Illicit Drug Use and Emergency Room Utilization

Kerry Anne McGeary and Michael T. French

Objective. To provide an empirical examination of the effect that chronic illicit drug use has on emergency room (ER) utilization, controlling for the potential biases introduced by correlation between unobservable determinants of chronic illicit drug use and ER utilization.

Data Sources/Study Setting. From the National Household Survey on Drug Abuse 1994 (NHSDA94).

Study Design. Chronic illicit drug use and ER utilization are analyzed for 5,384 females and 4,177 males in 1994. The study uses a two-stage estimation technique. In the first stage, sociodemographic, drug use history, and drug use risk variables are used to estimate the probability that the subject is a chronic illicit drug user (CDU). In the second stage, the first-stage estimates provide information needed to test for the possibility of bias in the estimation of ER utilization. This bias is the result of the correlation between unobservable influences on the probability that the person is a CDU and the probability that he or she uses an ER.

Data Collection/Extraction Methods. The data were collected through a multistage stratified sampling design. With the use of this methodology, the resulting data set provides the most comprehensive information on household drug use.

Principal Findings. Without a correction for the possibility of endogeneity bias, chronic illicit drug use is a positive (for both males and females) and a significant (for females only) determinant of the probability of using an ER for medical treatment. After a correction for endogeneity, the influence of chronic drug use remains positive and significant for females and becomes significant for males. The corresponding change in probability for females is from 6 percent to 30 percent, while for males the increase is from an insignificant 0.1 percent to a significant 36 percent change.

Conclusions. We estimate that chronic drug-using females and males, after adjustments for bias, increase the probability that they use an ER by more than 30 percent compared to their casual or non-drug-using counterparts. Therefore, policymakers and health services providers may consider designing programs to bring primary care and prevention services to facilities where drug users are more likely to seek access to care, within an ER setting.

Key Words. Chronic illicit drug use, health services utilization, endogeneity, emergency room care

Vulnerable populations, such as individuals suffering from sociomedical morbidities, are typically associated with a high need for healthcare (Aday 1993; Chitwood, McBride, Metsch, et al. 1998). Certain types of healthcare treatment, for example, services provided by primary care physicians (PCPs), are limited in the sense that they are daily operations, while the need for healthcare is not confined to working hours. Given access constraints, in some cases individuals with an urgent need for care, perceived or actual, will find other outlets to receive healthcare such as emergency rooms (ERs) or 24-hour healthcare clinics. In 1994, U.S. ERs recorded 36 visits per 100 persons. More than half of those visits to the ER were for nonurgent reasons (Census Bureau 1997). In fact, vulnerable populations typically seek to receive care through one of the most accessible healthcare delivery units, ER services, therefore making ERs a de facto public health care system for the United States (Kopstein 1992; Padgett and Struening 1991; Vanek, Dickey-White, Signs, et al. 1996).

One vulnerable population that has generated concern since the advent of the AIDS epidemic is chronic illicit drug users (CDUs), especially injection drug users. Illicit drug users are prone to several chronic health effects related to drug use.[1] For instance, the use of opiates is associated with pulmonary complications, cerebrovascular disease, hepatic dysfunction, duodenal ulcers, and endocrine abnormalities (Louria, Hensle, and Rose 1967; Novick and Kreek 1992). Cocaine use has been associated with seizures (Myer and Earnest 1984), strokes (Levine and Welch 1988), and neurologic disorders (Brody, Slovis, and Wrenn 1990; Satel and Edell 1991). Crack cocaine use has intensified health-related disorders and is associated with damage to the central nervous, circulatory, and respiratory systems (Van Thiel and Perper 1992; Perper and Van Theil 1992; Bunn and Giannini 1992). In addition to the damaging effects associated with the ingestion of opiates and cocaine, unsafe injection practices lead to additional physical problems including bacterial endocarditis (Nahass et al. 1990), tuberculosis (Selwyn, Hartel, Lewis, et al. 1989), pulmonary disease (Hind 1990), and hepatitis (Schade and Komorwska 1988).

