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Drug and Alcohol Dependence 61 (2001) 195–206

DRUG and ALCOHOL DEPENDENCE

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The economic costs of heroin addiction in the United States

Tami L. Mark *, George E. Woody, Tim Juday, Herbert D. Kleber

The MEDSTAT Group, Inc., 4301 Connecticut Avenue, NW, Suite 330, Washington, DC 20008, USA

Received 13 September 1999; received in revised form 1 June 2000; accepted 1 June 2000

Abstract

This study documents the costs of heroin addiction in the United States, both to the addict and society at large. Using a cost-of-illness approach, costs were estimated in four broad areas: medical care, lost productivity, crime, and social welfare. We estimate that the cost of heroin addiction in the United States was US$21.9 billion in 1996. Of these costs, productivity losses accounted for ~US$11.5 billion (53%), criminal activities US$5.2 billion (24%), medical care US$5.0 billion (23%), and social welfare US$0.1 billion (0.5%). The large economic burden resulting from heroin addiction highlights the importance of investment in prevention and treatment.

Keywords: Heroin; Opiates; Injecting drug use; Methadone; Cost-of-illness; Economics; Policy

1. Introduction

Over the years, several studies have estimated the economic costs of substance abuse, yet there are no published studies on the proportion of these costs that can be attributed to heroin addiction. While heroin use makes up only a small part of total illicit drug use (less than 5%), heroin is a highly addictive and devastating drug, thus its impact on society may surpass that of more widely used illicit drugs like marijuana. Moreover, heroin addiction treatment policy faces unique obstacles due to the fact that agonist treatment with methadone or LAAM — the most widely used and effective treatment available — continues to be highly regulated and politically controversial in the United States and many other countries. This study documents the tremendous costs of heroin addiction, both to the addict and society at large, thereby providing a context for the development of policies to prevent and treat heroin addiction. Although the study focuses on the United States, the consequences of heroin use are pervasive in many parts of the world.

The foundation for the estimates is the cost-of-illness methodology outlined by Hodgson and Meiners (1982). Hodgson and Meiners identify three types of costs that can be included in cost-of-illness studies: (1) direct costs; (2) indirect costs resulting from losses in output; and (3) psychosocial costs. Direct costs include medical care expenditures for diagnosis and treatment of the addiction and its medical sequelae as well as nonmedical expenditures occasioned by the illness, such as prison and law enforcement related costs. Indirect expenditures include loss of earnings due to premature mortality, incarceration, and reduced human capital. Our analysis excludes psychosocial costs (such as reductions in the quality of life of the heroin addict and members of his/her social network) because these costs, though very important, are extremely difficult to quantify.

The methods used in this study build upon prior cost-of-illness studies, particularly those focused on substance abuse (i.e. Rice et al., 1990; Merril et al., 1993; French and Martin, 1996; Harwood et al., 1998; Xie et al., 1998). The estimates are developed using an array of data sources, including secondary analyses of existing databases and literature reviews. Whenever possible, triangulation of various data sources is employed to build confidence in the estimates. The base-year for the estimates is 1996, because that is the year for which the most recent survey data are available.

In this paper, we begin by reviewing estimates of the prevalence of heroin addiction. Next, we present an

* Corresponding author. Tel.: +1-202-7197832; fax: +1-202-7198701.

E-mail address: tami.mark@medstat.com (T.L. Mark).

0376-8716/01/$ - see front matter
PII: S0376-8716(00)00162-9

overview of the economic costs of heroin addiction. Then, we present each component of the cost estimate and how it was derived. We conclude by discussing the nature and degree of uncertainty in the estimates and the implications of our results for policymakers.

2. Results

2.1. Prevalence of heroin use

The prevalence of addiction is an important input in cost estimates. Unfortunately, prevalence statistics on heroin addiction are inexact due to the difficulty of surveying heroin users using traditional sampling techniques (Hughes, 1998. Personal communication, National Institute on Drug Abuse). In this study, we use the National Institutes of Health (1998) (NIH) Consensus Panel estimate that there were 600 000 heroin addicts in the United States in 1997 (NIH, 1997; National Consensus Development Panel on Effective Medical Treatment of Opiate Addiction, 1998). In part, this estimate was selected because it falls between two other estimates — one derived by the Substance Abuse and Mental Health Services Administration (SAMHSA) and the other by the Office of National Drug Control Policy (ONDCP).

Using the National Household Survey on Drug Abuse (NHSDA), SAMHSA estimated that there were 408 000 past month heroin users in 1996 (Office of Applied Studies, 1998a,b,c,d). Although the NHSDA provides the only nationally representative estimate of heroin users in the United States, the estimate is considered conservative due to probable under-reporting and under-coverage of the population of heroin users (Office of Applied Studies, 1998a,b,c,d). SAMHSA's Office of Applied Studies partially corrected for under-reporting by using secondary data on the number of people in treatment for drug problems and the number of arrests for non-traffic offenses (Wright et al., 1997). The unadjusted estimate of current heroin users was 325 000 in 1997. Despite this correction, the NHSDA adjusted estimate may still be too low (US General Accounting Office, 1998).

ONDCP estimated that there were 810 000 hardcore heroin users in 1995 and another 320 000 occasional heroin users (Office of National Drug Control Policy, 1997). The ONCDP estimates are based on the NHSDA as well as data collected in the Drug Use Forecasting (DUF) program, which questions a random sample of arrestees in 24 central city jails and lockups about their drug use[1]. It should be noted that throughout this analysis we use the term 'addict' and heroin 'addiction' to refer to both persons who would meet the clinical definition of 'dependence' as well as problem users.

