively skewed, with many respondents reporting zero activity (see Active in Table I). Also consistent with the NTORS, mean point estimates are larger than the median values, which are generally zero (see mean, median in Table I). Survey responses confirmed that a set of interrelated activities[25] explains the social cost of untreated opioid dependence (% of survey respondents reporting activity): inpatient (33%), emergency (62%), and office (79%) care for physical health concerns; ambulance use for drug overdoses (32%) and attempted suicides (28%); diversion of prescriptions (42%); income-related property victim-izations (38%), arrests (36%), and charges (38%); imprisonment (42%); and no paid work over the past 12 months (45%).

GENERALIZATION OF SAMPLE SOCIAL COSTS TO THE TORONTO POPULATION

In the absence of other samples of untreated illicit opioid users in Toronto and elsewhere, assessing the external validity of samples drawn from hidden populations is problematic. Comparison to other North American surveys of illicit drug users finds that our respondents exhibited and confirmed relevant demographics and socioeconomic characteristics, history and profile of illicit drug use, health status and health risks, as well as involvement with criminal justice system.[67-70] One major caveat limiting the generalization of our findings, however, is that most respondents were recruited within the context of needle exchanges and social service agencies. To the extent that these users are informed better about risks to their health and better motivated to access health/social services, their social costs may be lower compared to otherwise similar but more isolated individuals. Overall, we believe that these data provide valuable insights into a typical sample of these less-isolated untreated (dependent) opioid users.

The $105–$171 million range of the social cost of untreated opioid use and

the corresponding $43 to $69 spread in the economic burden per capita was estimated for Toronto (2.456 million residents,[9] 8,000 to 13,000 untreated users) using the expected $13,100 per user estimated from the mean of the transformed data of the cost-items accounting for uncertainty in the estimated number of opioid users (10,000 to 15,000[31-71]) and the proportion not in methadone maintenance (80% to 85%).* In contrast to the sample, law enforcement (39.1%) and productivity losses (33.2%) explain the greatest proportions of social cost, followed by crime victimization (21.2%) and health care (6.6%).

SENSITIVITY ANALYSIS

Analysis is sensitive to the precision of estimated statistics for the model cost-items, the set of items used, and uncertainty in the specification of model parameters. Social cost is also sensitive to assumptions made about crime victimization, out-of-pocket costs, productivity losses, and the expected reduction in the days of drug use.

The 95% confidence intervals estimated for means of the cost-items (see LL, UL in Table I) provide guidance on the precision of the estimated social cost per untreated (dependent) opioid user. The $6,950 smaller social cost per user was estimated from the lower 95% confidence limits for health care, law enforcement, and crime victimization cost-items, but the upper limit for reported paid/volunteer activities. Similarly, the $24,700 greater social cost per user was estimated from the upper 95% confidence limits for health care, law enforcement, and crime victimization cost-items, but the lower limit for reported paid/volunteer activities.

Assuming that crime victimization expenses constitute a transfer from the victim to the culprit, excluding this cost-item reduces the average social cost to $10,600 ($6,610 to $17,700). Excluding productivity losses (i.e., assuming zero friction cost) reduces the average social cost attributable to opioid dependence to $8,760, with similar effects on the range of values ($3,100 to $20,000). Alternatively, if 100% of the sample otherwise would have engaged in minimum wage employment, the average social cost increases to $17,600 ($11,400 to $29,200). Finally, changing the expected reduction in days of drug use from 82% to 55% decreases the average social cost to $11,200 ($5,540 to $22,300). Analysis excluding productivity losses and crime victimization expenses and using the lower expected reduction in days of drug use estimates the average social cost as $5,880 ($2,610 to $13,200).

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*R. S. Remis, M. Millson, and C. Major, The HIV epidemic among injection drug users in Ontario: the situation in 1997, unpublished study, University of Toronto Department of Public Health Sciences, Toronto, Ontario, Canada, 1997.

DISCUSSION AND POLICY IMPLICATIONS

The $34 to $55 range in per capita social cost estimated here for untreated opioid dependence in Toronto includes the revised $46 figure for all illicit drug use in Ontario[6] (11.256 million residents[9]) after excluding items not common to both studies (e.g., crime victimization, employee assistance programs) and adjusting for inflation. The distribution of the economic burden across cost components, however, differs, with untreated opioid dependence generating greater law enforcement expenditures (50% vs. 29%), comparable health care costs (8% vs. 8%), but lower productivity losses (42% vs. 63%). These variances are likely explained by differences in the mix of psychoactive substances consumed (opioids vs. all illicit drugs), greater heterogeneity among opioid users (untreated dependent vs. all users), the degree of social disadvantage (the disadvantaged vs. a broader cross section of citizens), and the data used (aggregate secondary sources vs. responses to a comprehensive questionnaire).