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Rice, Kelman, and Miller (1991) estimated the direct medical costs of adverse health consequences associated with drug abuse in the United States to be $58.3 billion in 1988. They associated the higher healthcare costs for drug users with a higher number of health problems as well as with the use of ER services. From 1988 to 1994, the Drug Abuse Warning Network (DAWN) survey estimated that the number of drug-related episodes in U.S. ERs rose by 65 percent to 518,521 episodes (i.e., .5 percent of the all ER visits in the U.S.). In addition, the DAWN survey reported that chronic drug users and drug-dependent individuals account for approximately 33 percent of the 518,521 drug-related episodes (Substance Abuse and Mental Health Services Administration [SAMHSA] 1998). Overall, the second most frequently recorded reason for a drug-related ER visit was treatment for adverse health consequences associated with chronic drug use, or chronic effects, while the most frequently reported reason was drug overdose (Census Bureau 1997).

One analytical problem associated with studies on ER utilization by drug users is that they do not investigate the issue of endogeneity. Without controlling for endogeneity, unobservable determinants of both drug use and medical services that may be correlated are ignored. For instance, some unmeasurable factor, such as an attitude that increases the probability of being a drug user, may be negatively correlated with the utilization of healthcare services and/or ER services.[2] If these underlying unmeasurable and potentially correlated influences are ignored, they may bias traditional estimates of a drug user's utilization of medical services. Our study addresses an important gap in the research by providing an empirical analysis of the increased pressure that illicit drug users exert on the emergency health care system while controlling for the potential endogeneity associated with the estimation of this relationship.

MODEL OF HEALTHCARE SERVICES DEMAND

The traditional model of healthcare service demand follows from Rosenzweig and Schultz's (1983) theory on the demand for medical care. We will use this framework in conjunction with Grossman (1972) to describe the demand for healthcare services as a derived demand from the production of health, modeled by the following equation:

$$H = h(B, HZ, \mu) \tag{1}$$

where H is the production of "health," B is a list of beneficial activities, HZ represents a list of hazardous or risky activities, and μ is a set of characteristics that describe the genetic, environmental, and social influences on the individual. Specifically, B could include activities such as consumption of health services, taking vitamins, or exercising, while HZ includes ingestion of harmful substances and other "hazardous" acts that would negatively affect an individual's health production. The set μ is not controlled by individual behavior and is heterogeneous across individuals. Because health services enter into the production function for health, individuals derive utility from the good health that is produced by using healthcare services.

The traditional model of the demand for health services is influenced by demand-side determinants such as income, healthcare prices, and the individual's health endowment (Rosenzweig and Schultz 1983). To model the effect of drug use on the demand for health services, we had to establish a mechanism to describe the influence of drug use. The following model is a variant of the household production model of health. An individual's drug use will influence the individual's utility; health; and, potentially, healthcare services demand. The model is described as:

$$U = u\,(X, H, D) \tag{2}$$

$$H = h\,(HC, D, \mu) \tag{3}$$

$$HC = hc\,(M, P_{HC}, X, D, \mu) \tag{4}$$

$$D = d\,(M, P_D, X, HC, \mu) \tag{5}$$

Equation 2 is a model of utility, U, where X is a composite good, H represents health that is produced from the technology described in Equation 3, and D is drug use and a member of the vector HZ.[3] Equation 3 models the household production of "health," H, and is analogous to Equation 1. HC is the consumption of health services, a beneficial activity; hazardous activities are represented by D, drug use; and μ represents the unobservable and heterogeneous characteristics as previously defined.

After maximization of the utility function using the traditional budget constraint where M is the individual's income, P_D is the price of drugs, and P_{HC} the price of healthcare, we arrive at the demand for healthcare services, Equation 4, and the demand for drugs, Equation 5. Empirically, we are estimating the effect of chronic drug use, D, on the demand for health services, using Equation 4. We estimate Equations 4 and 5 using a two-stage method of moments technique to account for the endogeneity associated with

drug use, D. The actual direction of influence and the magnitude of drug use on health services demand is left to the estimation of the model, which is discussed in the Analysis section.