2.2. Total cost by type

As shown in Table 1, we estimate that the total economic cost of heroin addiction in 1996 was US$21.9 billion. Of this total, the largest portion (52.6%) is the indirect costs of lost productivity due to heroin addiction, including lost earnings due to premature mortality, unemployment, incarceration, and lower earnings. Crime costs are the next largest component of total

Table 1
Summary of the economic costs of heroin addiction

	Costs (US$ millions)	Percent of total costs (%)
Medical care costs		
Heroin addiction treatment costs		
Specialty substance abuse facilities	862	3.9
General hospital inpatient	330	1.5
General hospital outpatient	11	0.1
General hospital emergency room	28	0.1
Physician office	10	0.0
Treatment costs sub-total	1241	5.7
Medical complications from heroin addiction		
AIDS	2972	13.6
Tuberculosis	18	0.1
Hepatitis B	33	0.2
Hepatitis C	537	2.5
Pregnancy problems	9	0.0
Medical complications sub-total	3570	16.3
Health Insurance Administration	229	1.0
Sub-total (all medical care costs)	5040	23.0
Productivity costs		
Mortality	5027	23.0
Unemployment	4557	20.8
Incarceration	1816	8.3
Lower earnings	113	0.5
Sub-total	11 513	52.6
Crime costs		
Policing	1751	8.0
Legal	885	4.0
Incarceration	1787	8.2
Cost to crime victims	796	3.6
Sub-total	5220	23.9
Social welfare costs	99	0.5
Total	21 872	100.0

[1] Note: The Arrestee Drug Abuse Monitoring (ADAM) program replaced the DUF in 1997.

costs (23.9%) and comprise the legal, policing, and incarceration costs associated with heroin addiction, as well as the cost to victims of crimes committed by heroin-dependent persons. The medical care costs of heroin addiction is the third largest cost component (23.0%) and included medical complications (16.3%), direct treatment costs (5.7%), and health insurance administration (1.0%). The remaining costs are attributed to social welfare programs (0.5%).

2.3. Medical care costs

Medical care expenditures associated with heroin addiction include the direct cost of treating heroin addiction, such as methadone maintenance, as well as the costs of treating illnesses that are a consequence of heroin use. The derivation of each component of medical care expenditures is discussed below.

2.3.1. Heroin addiction treatment costs

Three separate data sources provide information on the number of persons being treated for heroin addiction in specialty substance abuse facilities. The Uniform Facility Data Set (UFDS) is a census of US substance abuse treatment facilities including substance abuse and psychiatric hospitals, Veterans Affairs Medical Centers, therapeutic communities, methadone maintenance clinics and other types of specialty providers. According to the UFDS, the 1-day census for individuals being treated with a narcotic substitute in 1996 was ~124 000. The UFDS does not capture the number of persons who were primarily abusing heroin.

The Treatment Episode Data Set (TEDS) indicates that there were 214 000 admissions to specialty substance abuse facilities in 1996 by persons who were primarily abusing heroin at the time of admission[2]. TEDS aggregates information collected through state substance abuse agency data collection systems and only includes facilities reported in States' administrative data systems. In general, facilities reporting TEDS data are those that receive State alcohol and/or drug agency funds (including Federal Block Grant funds) for the provision of alcohol and/or drug treatment services. The TEDS data exclude most private for-profit programs, some private nonprofit programs, and some public programs, such as those offered by the Department of Veterans Affairs.

The National Association of State Alcohol and Drug Abuse Directors (NASADAD) also estimates the number of patients in treatment programs for heroin addiction using data from state substance abuse agencies. According to the NASADAD survey, in fiscal year 1995 there were 211 654 admissions of persons who were primarily abusing heroin (Gustafson et al., 1997).

[2] Note: the admission data is not unduplicated. The same person could account for more than one admission.

Each of these systems tends to underestimate the number of persons being treated for heroin addiction — the UFDS because it excludes persons treated for heroin addiction not taking a narcotic substitute and the TEDS and NASADAD because they exclude facilities not receiving state agency funds. Thus, we conservatively estimate that there were 214 000 treatment admissions for heroin addiction in specialty substance abuse facilities in 1996.

Two approaches were used to determine the expenditures incurred from treating individuals for heroin addiction: a top–down and a bottom–up approach. A recent SAMHSA report indicated US$7866 million was spent in specialty substance abuse facilities in 1996 (Mark et al., 1998). Using data from UFDS and TEDS, we estimate that ~15% of episodes in specialty substance abuse facilities were for treatment of heroin addiction. Thus, ~15% of all expenditures in specialty facilities may have been for treatment of heroin addiction, totaling US$1180 million (15% of US$7866 million) or US$5514 per episode per year. This calculation assumes that the type of treatment received by persons with heroin addiction is similar to that of all drug abusers. To test this assumption, we examined data from the National Treatment Improvement Evaluation Study (NTIES) and an analysis of UFDS by Harwood (in Mark et al., 1998) on the cost per client by treatment modality. Cost per client was then multiplied by the percentage of heroin users in different types of treatment settings using data from the TEDS. This approach yields an estimate of US$544 million spent on heroin addiction in specialty substance abuse settings in 1996. Our 'best guess estimate' is US$862 million — a number that is between these two estimates.