The key concern of economic analysis using survey data is the accuracy of self-reported responses—especially those reporting on illegal activities. While we have no data about the current survey, there are a number of factors that provide some confidence about the accuracy of these responses. Kilias and colleagues found a favorable agreement between subjective self-reports and objective administrative records of criminal activity.[72-75] Comprehensive reviews[76-80] conclude that self-reported data provide a reliable and valid basis for studying drug users' criminal activity, HIV risk behaviors, work status, and sources of income. Finally, the comparability of the average 496 drug trafficking and property infractions reported here with the findings of other surveys—between 223 and 630 incidents per subject[18,25,53,55,56,81-83]—provide further support for the accuracy of our data.

The costs of health care attributable here to untreated opioid dependence are comparable to differences reported for untreated chronic IDUs compared to nonusers,[84] as well as reductions observed 3 years following discharge from involuntary treatment[85] (study vs. nonusers vs. involuntary): inpatient care (25% vs. 33% vs. 21%), emergency care (37% vs. 51% vs. 35%), and outpatient care (26% vs. −34% vs. 32%), nondiverted prescriptions (38% vs. not reported vs. 23%). Finally, the 32% drug overdoses receiving treatment used here to calculate the cost of ambulance, emergency, inpatient, and outpatient physical health care attributable to opioid dependence is similar to the 27% reported by IDUs in London, UK.[86] Agreement among these figures provides assurance about our estimates.

The accuracy of the calculated cost of follow-up office visits for physical health

was examined through unadjusted comparison to the 1996–1997 Canadian National Population Health Survey.[87] Comparable rates of contact with general practitioners (79% vs. 77%) but lower utilization of follow-up visits (4.6 vs. 6.1) is explained by the use of the emergency room for ambulatory care (6.7 vs. 6.1 visits).

The proportion of criminal activity attributable to untreated opioid dependence estimated here from between-group differences in the activities of New York City daily and irregular heroin users appear to be a reasonable proxy measure for the City of Toronto. The proportion of overall illicit drug-related criminality (possession/use, trafficking, property, and other income-related infractions) is similar to the 81% reported by the survey respondents and comparable across US areas, regardless of differences in samples of users, settings, and data collection methods.[51] Also, the 48% difference in property crime is very similar to the 49% decline following the introduction of prescription heroin in the recent Swiss trial.[24] Moreover, the difference in income-related criminality (trafficking, property, and other income-related crimes) is remarkably similar to the amount that the survey respondents report they would eliminate if heroin were provided to them (62.6% vs. 62.9%). Finally, the predicted 82% reduction in days of drug consumption between daily and irregular drug users is comparable to reductions over 1 year achieved by patients in continuous treatment (83%) and other long-term methadone maintenance treatment (71%).[54]

Analysis is sensitive to the out-of-pocket expense of crime victimization. Although including stolen property in economic analysis is controversial (see Methods, above), simply excluding victims' out-of-pocket expense underestimates the economic burden of untreated opioid dependence. Whereas the theft of personal/household goods and retail stock—an (involuntary) transfer between members of society—does not generate economic loss per se, the victim's net out-of-pocket expense can be viewed as a proxy measure of the lower bound of their willingness to pay to avoid victimization.[25] While victims of household and personal crimes experience uncompensated losses from stolen goods and damage to property, poorer urban residents who use alcohol and other drugs are at greater risk of victimization.[61,63,64] In contrast, to the extent that merchants are insured and able to pass these expenses on to paying customers, the burden of retail victimization is distributed in complex ways across society, and estimation of its economic cost is correspondingly more difficult. In the absence of more accurate data, out-of-pocket expense is a conservative proxy measure of the economic cost of household/personal crime victimization.

The victim compensation approach used here to assign monetary value to crime victims' pain and suffering is more consistent than jury-based awards as

it better reflects society's willingness to pay to prevent crime. Unfortunately, we have no data sources from which to estimate the monetary value of the pain and suffering of opioid users and their family/friends. However, a recent exercise assumed that users or their friends/family would be willing to pay US $10,000 (Can $15,000) to avoid 1 year of the day-to-day suffering caused by drug addiction.[28]

The 85% underemployment among survey respondents is comparable to rates reported elsewhere.[17,22] For this sample, 45% reported no paid work over the past 12 months. Among those reporting paid work, however, respondents were not active throughout the year (an average of 27.7 weeks worked per year), but they worked full time when employed (an average of 4.9 days worked per week). More respondents reported volunteering than the general Ontario population (25% vs. 16%). Compared to the general population, differences in paid and nonpaid activities reflect personal choice, stigma, and other barriers to obtaining employment, as well as performing mandated community service.

