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Chronic illicit drug use, health services utilization and the cost of medical care

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Abstract

Few studies have examined the relationships between drug use, health services utilization and the cost of medical care for a community-based sample of drug users. The purpose of this study was to analyze recently collected data on chronic drug users (CDUs), CDUs who were also injecting drug users (IDUs) and non-drug users (NDUs) to determine whether these groups exhibited differences in health services utilization and cost. In addition to descriptive analyses, these relationships were estimated with multivariate regression models.

Data were collected in 1996 and 1997 through a standardized self-reported questionnaire administered to individuals who were recruited through community outreach activities in the USA. Annual differences in health services utilization between CDUs, IDUs and NDUs were estimated for three measures: number of times admitted to a hospital, number of outpatient visits and number of emergency room episodes.

Results of this study indicate that CDUs and IDUs consumed significantly more inpatient and emergency care, but less outpatient services relative to NDUs. Analyses of total health care costs showed that CDUs and IDUs each generated about $1000 in excess services utilization per individual relative to NDUs.

This research is the first study to compare differences in health services utilization and cost among out-of-treatment drug users relative to a matched group of non-users in a community-based setting. The findings suggest that health care providers and managed care organizations should consider policies that promote more ambulatory care and discourage emergency room and inpatient care among drug users. Innovative and culturally acceptable approaches may be necessary to provide incentives without posing unusual financial hardship.

Keywords: Drug use; Health services; Cost; USA

Introduction

Illicit drug use is often associated with relatively high utilization and cost of health services, es-

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pecially emergency room care (Stein et al., 1993; Ottaway and Erickson, 1997). Among drug users, injection drug users (IDUs) may be the most frequent consumers of health services due to unsafe needle practices and the elevated risk of overdosing (Wartenberg, 1991; Beaufoy, 1993). The link between drug use and health care utilization is not well established, however, because few data sets contain detailed health services information for active drug users combined with a matched group of non-drug users. Most studies in the literature analyzed data on drug abusers in treatment or clinical settings compared to a general population sample with quite different underlying characteristics (Padgett and Struening, 1991; Umbricht-Schneiter et al., 1994; Hollander et al., 1995).

More utilization studies on out-of-treatment drug users are necessary to determine (1) what type of care these individuals are consuming, (2) whether consumption patterns are different from other, demographically similar, individuals and (3) the differential cost of service utilization. Although out-of-treatment drug users exhibit numerous health problems, both self-reported and clinically diagnosed (White and Bates, 1993; Chen et al., 1996; Cornish and O'Brien, 1996; Morrison et al., 1997), recent studies have found that access to health care (both financially and geographically) is limited for some users while others suffer from serious health consequences without seeking care (Druss and Rosenheck, 1997; O'Connor et al., 1992; Weissman et al., 1995).

Researchers, policy makers and clinicians could benefit from more recent and accurate information on the relationships between drug use and health care utilization. For example, new empirical information would help researchers verify existing theories, develop alternative models and formulate research initiatives. Policy makers could use such information to determine areas for potential intervention and improvement (e.g., access and incentives). Finally, clinicians could compare and adjust their observations and practice patterns.

To address such information needs, the present study estimated the associations among three groups of drug users (CDUs, IDUs and NDUs) and three types of health services utilization (emergency room use, outpatient care and inpatient care). Epidemiological data from both drug users and non-drug users recruited through street outreach activities were analyzed. In addition, the aggregate cost of service utilization was estimated and compared across the three groups. To our knowledge, this is the first study to offer comparative information on health services utilization and cost by out-of-treatment drug users and non-drug users in a community-based setting.

Review of the literature

Researchers have determined that drug abuse is associated with numerous medical consequences such as HIV (Allen et al., 1992; Bruneau et al., 1997; Kral et al., 1998), psychiatric disturbances (Anthony and Petronis, 1991), neurologic complications (Brust, 1998), Hepatitis A (Harkess et al., 1989), cardiovascular problems (Bunn and Giannini, 1992), infections (Haverkos and Lange, 1990) and attention and memory deficits (McKetin and Mattick, 1997). Drug use may also cause health consequences indirectly because certain behaviors that are associated with drug use (e.g., needle sharing, unprotected sex) can also lead to medical problems (Cottler et al., 1990; Rolfs et al., 1990; Chirgwin et al., 1991; Gunn et al., 1995).