Estimates of costs for treatment in the general service sector were developed by multiplying utilization data for each type of service by per episode costs. Table 2 describes utilization by type of facility and the data sources. The number of admissions for heroin addiction treatment in general hospitals came from the 1995 Healthcare Cost and Utilization Project, Nationwide Inpatient Sample (HCUP-NIS). Information on emergency room visits came from the 1996 Drug Abuse Warning Network (1997) (DAWN). The number of physician office visits was derived from the 1996 National Ambulatory Medical Care Survey (NAMCS). Treatment was determined to be for heroin addiction if the record had an ICD-9-CM primary diagnosis code indicating opioid dependence or abuse (specifically, ICD-9 codes: 304.0 drug dependence: opioid type; 304.7 drug dependence: combinations of opioid type drug with any other; and 305.5 nondependent abuse of drugs: opioid type).

The HCUP-NIS provided expenditure information for acute care hospital inpatient treatment. Information on per visit costs in hospital outpatient, emergency

Table 2
Utilization of heroin addiction treatment by type of setting

Type of service	Utilization[a]	Source[b]
Specialty substance abuse facilities	214 000 admissions	TEDS, 1996
General hospital inpatient[c]	83 328 discharges	HCUP-NIS, 1995
General hospital outpatient	41 184 visits	NHAMCS, 1996
General hospital emergency room	72 217 visits	DAWN, 1996
Physician office	190 561 visits	NAMCS, 1996

[a] Utilization estimates for general service providers are based on encounter records with the following ICD-9 codes: 304.0 (drug dependence: opioid type); 304.7 (drug dependence: combinations of opioid type drug with any other); and 305.5 (nondependent abuse of drugs: opioid type).

[b] Abbreviations: TEDS, Treatment Episode Data Set; HCUP-NIS, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample; NHAMCS, National Hospital Ambulatory Medical Care Survey; DAWN, Drug Abuse Warning Network; NAMCS, National Ambulatory Medical Care Survey.

[c] Specialty units of hospitals are not included in the specialty sector estimates because they are captured in the acute care hospital estimates.

rooms, and physician offices came from a recent SAMHSA study that employed a variety of nationally representative data sets (Mark et al., 1998).

2.3.2. Medical complications from heroin addiction

Heroin addiction is associated with a host of secondary medical consequences including HIV/AIDS, tuberculosis, hepatitis B and C, and pregnancy complications. To estimate their cost we looked to research that indicated the proportion of the cases with the condition attributed to heroin addiction or, in the case of births, determined the additional incremental cost of labor and delivery for substance abusing mothers (Table 3). We then multiplied the cost of treating the medical condition by the number of cases caused by heroin addiction. The costs of treating cellulitis or other expensive but less common medical complications such as bacterial endocarditis, osteomyelitis, and abscesses in major organs are not included, which probably makes the cost estimates conservative.

2.3.2.1. HIV/AIDS. Injecting drug use and unprotected sex are two of the greatest risk factors for HIV infection. According to the CDC's National Notifiable Diseases Surveillance System (NNDSS), there were ~84 500 injecting drug users (IDUs) living with AIDS in 1996 (CDC, 1998a). Of these IDUs, 15 000 of them were men who have had sex with other men. We did not include these 15 000 IDUs in the cost estimates because they have two risk factors, thereby making it impossible to determine whether their infection was attributable to injecting drug use or sexual contact. Thus, we conservatively estimate that 69 500 individuals living with AIDS became HIV-positive because of their injecting drug use. Note that although we assume that all ID use is heroin ID use some proportion may be cocaine ID use.

Data on annual treatment costs for AIDS patients were obtained from the AIDS Cost and Service Utilization Survey (ACSUS), a national survey sponsored by the Agency for Health Care Policy and Research and fielded in 1991–1992[3]. We do not estimate the cost of treating HIV-infected IDUs who have not yet been diagnosed with AIDS. This is because HIV-infected IDUs tend to underutilize the health care system until their immune systems have declined to the point that they develop the serious opportunistic infections that are the hallmark of full-blown AIDS (Solomon et al., 1991).

2.3.2.2. Tuberculosis. According to national surveillance data collected by the CDC, the reported number of newly diagnosed tuberculosis (TB) cases in 1996 was 21 337, of which 939 (4.4%) were injecting drug users (CDC, 1997b)[4,5]. Unfortunately, it is unclear how many of these 939 cases were caused by factors associated with injecting drug use. Because the total number of IDUs with TB is relatively small, changing the assumptions about the percentage of these cases caused by heroin addiction has little effect on the overall cost

[3] A more recent national estimate for HIV/AIDS treatment costs based on HCSUS data became available in December 1998 (Bozzette et al., 1998). However, the earlier cost estimate from ACSUS was used in our cost calculations for several reasons. First, HCSUS cost estimates by disease stage have not yet been published. This omission is a critical one for our calculations, as most HIV-related treatment costs for the IDU population are incurred after an AIDS diagnosis (Solomon et al., 1991). Second, the treatment cost estimates from HCSUS are closely tied to the use of combination therapy, which has lowered annual treatment costs since they were introduced in the mid-1990s (Hellinger, 1993; Bozzette et al., 1998). However, in a recent study in Baltimore, only 14% of IDUs received combination therapy (Celentano et al., 1998) — a much lower rate than other major HIV risk groups. Thus, using a cost estimate that has been heavily influenced by the use of combination therapy would provide a cost estimate unrepresentative of the IDU population.

[4] Note that since symptomatic TB is typically treated in a period of six months or less, the annual incidence rate and annual prevalence rate are roughly equivalent.

[5] This percentage was derived using data only from those jurisdictions which had at least 75% reporting on whether a person diagnosed with TB had also injected drugs within the past six months. The CDC reported that 3.8% of known TB cases were injecting drug users (CDC, 1997a). However, since only 86.5% of TB case reports included information on injecting drug use over the past 12 months (CDC, 1997a), the 3.8% figure was inflated by 1.156 (100% divided by 86.5%) in order to represent 100% of cases. The revised figure is 4.4%, which translates into 939 cases.