Data Sources

The data are from the National Household Survey on Drug Abuse 1994 public use file (NHSDA94) administered by the U.S. Department of Health and Human Services (Office of Applied Studies 1996). The Department of Health and Human Services started the NHSDA series in 1971, with the objective of collecting information on the use of illicit drugs, alcohol, and tobacco among the noninstitutionalized U.S. population ages 12 and over. Illicit drugs include marijuana, cocaine, sedatives, tranquilizers, analgesics, inhalants, hallucinogens, crack cocaine, heroin, and illegal use of prescription drugs. We use the NHSDA94 because the 1994 survey included a special section on healthcare.

This article focuses on the U.S. population 18–65 years old (9,551 individuals). We segment the sample by gender, 5,374 females and 4,177 males. Of the females, 163 are classified as CDUs, with 251 males classified as CDUs. The classification of a CDU, established by the Office of National Drug Control Policy (ONDCP), includes anyone using illicit drugs weekly or more often. Additionally, we created mutually exclusive groups to determine the number of individuals who had ever tried a drug (on only one occasion) or had formerly used drugs at least monthly in their lifetime. We focus on CDUs (weekly or greater use) because we are interested in ways in which heavy drug use, not casual use, may affect ER utilization. Another reason to focus on CDUs is interest from the public health perspective on whether a vulnerable population, CDUs, has significantly different ER utilization compared to casual or non-drug users.

The data were collected using a multistage stratified sampling design. This technique combined with in-person interviews provides the most reliable and comprehensive estimates of drug use in the U.S. population.[4] Most surveys, including the NHSDA94, exhibit some limitations. One traditional limitation of survey data is self-reported information. However, technological advances in the collection of such data have improved the accuracy of self-reported data (Harrison and Hughes 1997). The possibility of some under-reporting may remain because the survey excludes persons in institutional settings such as military personnel, imprisoned individuals, and people in treatment centers, hospitals, and nursing homes. In an effort to maintain the confidentiality of the data, none of the NHSDA surveys provide any county

or state information (e.g., drug price), an omission that precludes us from using either drug prices or healthcare prices in our empirical model. Finally, the NHSDA94 is not a panel data set; therefore, we are not able to model the lifetime and dynamic effects of drug use. Nonetheless, we are able to construct a measure of former use for the individuals in the sample, and this enables us to estimate a myopic model of addiction. Despite the foregoing limitations, the NHSDA series is the most detailed data set to describe the state of drug use in the United States.

Table 1 reports the bivariate statistics of our sample segmented by gender. The variables that measure whether a person currently uses drugs (current drug user) and whether a person formerly used drugs (former drug user) illustrate a higher prevalence of both current and former drug use among males (49 percent and 29 percent, respectively) compared to females (35 percent and 28 percent, respectively). Additional discrepancies between females and males can be seen in employment at the full-time or part-time levels (full/part work). Only 65 percent of females, compared with 83 percent of the males, worked full-time or part-time. Given these and other significant differences, we estimated all equations separately for females and males.

ANALYSIS

To estimate the influence of drug use on the probability of using emergency room services, we describe a two-stage empirical model of the demand for ER services that accounts for potential endogeneity bias. Recall that endogeneity bias could result from a possible correlation between the unobservables that influence the decision to chronically use drugs and the unobservables that influence ER utilization. A Hausman test is traditionally used to test the null hypothesis that a particular explanatory (right-hand side) variable is exogenous (Hausman 1983). However, a major criticism of the Hausman test is its low power, which leads to a lower probability of rejecting the null hypothesis of exogeneity. Fortunately, we minimize this problem because the two-stage estimation technique we employ also allows us to test for the exogeneity of the chronic drug use variable. This two-stage methodology is outlined by Terza (1998a,b).[5]

The first equation estimated is a probit regression that estimates the probability that a person is a CDU:

$$D_i = Z_i\alpha + \nu_i \tag{6}$$

Table 1: Variable Means (By Gender)