Research on health services utilization of drug users is less voluminous than the literature on the health consequences of drug abuse. Kissinger et al. (1995) examined outpatient visits and use of emergency room care that did not lead to a hospital admission for HIV patients. Multivariate analysis of 1824 clients indicated that IDUs were more likely to miss outpatient visits and had at least one more emergency room visit relative to other groups. Similarly, Mor et al. (1992) found that white, male and non-IDU clients had higher rates of outpatient visits for HIV-related services whereas nonwhite, female and IDU clients had higher rates of emergency room use.

In a study of inpatient hospital stays, Seage et al. (1993) found that IDUs with AIDS had a 42% longer length of stay and a 38% higher cost per hospitalization than non-IDU AIDS patients. Bradley and Zarkin (1996) examined the length of inpatient hospital stays for patients who had a substance abuse comorbidity along with a diagnosis for either schizophrenia or affective psychoses. Although some studies found that substance abusers had relatively longer inpatient stays, Bradley and Zarkin demonstrated that the relationship depended on numerous factors. In some specifications, individuals with a substance abuse comorbidity actually had shorter stays in the hospital.

Hoff and Rosenheck (1998) also studied health care utilization of drug users, but their results were partially counter to the findings of Bradley and Zarkin (1996). Specifically, Hoff and Rosenheck analyzed a large cohort of patients treated at Veterans Affairs mental health programs to determine whether dually diagnosed patients (psychiatric and substance abuse disorders) had higher health care costs than other psychiatric outpatients. Over a 6 yr follow-up period, they discovered that dually-diagnosed outpatients indeed incurred higher health care costs than other psychiatric clients, but cost differences were not present for inpatient clients.

Solomon et al. (1991) examined health services utilization among a sample of IDUs and concluded that HIV seropositive IDUs did not receive sufficient preventative care. However, like most studies of this type, the authors did not have a matched group of non-IDUs or non-drug users to compare differences in health services utilization across groups.

Concentrating on emergency room care, McGeary and French (in press) found that chronic drug users had a higher probability of using emergency room services relative to a combined group of non-chronic drug users and non-drug users. Data from the 1994 National Household Survey on Drug Abuse offered detailed information on a large number of individuals across the US. McGeary and French used a two-stage estimation technique and found that chronic drug use had a positive and significant effect on the probability of emergency room utilization.

Conceptual framework

There are several ways to model the consumption of health care (e.g. Andersen and Newman, 1973; Aday and Andersen, 1974; Duan et al., 1983). We adopted an approach commonly used by economists, which describes the demand for health care through a household production process for good health (Grossman, 1972a,b; Rosenzweig and Schultz, 1983). The economic approach is intuitively appealing, but some data requirements (e.g., medical care prices) are sometimes difficult to fully meet.

The essence of the economic approach is that individuals do not consume health care for the direct pleasure, but for the effect that health care has on health status and consequently, overall utility or well being. Utility-maximizing individuals are faced with a budget constraint that limits the amount of health care (and other goods) they can consume. Solving this constrained maximization will provide the demand relationship for each good and service in the person's utility function, including health care (Folland et al., 1993). In addition to the prices of health care and other consumption goods, several factors will influence the timing and amount of health care utilization. These include personal characteristics that influence preferences and tastes such as age and education; behavioral choices such as drug use; environmental factors such as availability of care; and income available to the individual[1]. The implicit form of this demand relationship is presented below:

$$\mathrm{HC} = \mathrm{HC}(P_{\mathrm{hc}}, P_{\mathrm{x}}, \mathrm{PC}, \mathrm{BC}, I), \tag{1}$$

where HC is a measure of health care utilization (e.g., outpatient visits, inpatient episodes), P_{hc} is the price of health care (which is also dependent on the type of health insurance), P_{x} is the price of a composite good (normalized to 1), PC is a vector of personal characteristics (e.g., age, education, marital status), BC is a vector of behavioral characteristics (e.g., drug use, eating habits) and I is income.

The hypothesized relationships between HC and the set of explanatory variables are as follows. P_{hc} will be inversely related to HC due to the law of demand (Rosenzweig and Schultz, 1983; Phelps, 1992). Individuals with any health insurance should consume more health care and possessing private health insurance may have a stronger effect relative to public insurance. Personal characteristics (PC) could affect HC in a variety of different ways. For example, one would presume that age is positively related to HC because of the onset of illness and disease attributed to the aging process and a corresponding decline in health capital (Getzen, 1997). Conversely, one could argue that education is negatively related to HC due to better disease management information and overall healthy behaviors by more educated individuals. However, education could also be positively related to HC because educated people may be more aware and protective of their health. A priori, the exact direction and magnitude of these relationships are not easy to discern.