Table 3
Prevalence of medical complications associated with heroin addiction

Medical condition	Number of heroin users with heroin-attributable illness during 1 calendar year	Annual per case expenditures[a] (US$)	Total (US$ millions)
AIDS	69 500	42 763	2972
Tuberculosis	808	22 539	18
Hepatitis B[b]			
Acute			
Inpatient	3545	39 919	
Outpatient	33 783	31	
Chronic			
Inpatient	3062	45 687	
Outpatient	24 897	48	
Total Hepatitis B			33
Hepatitis C[b]			
Acute			
Inpatient	14 618	44 454	
Outpatient	348 067	27	
Chronic			
Inpatient	20 279	41 952	
Outpatient	136 240	50	
Total Hepatitis C			537
Pregnancy problems			
Livebirths exposed prenatally to heroin[c]	3600	1480	
Boarder babies born to opioid using mothers	567	6524	
Total pregnancy problems			9

[a] Adjusted to 1996 dollars using the medical component of the consumer price index.
[b] Note that these figures do not represent the number of patients; they refer to the number of inpatient admissions and number of outpatient encounters for injecting drug users.
[c] Cost is the incremental cost of labor and delivery for substance abusing mothers as compared with non-substance abusing mothers.

estimates. Cost per treated case estimates for TB were calculated using data from a study by Brown et al. (1995).

To avoid double-counting treatment costs, cost estimates for TB exclude people who have both AIDS and TB since HIV-infected persons are far more likely to contract TB than the general population. In the most recent national comparison of infectious disease registry data, 14% of all TB cases in 1993–1994 had a match in the national AIDS registry (Moore et al., 1997). This percentage translates into 131 comorbid cases in 1996. Subtracting this figure from the 939 cases attributable to injecting drug use in 1996 leaves 808 cases.

2.3.2.3. Hepatitis B and C. Viral hepatitis (primarily hepatitis C and hepatitis B) is responsible for most of the chronic liver disease (CLD), cirrhosis, and hepatocellular carcinoma in the world (Hoofnagle and Di Bisceglie, 1997). The acute phase of either virus can last several weeks to several months; the chronic phase can last for the remainder of a person's life. Chronic cases represent the bulk of hepatitis B virus (HBV) and hepatitis C virus (HCV) treatment costs, as they experience the most serious medical sequelae. An estimated 1–1.25 million Americans have been infected with HBV and ~3.9 million Americans have been infected with HCV (CDC, 1998a). One of the most insidious elements of HBV and HCV is the long incubation period; infections can progress slowly without physical signs or symptoms for more than 20 years (CDC, 1998a). Because of this fact, many cases of hepatitis B and hepatitis C remain undiagnosed until the disease has done significant damage.

Estimates of the costs for IDU-related hepatitis were derived by estimating inpatient and outpatient costs for each type of hepatitis. Patient admissions/visits that listed hepatitis B or hepatitis C in any of the diagnostic fields were identified. The 1995 HCUP-NIS was the source for the number of inpatient admissions and median charges for four categories (acute hepatitis B, chronic hepatitis B, acute hepatitis C, and chronic hepatitis C). The number of outpatient encounters for each type of hepatitis was obtained from the 1996 NAMCS and the 1996 NHAMCS. Median charges for

outpatient visits were obtained using 1996 MarketScan® data.

Inpatient and outpatient utilization figures were adjusted to reflect the proportion of admissions/visits associated with injecting drug use. The CDC attributes 60% of acute hepatitis C cases to injecting drug use (CDC and A. Fiore, Personal communication, 1999) and 20% of acute hepatitis B cases to injecting drug use (Fiore, 1999). Because corresponding figures are not available for chronic cases, this estimate was also used to determine the numbers of IDU-related chronic hepatitis B and C cases.

Interferon-alfa2b, the primary pharmaceutical treatment for hepatitis B and hepatitis C in 1996, can significantly increase treatment costs. A typical 6-month course of treatment costs US$2500 on average (Sharara et al., 1996). It is estimated that only ~20% of hepatitis patients are actually treated with interferon (Raguin et al., 1998). We did not include interferon-related costs in our estimates because very few IDUs receive interferon treatment. The crucial need for strict compliance with the medication regimen dissuades many doctors from prescribing interferon to IDU use, even those that are newly clean.

Due to the fact that injecting drug use is a major risk factor for HIV, hepatitis B, and hepatitis C, there is a significant amount of comorbidity between these diseases. In order to avoid overcounting, we have subtracted the proportion of hepatitis costs possibly associated with HIV infection. Using an estimate of 59% comorbidity between hepatitis C and HIV (Raguin et al., 1998), 59% of hepatitis costs were subtracted out. The same comorbidity figure was used to subtract out costs contained in the HIV cost estimate from the hepatitis B cost estimate.

Note that total treatment costs are significantly higher for HCV than HBV for two reasons. First, HCV is more prevalent among heroin addicts than HBV (CDC, 1998b,c). Second, there is a dramatic difference in the number of infected patients who go on to develop chronic liver disease. More than 70% of hepatitis C patients will develop chronic liver disease (CDC, 1998a), compared with less than 6–10% of hepatitis B patients (CDC, 1998a).