As to the amount of economic productivity lost through opioid dependence, guidance was sought from the evaluation literature. Empirical findings on the effects of treatment on employment are inconsistent and inconclusive, but employment prior to treatment is an important predictor of future economic activity.[53] Restricting analysis to the 55% of respondents who reported paid work in the past 12 months yielded a conservative estimate of productivity losses. A recent analysis reporting differences of 55% and 47%, respectively, in full- and part-time employment between chronic IDUs and otherwise comparable nonusers provides support for this assumption.[84] Consistent with the users' limited education and work experience,[31] the minimum wage is a conservative valuation of the value of their time in the formal economy. Productivity losses may be overstated, however, if lower activity within the formal economy is balanced partially by drug lifestyle benefits obtained from the alternative use of this time.[25]

Finally, the predicted 1.15% per annum incidence of premature mortality from drug overdoses and HIV infection is conservative compared to rates reported for other countries during this period: 1.8% in England (heroin), 1.8% in Scotland (drug injectors), and 4.4% in Sweden (drug addicts).[88] Although the survey respondents were comparatively healthy,[31] the recent 3.4% per annum rate estimated from a 10-year survival analysis of a cohort of heroin users in Catalonia with AIDS as the main cause of death[88] may foreshadow the future for Toronto if public health measures are not implemented or expanded.[1] While the effects of existing (i.e., diagnosed and unknown) viral hepatitis and HIV infections

should be reflected in subjects' reported use of health care, generalizing these findings to the future and other settings is limited by differences in prevalence, life expectancy, and cost of treating infected IDUs. As the prevalence of IDU-related hepatitis and HIV are increasing in Canada,[8],* these data may underestimate future costs.

In conclusion, this study confirms the high economic burden of untreated opioid dependence. The sources of harm, however, cannot be considered necessarily social costs inherent to, or exclusively tied to, opioid dependence per se. Rather, they emerge from a complex interplay among users, their drug use behavior, and their environment as defined by social settings, drug markets, and law enforcement and other controls. In this equation, policies directed at controlling drug use behavior not only are limited in their effectiveness, but also generate significant harms and costs themselves.[89] Therefore, caution must be taken in interpreting this study to support increased law enforcement efforts or more severe penalties for drug-related offenses. Such efforts are unlikely to be effective deterrents to drug use.[90,91] Rather, by further constraining the supply of opioids, social cost likely would increase with greater law enforcement and crime victimization from the increased criminal activity undertaken to purchase heroin and other drugs.

Clearly, more effective and less-counterproductive approaches are needed to reduce the social harm and cost of untreated opioid dependence. Comprehensive research finds that substitution programs—in the form of methadone or other opioid maintenance—effectively reduce a broad range of harms: illicit opioid and other drug use, crime and criminality (and related victimization), morbidity and premature mortality, as well as poorer social and economic functioning.[93-95] Canada currently has 15% to 20% of its population with opioid dependence in substitution treatment.[71] The strong evidence of the effectiveness of methadone maintenance in reducing both opioid usage and crime argues for continuing the expansion of methadone treatment availability seen over the past few years in Ontario.[95] Opioid substitution is not a panacea as it is not acceptable to all users nor is it universally effective among those electing treatment. However, increasing the availability of substitution programs promises to be a first effective step in reducing the social cost of untreated opioid dependence.

The social cost of untreated opioid dependence also argues for the examination

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*R. S. Remis, M. Millson, and C. Major, The HIV epidemic among injection drug users in Ontario: the situation in 1997, unpublished study, University of Toronto Department of Public Health Sciences, Toronto, Ontario, Canada, 1997.

of novel approaches able to attract and retain users who find substitute treatment unacceptable. For example, low-threshold methadone programs or the medical prescription of injection opioids have been found to reduce crime.[1] Patients with concurrent severe mental and substance abuse disorders benefit from integrated treatment.[96] Social cost may be reduced further from fewer overdoses, a decrease in the complications from injecting impure drugs, and reducing the spread of infectious diseases (viral hepatitis and HIV).

Significant in interpreting the results of this study is that, of the $311,000 health care cost attributable to opioid dependence, 42% is devoted to substance abuse treatment. This imbalance highlights the need to develop a more coordinated delivery of health care services in response to the problem of illicit drug use, encompassing screening to treatment options that cost-effectively engage and retain users in therapeutic relationships. Moreover, for *treating* users for whom substitution is not viable because of compliance and acceptability issues, other options should be considered.[8] Only then will the health care system cost-effectively allocate resources to reducing the burden of opioid dependence on both users and society. Clearly, further research is needed to increase our knowledge on how to reduce the social harm and derived cost of untreated opioid dependence effectively and appropriately.

ACKNOWLEDGEMENT

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