Drug use, the focus of this analysis, has an uncertain relationship with health care demand. Numerous studies have established that drug use is associated with health consequences, which would normally lead to increased demand for health care (Haverkos and Lange, 1990; Bunn and Giannini, 1992; McKetin and Mattick, 1997; Brust, 1998). However, drug users may decline health care despite these needs to avoid scrutiny and contempt associated with their drug use. In addition, financial barriers and difficulties navigating the health care system could further impede their use of health care. Again, the empirical analysis will determine which (if any) of these effects are dominant.

Lastly, income is positively related to the demand for health care. Although health care demand is usually more episodic than continuous, there is still ample evidence that individuals elect to consume discretionary care and more acute care overall as their income rises (Phelps, 1992).

[1] In our model, it is assumed the drug users face the same access conditions as non-drug users. This assumption is based on work by Rivers et al. (1999), which found that the vast majority of health care providers in Dade County, Florida believe drug abusers have equitable access to all types of health services.

Estimation approach

None of the three measures of HC in this analysis (number of outpatient visits, number of emergency room episodes and number of inpatient hospital days) were normally distributed. The values for each measure were clustered around zero and small integer numbers for the vast majority of the observations. The appropriate estimation technique for dependent variables that exhibit these count-data properties is Poisson or negative binomial regression (Greene, 1997).

Each equation was initially estimated using Poisson regression. However, the Poisson model makes the restrictive assumption that the conditional mean of the dependent variable (HC) is equal to the variance. Using a method developed by Cameron and Trivedi (1990), statistical tests of this assumption were not supported for any of the HC variables, so the relationships were re-estimated with the more flexible negative binomial regression, which allows for greater variation (i.e., overdispersion) of HC.

In addition, the analysis tested for zero inflation of the observed outcome HC = 0 to determine whether to implement the zero inflated negative binomial model (Econometric Software, 1995). As an example, the probability of a zero value could be "inflated" if some respondents reported no episodes of care during the past year simply because they would never use a particular type of service. A Vuong test (Vuong, 1989) indicated that zero inflation was not present in these data, which increased support for the negative binomial technique.

Another estimation challenge involved the potential correlation of an explanatory variable(s) with the error structure of the estimating equation (Manning et al., 1987; Mullahy, 1998; Norton et al., 1998; McGeary and French, in press). This situation could arise if an independent variable(s) was significantly correlated with missing or unobserved variables that were important predictors of HC. The correlated and unobserved influences would lead to biased coefficient estimates. Explanatory variables that are correlated with the residual of the regression are endogenously determined explanatory variables (Bollen et al., 1995; Norton et al., 1998).

The variables most likely to be considered endogenous in Eq. (1) are the choice variables associated with drug use (i.e. CDU and IDU). One of the most common techniques to address potential endogeneity bias is instrumental variables (IV) regression or two-stage least squares (Davidson and MacKinnon, 1993; Greene, 1997). The purpose of IV regression is to use exogenous variables (referred to as instruments in this example) that are correlated with the potentially endogenous explanatory variable (drug use), but uncorrelated with the dependent variable (HC). These exogenous instrumental variables can be used to predict drug use in a first stage equation and the results are then used in a second stage HC regression.

To address potential endogeneity bias associated with drug use, we first carefully reviewed the survey questionnaire for potential instrumental variables that were significantly related to drug use, but unrelated to HC (Bollen et al., 1995; Bound et al., 1995; Mullahy, 1998). The most intuitively appealing measures included indicator variables for the degree that religious beliefs would influence behavior (i.e., strongly, somewhat, a little, not at all)[2]. Second, we tested the reliability of these instruments using the partial R^2 statistic and a Wald test for joint significance (Bound et al., 1995; Norton et al., 1998). Third, we tested for misspecification of the regression model using the J statistic (Godfrey and Hutton, 1994). The reliability and misspecification results weakly supported the use of these instruments and the IV specification. Thus, we then conducted a Hausman test (Hausman, 1978) to determine whether drug use was indeed endogenous. The null hypothesis that drug use was exogenous could not be rejected. Finally, we tested the overidentifying restrictions of the model (i.e., the excluded instruments were orthogonal to the error in the HC regressions) and found that the null hypothesis could not be rejected (Davidson and MacKinnon, 1993). While acknowledging that our instrumental variables were not ideal, we concluded from these statistical tests that endogeneity corrections for drug use were not necessary[3].