2.3.2.4. Pregnancy problems. Heroin addiction can cause serious complications during pregnancy, including miscarriage and premature delivery. Estimates of the number of births by heroin-using women vary considerably by data source. The 1994 HCUP-NIS indicates that there were ~8300 births to heroin-using mothers in 1994. The 1995 National Hospital Discharge Survey (NHDS) indicates only 2900 births, while the 1992 National Pregnancy and Health Survey (NPHS) identifies 3600 births. The NPHS figure was used in our cost estimates since that survey was specifically designed to identify births to drug-using mothers. Estimates of the incremental cost of delivery for heroin-dependent mothers (US$1480) is based on a study by Norton et al. (1996).

In addition to experiencing more complications during pregnancy, heroin-dependent mothers may be incapable of caring for their newborn infants due to the addiction or to associated psychiatric or physical problems. Babies who remain in the hospital beyond the point at which they are medically ready to leave are termed 'boarder babies.' A 1991 nationwide census of 797 hospitals found that there were a total of 9700 boarder babies in these hospitals during the preceding 12-month period (US Department of Health and Human Services, 1993). Of these 9700 babies, an estimated 7663 infants (79%) had been exposed to drugs. Information on the proportion of these infants born to heroin addicted mothers is scant. We assume that mothers of boarder babies are most likely to have been heroin or cocaine users[6]. For calendar year 1992, the NPHS found that 45 100 infants were exposed prenatally to cocaine and 3600 infants were exposed to heroin. In other words, 7.4% of these infants were born to mothers using heroin. We multiplied the number of drug exposed infants (7663) by 7.4% to generate an estimated number of 567 boarder babies born to heroin abusing mothers. Note that cost estimates for the care provided to 'abandoned infants' (e.g. foster care) are not presented here as they are already included in the social welfare estimates.

The cost of caring for boarder babies was obtained from two sources — the US Department of Health and Human Services (1993), Harwood et al. (1998). The DHHS report found that the average cost of hospitalizing a boarder baby was US$460 per day in 1991. Harwood and colleagues estimated that boarder babies are in the hospital an average of 11 days beyond what is medically necessary. Multiplying these two figures produces a total of US$5060 additional inpatient cost per boarder baby in 1991. These costs were inflated to 1996 figures using the CPI, producing a cost per boarder baby of US$6524.

2.3.3. Health insurance administration

According to HCFA's National Health Accounts, insurance administration costs for all medical care delivered in the United States in 1996 were 5.3% of medical care costs, 7.4% for administration of private

[6] The heaviest users of drugs have demonstrated a much lower ability to handle life's burdens, including raising children, than less frequent drug users. In general, heavy drug users have significantly fewer economic and social support resources (such as housing) than less frequent drug users, which makes caring for children much more difficult (Marcenko et al., 1992). Thus, it is logical to assume that heavy drug users are responsible for an overwhelming proportion of boarder babies.

insurance and 3.2% for administration of public insurance. A recent study estimated that 62.7% of the funding for substance abuse treatment came from public sources (Mark et al., 1998). We used the weighted average of public and private insurance administrative costs to estimate the cost of insurance administration for medical services used by heroin addicted persons where the weights are 0.627 and 0.373, respectively. Thus, we estimate that administrative expenditures associated with treatment of heroin addiction and its consequences were US$229 million (4.8% of US$4810 million).

2.4. Productivity costs

Productivity losses associated with heroin addiction comprise the value of goods and services not produced due to: (1) premature mortality; (2) unemployment; (3) incarceration; and (4) lower earnings as a consequence of heroin addiction.

2.4.1. Mortality

Premature death inflicts a monetary price on society by removing productive citizens. To calculate these costs we estimated: (1) the death rate among heroin addicts; (2) the number of deaths among heroin addicts that can be attributed to the heroin addiction; and (3) the value of the years of life lost.

A recently published meta-analysis of studies of mortality from regular use of illicit opiates estimated that that the SMR (the ratio of observed numbers of deaths to expected deaths) for heroin addiction was 13.2 (Hulse et al., 1999). We used this rate to calculate the fraction of deaths attributable to heroin addiction in 18–50-year-olds in the United States in 1996. The resulting estimate was 11 878 deaths. According to the meta-analysis, the four major causes of mortality among regular opiate users were accidental overdose, suicide, violence and accident/injury, and medical condition.

We use the human capital approach to estimate the value of lost productivity from excess mortality associated with heroin use. According to the US Department of Labor, median annual earnings for persons in the workforce in 1996 were US$25 116. This figure assumes that heroin-addicted persons would have an employment profile similar to that of the average person in the US, were it not for their heroin addiction. Heroin addicts, however, have characteristics that lead them to be less productive than the average person even in the absence of their addiction (i.e., that were not caused by their heroin addiction). Heroin addiction often masks other serious psychiatric disabilities such as post-traumatic stress disorder, depression, bipolar disorder, schizophrenia, and antisocial personality disorders. Heroin addicts also have, on average, lower educational attainment than the US population as a whole.

To adjust the productivity estimates for education level, one needs to know: (1) the difference in education between heroin addicts and nonaddicts; (2) the proportion of the differential in education not attributable to heroin addiction; and (3) the implications of the difference in education for lifetime earnings. In the US, 49% of the population has some education beyond high school and 22% have at least a college degree (US Department of Commerce, 1998). Data from the TEDS indicate that 18% of persons being treated for heroin addiction have education beyond high school (Office of Applied Studies, 1999); unfortunately, the TEDS does not indicate what percent completed college. Based on the CPS, we assume that half of the 18% with education beyond high school have a college degree, or 9%. We also assume that the differential in education between heroin addicted persons and the rest of society is not attributable to their drug use. Information from the Department of Labor indicates that college graduates earned nearly 75% more than high school graduates (US Department of Labor, 1998).

We also adjust the earnings estimates for a higher prevalence of psychiatric illness among heroin addictions. To do this, one needs to know: (1) the difference in the prevalence of psychiatric illness between heroin addicts and nonaddicts; (2) the proportion of the differential in psychiatric illness not attributable to heroin addiction; and the (3) the implications of the difference in psychiatric illness for lifetime earnings. According to the National Comorbidity Survey, more than 40% of persons with addictive disorders also have co-occurring mental disorders. In comparison, in any given year, $\sim$18% of the noninstitutionalized US population have a diagnosable psychiatric disorder. Mental disorders precede substance abuse more than 80% of the time, generally by 5–10 years (Kessler et al., 1996). We use information from Ettner et al. (1997) to adjust the earnings estimates for the effect of psychiatric disorders[7].

To determine the number of working years lost due to premature death one needs to know the average age of heroin addicts. The NHSDA indicates that the median age of past-year heroin users was 24. The TEDS indicates that the median age of heroin users in treatment was 36. Thus, we use a median age of 30 years for our 'best-guess' estimate and a range of 24–36 years in our sensitivity analyses. Using these assumptions, we determined that the average heroin addict would have worked an additional 25–37 years in the absence of the

[7] We explored making additional adjustments based on differences in the gender and race characteristics of the heroin-addiction population but found that it had a negligible effect on the estimates and were concerned that it would convey a false sense of precision and that most of the difference would already be captured in the education adjustment.

illness (Gendell and Siegel, 1992). We use a discount factor of 3% to estimate the present value of the years of lost future earnings and a range of 1–6% for sensitivity analyses. Our 'best guess' estimate was a total present value of US$5027 million dollars lost due to excess mortality.

2.4.2. Unemployment

According to the NHSDA, 32.7% of adults reporting heroin use in the past year were employed (20.6% full-time and 14.1% part-time). This estimate may be conservative given that the NHSDA may miss heroin users with the most chaotic and unstable lifestyles. The 1996 Treatment Episode Data Set (TEDS) indicated that only 21.5% of persons in treatment for heroin addiction were employed either full-time or part-time. In contrast, 66.8% of all adults worked either full-time or part-time in 1996. Thus, in 1996, conservatively 34.1% of unemployed heroin users were estimated to be unemployed due to their heroin use. This is equivalent to US$4557 million in lost earnings due to unemployment.

2.4.3. Incarceration

Approximately 81 547 persons were incarcerated as a result of heroin possession and/or use. All incarcerated individuals are considered to be old enough to be in the workforce. Assuming that average annual earnings for persons addicted to heroin in 1996 were US$22 272 per person (adjusting for education and the incidence of psychiatric disorders), lost earnings in 1996 due to incarceration amounted to US$1 816 million (US$81 547 × 22 272).

2.4.4. Lower earnings

Unfortunately, no existing database has an adequate sample to directly estimate the effect of heroin use on the earnings of those in the workforce. Therefore, we rely on studies that look more broadly at illicit drug abuse and make some inferences about how they apply to heroin use. Using NLAES data, Harwood et al. (1998) estimated that males with a history of dependence on any drug had monthly earnings of US$2356 compared with an expected value of US$2552, which indicates a net loss of US$196 per month and US$2352 per year (US$2630 in 1996 dollars). In females, Harwood et al. found drug abuse to have weak or insignificant effects on earnings. According to the NHSDA and TEDS, 65–67% of heroin users were male (Office of Applied Studies, 1997a,b,c). Using information from the US Department of Labor on employment, we estimate that reduced earnings among the employed males with heroin addiction amounted to US$113 million in 1996.

2.5. Crime costs

The close connection between crime and drug abuse has been extensively documented (see Tonry and Wilson, 1990, for a review). Costs stemming from criminal acts include policing, legal, and incarceration costs and the cost to crime victims. We could not find reliable estimates on the cost of crime avoidance, such as locks and security systems, nor the effect of crime on property values. In addition, we do not attempt to quantify intangible crime-related costs such as fear and avoidance of high-crime neighborhoods.

2.5.1. Policing

Data on police protection and correction expenses were derived from the Justice Expenditure and Employment Extracts, 1992, and inflated to 1996 levels using the CPI. Police protection includes expenditures on police patrols, crime prevention, and the like. We use information on the proportion of arrests associated with heroin use and the sale of heroin to apportion these expenditures to heroin use. According to the Uniform Crime Reports, ~10.4% of a total of 15,284,300 arrests in 1997 were due to drug abuse violations. Of the drug abuse violation arrests, 35.7% were due to heroin possession, sale, or manufacture. Thus, we estimate that 3.7% of all arrests, and associated policing expenditures, can be attributed to heroin use.

This estimate seems consistent with data collected from other sources, although it might be conservative. In 1996, the Drug Use Forecasting program collected data from 19 835 male arrestees and 7532 female arrestees in 23 major metropolitan areas (National Institute of Justice, 1997). The percentage of male arrestees testing positive for opiates ranged from 20% (in Chicago) to 1% (in Omaha). In six of the 23 sites, more than 10% of the male arrestees tested positive for opiates. For females, the percent of arrestees testing positive for opiates ranged from 27% in Manhattan to 1% in Miami. If we assume that 3.7% of all arrests are associated with heroin use, then ~US$1,751 million in policing expenditures can be attributed to heroin use.

2.5.2. Legal

Information from the Justice Expenditure and Employment Extracts indicate that in 1992, US$20.99 billion was spent in the US Justice System on legal and adjudication expenditures (equivalent to US$23.929 billion in 1996 dollars). If 3.7% of all arrests are associated with heroin use, then ~US$885 million in legal and adjudication expenditures can be attributed to heroin use.