Estimation was further challenged by actual measurement of some independent variables. One of the most important variables in a demand relationship is the price of the good or service. Actual prices for health services are very difficult to obtain for individual consumers and variation within state or city boundaries depends upon quoted prices, insurance status and availability of care. Charge data from hospitals may be an acceptable approximation for actual prices, but this option was not possible because study participants did not indicate where they received care.

As an alternative to direct information on health care prices, availability and quality, a series of dummy variables were coded based on respondents' zip code of residence within the region. Twenty-one dummy

[2] Illicit drug prices and enforcement measures for drug laws may be better instruments for drug use. However, these measures were not available and the variation within a single county is probably minimal. In addition, recent studies have determined that the reliability of illicit drug price data is questionable (Chaloupka et al., 1999; Farrelly et al., 1999).

[3] All calculations and regression output are available from the corresponding author.

variables were created to proxy market variation in health care and associated prices. Several zip codes with less than 5 observations in the data set were coded together to form the index category. Zip codes are not an ideal proxy for health care prices, but they do represent a fine level of distinction between small geographical markets.

The only behavioral characteristic included in the estimating equations was represented through dummy variables for CDU and IDU. The analysis was limited to drug use only because the questionnaire offered little information on other behavioral characteristics that were related to the demand for HC[4]. In addition, including other potentially endogenous right-hand-side variables such as alcohol use would introduce unnecessary bias (Mullahy, 1998).

Sample and data

The sample design and data collection procedures for this study were complex and rigorous. The primary objective was to administer a health services questionnaire to 1800 African–American, Hispanic and non-Hispanic white individuals who were demographically similar, but differentiated by their drug-using status. Sample accumulation was closely monitored to ensure that roughly equivalent sample sizes were obtained for CDUs, IDUs and NDUs. In addition, adequate representation by gender and race/ethnicity was also monitored. This ambitious data collection effort required about 2 years to complete and resulted in a final analysis sample of 1480 individuals.

Subjects

Separate inclusion criteria were established for the three groups of subjects. CDUs included individuals who consumed an illicit drug(s) once a week or more during the previous 12 months, tested positive for cocaine and/or opiates on a urine screen, but never injected illicit drugs and therefore, had no evidence of track marks. Active IDUs were distinguished from CDUs by the fact that the most common route of drug ingestion was through a hypodermic needle. IDUs injected cocaine and/or opiates at least once a week during the past year, had recent (past 48 h) track marks from injection and tested positive on urine screens for cocaine and/or opiates. NDUs never used cocaine or opiates, tested negative on a urine screen for both drugs and had no visible track marks. Individuals who used marijuana less than 13 times during the past year were eligible for the NDU group. Consequently, NDUs included individuals who (1) never used cocaine or opiates, (2) never injected drugs, but (3) might have used marijuana during the past 12 months on a "casual" basis. The eligibility criterion for a CDU was consistent with the definition that was developed by the Office of National Drug Control Policy (1995).

Eligibility for the study was determined through a brief screener prior to full administration of the instrument. Individuals were excluded from the study if they (1) were significantly impaired, (2) had difficulty understanding the questions, (3) were violent or abusive, or (4) misreported their eligibility based on laboratory reports of specimens.

Recruitment

The recruitment territory encompassed the entire area of metropolitan Dade County, Florida. The largest cities in Dade County are Miami, Miami Beach, Homestead and Opa-Locka. Using geocoding procedures, high-risk areas within Dade County were identified based on indicator data from drug treatment, criminal justice and street outreach databases (Rivers et al., 1999) and recruitment efforts were mobilized in these areas. A high-risk designation was based on above average scores for crime, drug use, poverty and other social indicators.

Subjects were recruited from an area that spanned 78 zip codes. NDUs were recruited from the same zip codes as IDUs and CDUs. Three full-time outreach workers visited these neighborhoods and potential participants were screened in the community by the outreach workers. Consenting individuals who appeared to be eligible were provided round-trip transportation to a central assessment center for a more comprehensive screen. The outreach workers recruited subjects at all times and days of the week to obtain the targeted sample accumulation. After passing the full eligibility criteria, the subjects were escorted to a private room to complete the questionnaire with the assistance of an experienced survey administrator. Total participant time (including transportation) generally ranged from 1.5 to 2.5 h.