2.5.3. Incarceration

We estimate that, in 1996, ~81 547 persons were incarcerated as a result of heroin use, totaling 5% of all correction costs or ~US$1787 million. To derive this estimate, we first determined how many individuals were incarcerated due to heroin use and then applied that number to the total cost of incarceration as provided in the Justice Expenditure and Employment Extracts.

According to the Bureau of Justice Statistics (1998b), in 1996 there were 93 167 Federal prisoners, 1 019 281 State prisoners, and 518 492 jail inmates. The 1996 Profile of Jail Inmates found that approximately 9% of jail inmates had used heroin within a month prior to their offense. Similarly, the 1991 Survey of Inmates in State Correctional Facilities (SISCF) found that ~10% had used heroin within a month prior to their offense. We estimate that half of the incarcerations where heroin was used within a month prior to the offense were directly due to heroin use. Information on the connection between crime and heroin addiction must necessarily be inferred. One source of information on this relationship is from arrestees' reports about whether they thought their drug use and their offense were connected. In a study conducted in the UK, 46% of arrestees who tested positive for drug use reported that their drug use and crime were connected (Bennett, 1998). Additional information comes from the high positive correlation found between illegal income and positive urinalysis test for illegal drugs (Bennett, 1998). Finally, over the past two decades, clear and convincing evidence has been collected from multiple studies that effective treatment of opiate dependence markedly reduces the rates of criminal activity. For example, the National Treatment Improvement Evaluation Survey (NTIES) examined criminal behavior during the 12-month period before and after treatment in 1997. The results show substantial reductions in criminal behavior and arrests after treatment including a 64% reduction in arrests for any crime and a 48% drop in the percentage that largely supported themselves through illegal activity.

2.5.4. Costs to crime victims

Information on the number of crime victims and costs of crimes to victims was derived from the Bureau of Justice Statistic's National Crime Victimization Survey (NCVS). The NCVS collects data on victimization through household interviews. Each interviewee is asked whether he/she has been the victim of a crime, the type of crime, and the costs incurred as a result of the crime. The NCVS calculated that that there were 26.9 million crimes involving economic loss into 1992 at an average loss of US$958 per victim. We apportion the victim costs to heroin use using information from surveys on the association between crime and drugs. Specifically, data from the Bureau of Justice Statistics (i.e. drugs and crime facts, 1994) indicated the percent of inmates who committed their offense for money to buy drugs, by type of offense. Information from the Profile of Jail Inmates and the Survey of Inmates in State Correctional Facilities was used to determine that ~20% of inmates using drugs used heroin. This approach leads to an estimate that victims experienced US$796 million in total economic losses associated with heroin-related crimes.

2.6. Social welfare costs

Social welfare costs fall into three categories: social insurance, public aid, and direct human services. Our estimates begin with the 1992 cost figures presented by Harwood et al. (1998) for each of these three categories. Consistent with most prior substance abuse cost-of-illness studies we exclude all transfer costs. The remaining expenditures — administrative and direct service costs — are then inflated to 1996 levels using the CPI. Harwood estimated that drugs were responsible for approximately one-third of social welfare costs. Data from Rhodes et al. (1994) indicate that ~29% of 'hard core drug users' are heroin users thus we attribute ~29% of the social welfare costs of drug abuse to heroin[8]. Applying this algorithm produces a social welfare cost estimate of US$99 million.

3. Discussion

Our 'best guess estimate' of the total cost of heroin addiction in the United States in 1996 is US$21.9 billion. Of these costs, productivity losses accounted for 52.6%, criminal activities 23.9%, medical care 23.0%, and social welfare 0.5%. Costs generated using the most and least conservative assumptions range from US$19.6 to 33.4 billion[9].

A number of factors limit the accuracy of the estimates and need to be considered when using them for

[8] Note that the Contract with American Advancement Act of 1996 ended OASDI and SSI benefits for persons whose drug addiction or alcoholism contributed significantly to their disability. The law denied benefits to individuals who applied for OASDI or SSI on or after July 1, 1996. Individuals already collecting benefits on 1 July, 1996, continued to receive them until 1 January, 1997 (Social Security Administration, 1996). Thus, the implementation of this law had little impact on our cost estimates since benefits were paid for this population through 1996. The only real effect on our cost estimates stemmed from the denial of benefits to new applicants on or after 1 July, 1996. Our estimates may slightly overestimate costs because they do not exclude this relatively small subpopulation of heroin addicts.

[9] The range was calculated using alternative data when such data existed. For example, assuming that the size of the heroin addicted population was 810 000 persons rather than 600 000 persons.

policy evaluation and formulation. The first general issue relates to the availability of data characterizing persons addicted to heroin. Estimates of the prevalence of heroin addiction are notoriously difficult to produce (Epstein and Gfroerer, 1998). Furthermore, databases often do not indicate the number of 'addicts' according to a strictly clinical definition. Rather, they capture a more general concept of relatively intensive and problematic use of heroin. Similarly, survey and treatment data can only partially inform our knowledge about the demographic characteristics of heroin addicts. Perhaps the most correctable problem is the current gap in our knowledge about heroin addicts receiving treatment.

A second common challenge faced in substance abuse cost-of-illness studies is that of calculating attributable risk factors. We assume, for example, that heroin addiction was directly related to incarceration in half the cases where heroin use was reported in the month before the offense. Although there is clear evidence connecting opiate addiction to criminal activity, whether the attributable risk factor among heroin users should be 50 or 30 or 40% could be debated. In most cases, we address these uncertainties by providing a range of estimates and using a conservative estimate for the base estimate.