Recruitment was completed in December 1997 with 1570 individuals enrolled in the study. After cleaning the data and eliminating unusable observations, the total sample included 386 CDUs, 542 IDUs and 552 NDUs. Subsamples by gender and race/ethnicity

[4] Information on alcohol consumption was also obtained from the survey questionnaire. However, a measure for alcohol consumption was not included in the final specification because drug use and alcohol use were highly correlated ($p < 0.01$) and including both variables in the model led to multicollinearity problems.

included 842 men, 638 women, 557 African–Americans, 481 Hispanics and 442 non-Hispanic whites.

Instrumentation

Considering the broad aims and objectives of the research project, it was not possible to locate a single data collection instrument that addressed all information needs. Thus, questions from several of the leading health services instruments (e.g. McLellan et al., 1985; Weisner and Schmidt, 1995; Dennis et al., 1996; Substance Abuse and Mental Health Services Administration, 1996) were reviewed and selected. Since health services information, especially with respect to drug users, has not been widely explored in the literature, many new questions were designed to obtain important information on demographics, health status, morbidity, health care utilization, barriers to utilization, drug use, route of drug ingestion and related lifestyle behaviors. The final questionnaire was divided into 7 sections — screening, general, medical, satisfaction, alcohol and drug use, demographics, safety — and contained well over 300 questions. A complete version of the Health Services Research Instrument is available from the corresponding author.

Sample statistics

Table 1 presents mean values for all of the variables used in the empirical analysis. In addition to overall sample means, values were reported by drug using status including CDU, IDU and NDU. Most of the variables displayed significant differences in mean values across the drug-using groups ($p < 0.05$, Kruskal–Wallis rank-sum test).

The average age of the sample was just over 37 yr. NDUs were less likely to be married and IDUs had more years of schooling relative to the other groups. Only 10% of the sample was working full-time and 9% was working part-time at the time of the interview. However, 58% of the full sample was employed at least part of the year during the past 12 months. Average legal income during the past year ranged from $5411 for CDUs to $8296 for NDUs. Illegal income was very small for NDUs, but surpassed legal income for both CDUs and IDUs.

Regarding health services utilization and access to care, only 35% of the sample had some form of health insurance during the entire term of the previous 12 months and 17% had part-year coverage. The average times admitted to a hospital and the average number of emergency room episodes was less than one for all three groups, with CDUs and IDUs showing higher averages than NDUs. The average NDU had a higher number of outpatient visits during the past year (1.89) compared to the other groups, with the average for the full sample equal to 1.55.

To estimate the cost of health care, average charges were obtained for an emergency room visit ($495), an

Table 1
Variable means, by drug using status[a]

Variable	CDU ($N = 542$)	IDU ($N = 384$)	NDU ($N = 553$)	Total ($N = 1479$)
Age (yr)[b]	35.9576 (7.7674)	39.4609 (7.7496)	37.2351 (11.5270)	37.3448 (9.4417)
Married[b]	0.3173 (0.4659)	0.3203 (0.4672)	0.1863 (0.3897)	0.2691 (0.4436)
Single[b]	0.1734 (0.3790)	0.2839 (0.4515)	0.3038 (0.4603)	0.2508 (0.4336)
Male[b]	0.5351 (0.4992)	0.6797 (0.4672)	0.5335 (0.4993)	0.5720 (0.4950)
White	0.2934 (0.4557)	0.2760 (0.4476)	0.3165 (0.4655)	0.2975 (0.4573)
Black	0.3653 (0.4820)	0.4245 (0.4949)	0.3526 (0.4782)	0.3759 (0.4845)
Hispanic	0.3395 (0.4740)	0.2995 (0.4586)	0.3309 (0.4710)	0.3259 (0.4689)
Highest grade completed[b]	10.7971 (2.6682)	11.4297 (2.4855)	11.2098 (2.7272)	11.1156 (2.6554)
Working full-time[b]	0.0609 (0.2393)	0.0729 (0.2603)	0.1609 (0.3678)	0.1014 (0.3020)
Working part-time	0.0793 (0.2705)	0.0599 (0.2376)	0.1121 (0.3158)	0.0865 (0.2813)
Legal income ($ in past year)[b]	5411 (6480)	7350 (11,436)	8296 (11,929)	6993 (10,197)
Illegal income ($ in past year)[b]	6534 (15,841)	10,385 (23,328)	222 (1795)	5169 (15,836)
Any health insurance[b]	0.4668 (0.4994)	0.4922 (0.5006)	0.6076 (0.4887)	0.5260 (0.4995)
Had insurance for past 12 months	0.3118 (0.4637)	0.3568 (0.4797)	0.3870 (0.4875)	0.3516 (0.4776)
Had insurance for past 1–11 months	0.1550 (0.3622)	0.1354 (0.3426)	0.2188 (0.4138)	0.1738 (0.3790)
Times admitted to hospital (past year)	0.3100 (0.9784)	0.3203 (0.8844)	0.2409 (0.6961)	0.2869 (0.8576)
Outpatient visits (past year)[b]	1.4243 (2.2654)	1.2318 (1.7195)	1.8861 (2.2189)	1.5470 (2.1349)
Emergency room episodes (past year)[b]	0.7915 (2.0795)	0.7839 (1.8459)	0.5190 (1.2069)	0.6876 (1.7398)
Total health care costs (past year)	2666 (7526)	2717 (6868)	2094 (5265)	2466 (6588)

[a] Standard deviations in parentheses. CDU = chronic drug user; IDU = injection drug user; NDU = non-drug user.
[b] Statistically significant differences in variable means across the drug-using categories, $p \leq 0.05$, Kruskal–Wallis rank test.

Table 2
Regression results for health services utilization during the past year[a]

Variable	Emergency room episodes	Outpatient visits	Hospital admissions
CDU	0.4267[c] (0.1337) [0.2360]	−0.1312[b] (0.0751) [−0.1631]	0.3685[c] (0.1821) [0.0783]
IDU	0.5466[c] (0.1485) [0.3270]	−0.2937[c] (0.0854) [−0.3473]	0.4900[c] (0.2011) [0.1120]
χ^2 test (CDU = IDU)	0.78	3.70[b]	0.41
Age	−0.0047 (0.0343)	−0.0108 (0.0185)	−0.0401 (0.0465)
Age squared	0.0000 (0.0004)	0.0002 (0.0002)	0.0005 (0.0006)
Married	−0.1324 (0.1352)	−0.1301 (0.0815)	−0.4449[c] (0.1889)
Single	−0.1559 (0.1409)	0.0065 (0.0832)	−0.5084[c] (0.1968)
Male	−0.2568[c] (0.1113)	−0.4725[c] (0.0651)	−0.1508 (0.1577)
Black	−0.2104 (0.1439)	0.0464 (0.0846)	−0.1067 (0.1996)
Hispanic	0.0862 (0.1387)	0.1121 (0.0842)	0.2818 (0.1883)
Highest grade completed	0.0128 (0.0200)	0.0135 (0.0116)	0.0025 (0.0266)
Working full-time	−0.5007[c] (0.2037)	−0.2141[c] (0.1087)	−0.5875[c] (0.2896)
Working part-time	−0.2704 (0.1964)	−0.2380[c] (0.1141)	−0.4459 (0.2816)
Legal income/1000($) (past year)	0.0127[c] (0.0058)	0.0048 (0.0030)	0.0010 (0.0081)
Illegal income/1000 ($) (past year)	0.0097[c] (0.0032)	0.0029 (0.0020)	0.0061 (0.0046)
Had insurance for past 12 months	1.1684[c] (0.1249)	1.0240[c] (0.0722)	1.5366[c] (0.1775)
Had insurance for past 1–11 months	1.4012[c] (0.1386)	0.8887[c] (0.0835)	1.4675[c] (0.1982)
Constant	−1.3253[b] (0.6791)	0.1689 (0.3770)	−1.3275 (0.8922)

[a] Standard errors for the coefficient estimates reported in parentheses. Marginal effects reported in brackets. Estimates for 21 zip code variables are not reported. CDU = chronic drug user; IDU = injection drug user.
[c] Statistically significant, $p \leq 0.05$.
[b] Statistically significant, $p \leq 0.10$.

outpatient visit ($89) and an inpatient hospital episode ($6929) (French and Martin, 1996)[5]. These charges were then applied to each type of care and a variable was created for total cost of medical care by summing across the three categories. The mean annual total cost for CDUs, IDUs and NDUs was $2666, 2717 and 2094.

Estimation results

Separate models were estimated for emergency room episodes, outpatient visits and hospital admissions. Regression output for all independent variables is reported in Table 2. All of the coefficient estimates for the drug use indicator variables (CDU and IDU) were significantly different from zero at the 10% level and usually at the 5% level or lower. Both CDUs and IDUs had significantly more emergency room episodes relative to NDUs. These two groups also had significantly more hospital admissions. However, utilization of outpatient visits was significantly lower for CDUs and IDUs relative to NDUs. Interestingly, equality of the coefficient estimates for CDUs and IDUs was only rejected for outpatient visits ($p = 0.054$, χ^2 test). Stated differently, CDUs and IDUs had statistically similar rates of emergency room use and hospital admissions. But, IDUs had fewer outpatient visits than NDUs *and* other CDUs.