Determining attributable risk is also complicated by the presence of comorbid factors that could influence the outcomes of interest such as crime and mortality. We try to account for most of these factors. For example, we subtract out the costs for men who are both IDUs and having sex with other men from the estimates of costs due to AIDS. We also subtract out the costs of psychiatric comorbidity and lower education from the productivity loss calculations. Again, in general, we tried to err on the conservative side (discounting costs where comorbidities occurred).

Despite these limitations, this cost-of-illness study should help place some parameters around our understanding of the burden of heroin addiction. How big a problem is heroin addiction? Although only $\sim$5% of users of illicit drugs use heroin, heroin makes up $\sim$20% of the total economic costs of illicit drug use, estimated to be US$109.8 billion in 1995 (Harwood et al., 1998). Another context is its economic impact relative to spending on treatment and prevention. The economic cost of heroin addiction exceeded the total drug control budget of the US Federal Government in 1996, which was US$13.5 billion.

A key question that cost-of-illness studies can only partially address is whether the correct investments in treatment and prevention are being made. Some important changes are underway in the treatment of heroin in the US. A mainstay of the American treatment approach to heroin addiction has been methadone and more recently LAAM. Agonist maintenance treatment with methadone or LAAM has been shown to reduce the spread of infectious disease such as HIV (Metzger et al., 1998), to increase employment rates, to reduce wages lost from incarceration, and to reduce costs from addiction-related crime (DeLeon, 1995; Ralston and Wilson, 1996; National Consensus Development Panel on Effective Medical Treatment of Opiate Addiction, 1998).

Even so, a recent National Institutes of Health (1998) Consensus Panel concluded that there are major barriers to agonist maintenance treatment in the US. These barriers include: (1) a shortage of physicians and other health care professionals prepared to provide treatment for opiate dependence; (2) unnecessary regulations; (3) lack of funding by public and private insurers; and (4) stigma and misperceptions attached to opiate dependence. As a result, only $\sim$20% of heroin addicts currently receive treatment. To begin to address this problem, regulations are being crafted to reduce the historical emphasis on regulating the provision of methadone and to place greater emphasis on clinical care and the quality of maintenance programs (Federal Register, 1999).

In addition, new agents to treat heroin addiction, such as the buprenorphine/naloxone combination, are currently under review by the Food and Drug Administration (FDA). This medication is proposed to be in schedule IV or V due to evidence that it has substantially lower abuse liability than schedule II medications. If the abuse liability and safety of this or other similar medications is in fact low, particularly when used to treat a high-risk group of patients such as heroin addicts, it may be possible to use this or other similar medications outside of the current methadone/LAAM clinic structure, for example, in physician offices. A recent brief by the National Institute on Drug Abuse (NIDA) articulated some of the potential advantages of moving treatment outside its currently highly regulated environment (NIDA, 1999). The brief noted that a recent NIDA funded study (NIDA/VA1008) found that $\sim$50% of the heroin-addicted subjects had never been in treatment before. Of that group, fully half maintained that they did not want treatment in the current narcotic treatment program system, citing stigma and the urban location of most facilities as the two primary reasons.

While this paper focuses on the US, the immense burden posed by heroin addiction is likely to be similar in other countries. Within the European Union (EU), for example, only $\sim$20% of the 1.5 million problem opiate users receive treatment (European Monitoring Centre for Drugs and Drug Addiction, 1999). Countries with substantial numbers of heroin addicts have responded in widely divergent ways. Methadone and other agonist drugs are not allowed for treatment of addiction in Pakistan, Russia and Taiwan, for example. In these countries, drug free rehabilitation programs are

the only acceptable methods of treatment. In contrast, countries such as Australia, Austria, France, Germany, the Netherlands, the UK, Spain and Switzerland use agonist treatments extensively.

In Spain, the widespread use of methadone for maintenance began only about five years ago. The change in policy took place when it became clear that Spain had the highest rate of HIV infection in Europe and that it was being spread widely among heroin addicts. As a result, Spain changed course and established a network of methadone programs that work in collaboration with pharmacies and prisons (M. Suarez, Personal communication with Dr. G. Woody, 1999).

In France, a sudden and massive expansion of buprenorphine maintenance has been associated with a reduction in deaths from heroin overdoses (C.P. O'Brien, M. Auriacombe, Personal communication with Dr. G. Woody, 1999). In general, the Western European countries and Australia have substantially increased the use of agonist medication treatment over the past 10 years.

Heroin abuse in the United States is on the rise, particularly among younger persons who are smoking or sniffing heroin rather than injecting. Between 1991 and 1995, the annual number of heroin-related emergency department visits more than doubled. In 1997, heroin became the most common primary illicit substance used by persons in treatment, surpassing cocaine (US Department of Health and Human Services, 1999). By quantifying in economic terms the implications of these trends, policymakers can better weigh the benefits of efforts to prevent and treat heron addiction and to minimize its consequences. More difficult to estimate are the intangible savings that would accrue. These intangible items might include the community demoralization and disruption that occur when there is a concentration of untreated, criminally involved addicts in a neighborhood, the toll on the psyche and productivity of individuals who live with or who are otherwise involved with heroin addicts, and the spread of infectious diseases.

Acknowledgements

Support for this study was provided under contract to The MEDSTAT Group, Inc. and to Drs. Woody and Kleber by Integrated Therapeutics Group, Inc., a subsidiary of Schering-Plough Pharmaceuticals, 2000 Galloping Hill Road, K-6-2-D5B, Kenilworth, NJ 07033.

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