The negative binomial technique relies on an underlying gamma distribution to address overdispersion in the data. Thus, the estimated coefficients can be transformed to either incidence rate ratios (i.e. e^{β}) or marginal effects (i.e., $\partial E(\mathrm{HC}|\mathbf{x})/\partial \mathbf{x}$). Using the approach outlined in Greene (1997), the estimated marginal effects of the binary variables CDU and IDU on health services utilization (HC) were approximated using the formula below (Econometric Software, 1995):

$$\begin{aligned}\frac{\partial E(\mathrm{HC}|\bar{\mathbf{x}}_*)}{\partial CDU} &= \exp(\beta'\mathbf{x}|\bar{\mathbf{x}}_*, CDU = 1) \\ &\quad - \exp(\beta'\mathbf{x}|\bar{\mathbf{x}}_*, CDU = 0) \\ &= \exp(\beta'\bar{\mathbf{x}}_* + \beta_{\mathrm{CDU}}) - \exp(\beta'\bar{\mathbf{x}}_*) \qquad (2)\end{aligned}$$

where $\mathbf{x}$ is the vector of explanatory variables, $\bar{\mathbf{x}}_*$ is the vector of mean values of $\mathbf{x}$, excluding CDU and β is the vector of coefficient estimates. A similar formula was used to estimate the marginal effects for IDU.

[5] The estimates reported in French and Martin (1996) were converted to 1996 dollars using the medical care price index. It is preferable to use economic costs for health services in South Florida when calculating the total cost of health care for this sample. However, economic costs were not available for specific services, so charges were used as an approximation.

The marginal effects for CDU and IDU are reported in brackets next to the coefficient estimates and standard errors in Table 2. As an example of the interpretation, being a CDU was associated with 0.24 more emergency room visits than an NDU. In addition, injection drug use was associated with 0.35 less outpatient visits relative to non-drug use.

The next set of regression analyses (not shown in the tables) determined whether chronic drug use was related to the total cost of medical care. Recall that the mean annual total cost for CDUs, IDUs and NDUs was \$2666, 2717 and 2094. Using OLS with the same explanatory variables in Table 2, the estimated differentials in total cost (relative to NDUs) were \$959 for CDUs ($p = 0.026$) and \$1081 for IDUs ($p = 0.024$). Equality of these coefficients for CDUs and IDUs was not rejected at conventional levels.[3]

Returning to Table 2, drug-use status was clearly one of the most significant predictors of health care utilization. A few other variables were also noteworthy. Not surprisingly, individuals with health insurance had higher utilization of all types of health care. This result was significant even for part-year insurance. Men were less likely to consume each type of health care, with significant coefficient estimates for emergency room episodes and outpatient visits. Employment status and income were somewhat related to health care utilization within this sample. Currently working full-time was negatively related to all types of utilization and working part-time was negatively related to outpatient visits. However, income (both legal and illegal) was positively related to emergency room utilization.

Discussion

Using a rich set of variables from a community-based sample of drug users and non-drug users, this research estimated the relationships between drug use and three common measures of health services utilization: emergency room episodes, outpatient visits and hospital admissions. The total annual cost of health services utilization for these three categories of care was also estimated. Controlling for other important covariates, the results strongly suggest that CDUs and IDUs had a higher number of visits to the emergency room and more admissions to a hospital than NDUs. Disproportionately high use of health care by drug users was not consistent across all measures, however. CDUs and IDUs visited outpatient facilities *less* often than NDUs; IDUs had significantly fewer outpatient visits relative to other CDUs. Nevertheless, the estimated cost of health care during the previous year was approximately \$1000 higher for CDUs and IDUs compared to NDUs.

Despite the originality of the data and the diversity of the statistical techniques, the research had several limitations. The data were rich in many areas, but some measures were not ideal for the objectives of the paper and some important variables (e.g., prices for health services) were not available. Given the community-based sampling design, the findings naturally have direct applications to drug users and the health care system in South Florida, but the results are not necessarily generalizable. Additionally, ONDCP's (1995) definition for chronic drug use is one of several alternatives to characterize a problematic drug user or a drug abuser (see French et al., in press, for a similar analysis using the Drug Abuse Screening Test (DAST)).

The statistical models also had some limitations. One critical assumption of the empirical approach was that CDU and IDU were exogenous right-hand-side variables. We tested this assumption (Hausman, 1978) and found that both CDU and IDU were exogenous, but the validity of this test is strongly dependent on the instrumental variables in the model. The instrumental variables in our model included indicator variables regarding religious beliefs and behaviors. If better instruments (e.g. illicit drug prices, penalties for drug law violations) indicated that CDU and IDU were not exogenous variables, then the coefficient estimates reported in Table 2 could be biased (Norton et al., 1998; McGeary and French, in press).

Although limitations were present, some intuitive explanations exist for the direction and magnitude of the findings. For example, earlier research suggested that many health care providers did not view drug abuse as a chronic health condition (Rivers et al., 1999). In this potentially confrontational environment, drug users may be apt to avoid preventative care and ambulatory care for routine conditions. Neglected health care needs could degenerate into conditions that are more serious, precipitating contact with emergency services and/or hospitalization. Emergency room personnel may be less likely to confront individuals about their addiction and focus instead on the health problem that caused the visit. Thus, drug users could obtain less intrusive (albeit more expensive) care through the emergency room due to a systemic feature of conventional outpatient delivery.

Another possible explanation relates to the disposition and decision-making processes of drug abusers. These individuals tend to have a myopic view of their needs and desires with a high rate of time preference (Becker and Murphy, 1988; MacCoun and Caulkins, 1996; Madden et al., 1997). Health care needs are not typically given high priority. Even some serious health problems may be ignored

because drug abusers tend to place a high value on living in the present and the future may be discounted quite heavily. Consequently, all types of "personal investments" (e.g. education, job training, nutrition, exercise, health care) may be less important to drug users.

Intuitive explanations for the results are informative, but replication of previous findings is a better scientific test of robustness and stability. Unfortunately, a comprehensive literature review did not identify any other studies that analyzed a community-based sample of out-of-treatment drug users and non-drug users. In this regard, the novelty of the sample is one of the strongest features of the present research. Other studies have examined patterns of health care utilization for drug abusers with HIV/AIDS (Mor et al., 1992; Kissinger et al., 1995), drug abusers who received inpatient care (Bradley and Zarkin, 1996; Hoff and Rosenheck, 1998) and a national sample of drug users from the household population (McGeary and French, in press). But, this is the first study to collect and analyze detailed data on CDUs, IDUs and NDUs, with similar socioeconomic characteristics and living arrangements. In particular, the matched group of NDUs permitted convenient and rigorous tests of whether different types of drug users consumed more or less health care than non-users.

The policy significance of these findings is particularly high because the Office of National Drug Control Policy (ONDCP) singled out CDUs as a group for extended study and intervention. Including IDUs as a subsample of CDUs added another layer of distinction among drug users. Results displayed the type and magnitude of differences in health services utilization (and associated costs) among drug-using groups. These findings could have important implications for health policy, drug abuse interventions and health services research.

One implication of the findings is that health care providers and managed care organizations should develop policies to encourage more ambulatory care and discourage emergency room and inpatient care among drug users. Interventions in this regard would probably involve reducing the barriers to outpatient visits that may be present for drug users. For example, health care providers could offer free on-site childcare for single parents, who are heavily represented among drug users. In addition, mother and child visits could be merged to minimize waiting time and travel costs (Kissinger et al., 1995). On a systemic level, providers could develop methods to facilitate trust in the formal health care system that may not be present among drug users, especially African Americans (Leppert et al., 1996; Smith, 1998). Long-established stereotypes must be eroded so that drug users are comfortable and trusting that their drug use will not be treated as an illegal activity when they consume ambulatory care (Saffer and Chaloupka, 1998).

Hospice or home-based health care may be another option for seriously ill drug abusers to avoid future hospitalization or visits to the emergency room, Kissinger et al. (1995). However, Medicaid eligibility requirements for home-based health care may be too strict for most drug users to take advantage. Nevertheless, innovative and culturally acceptable approaches may be necessary to encourage ambulatory care without posing unusual financial hardship.

In summary, this paper answered some enduring questions about drug use, health services utilization and medical care costs, but additional information is needed on the behavioral reasons for service differentials and the cost-effectiveness of drug abuse interventions. Besides corroborating the emergency room findings in McGeary and French (in press), the present study determined that CDUs consumed *more* inpatient hospital care and *less* outpatient care. Medical care providers and drug abuse treatment programs should be aware of these findings when developing drug abuse interventions.

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