	Female Sample (N=5,374)		*Male Sample (N=4,177)*	
Variable	*Mean*	*s.d.*	*Mean*	*s.d.*
Age	32.1317	12.8309	31.1913	12.6515
Age-squared/100	11.2681	10.6135	10.6482	10.3718
White	0.4877	0.4381	0.4965	0.4337
Black*	0.2451	0.3307	0.1882	0.3065
Veteran*	0.0153	0.1204	0.1410	0.4397
Married	0.4812	0.4856	0.4623	0.4869
High school graduate	0.7936	0.3425	0.7704	0.3587
Number of moves*	0.2834	0.6551	0.4664	0.7801
Annual personal income*†	0.3184	0.4659	0.5970	0.4905
Medicaid*	0.1699	0.2787	0.0500	0.1818
Current drug user*	0.3490	0.0125	0.4889	0.0129
Former drug user*	0.2787	0.0106	0.2851	0.0124
Full/Part-time work*	0.6520	0.4636	0.8343	0.3753
Rural	0.1911	0.4190	0.1836	0.4004
Depression	0.0095	0.0012	0.0096	0.0655
Anxiety	0.0030	0.0701	0.0043	0.0694
Panic*	0.0638	0.0344	0.0117	0.1077
Chronic drug use current*	0.0347	0.1706	0.0661	0.2484
Risk intox‡	2.6781	1.1264	2.5466	1.1323
Risk sale‡	3.3281	1.0007	3.2820	1.1007
Visit ER	0.1900	0.3719	0.1752	0.3694

*Statistically significant differences in variable means across gender, $p \leq .05$.

†Greater than or equal to $20,000.

‡Minimum value of 1 and maximum value of 4; lower values are associated with more risk.

Here, D_i is the binary indication of chronic drug use; Z_i is a vector of exogenous variables that influence an individual's propensity for chronic drug use (e.g., age, race, work status, drug use history, and access to drug markets); α is the vector of parameters that we will estimate; and ν_i is a random error term. The second stage of the method estimates the probability that ER services will be used and accounts for the potential bias introduced by the inclusion of chronic drug use, D_i, as an independent variable in the second stage. Therefore, the second-stage equation is:

$$V_i = \Phi\left(\mathrm{X}_i\beta + D_i\beta_D + \varsigma_i\right) + \xi_i \tag{7}$$

where V_i is the binary indication of an ER visit in the past year, Φ is a function (e.g., logistic function [logit] or cumulative density function [probit]) that allows for a binary dependent variable, X_i is a vector of exogenous

variables that influence V_i, D_i remains as previously defined, β and β_D are the corresponding vectors of parameters to be estimated, and ς_i and ξ_i are random error terms. This model assumes that $[\varsigma, \nu \mid w]'$ is bivariate, normally distributed with mean zero and a covariance matrix of the following form:

$$\begin{bmatrix} \sigma & \sigma\rho \\ \sigma\rho & 1 \end{bmatrix} \tag{8}$$

where w is the union of all the exogenous variables of the model (the variables contained in X and Z, excluding D). Therefore, the coefficients of interest are β, β_D, and θ. Note that the parameter θ is the product of $\sigma\rho$. From the estimation of this parameter (θ), we will determine the direction and significance of the correlation between the unobservables in Equations 6 and 7. We include the estimate of the parameter θ in addition to the less powerful Hausman test for exogeneity.

Variable Description

The first stage of the two-stage model estimates the probability of a person's being a CDU using the probit technique. Therefore, the dependent variable is chronic drug use (yes = 1, no = 0). Among the regressors of the first stage we include measures of age and age-squared to account for nonlinear effects of age on the probability of chronic drug use. Other demographic variables include binary measures of race (white, black), marital status (married), and education (high school graduate). We included an additional demographic variable, number of times moved in the past year (number of moves) to describe the influence that heavy migration or having a transient lifestyle has on the probability of using drugs. Ability to pay is measured through yearly income (annual personal income) and full-time or part-time work (full/part work). Full- or part-time work may influence drug use positively or negatively because employed individuals have (1) better ability to pay for drugs and (2) a higher opportunity cost of drug use. We included variables designed to measure access to drug markets or drug use risk: the frequency of seeing "high" or intoxicated individuals in the respondent's neighborhood and the frequency of seeing people selling drugs in the neighborhood (risk intox and risk sale, respectively; 1 = most often, 4 = never). Due to the recent evidence compiled on the gateway effect of cigarettes and alcohol on illicit drug use, we acknowledge the potentially strong influences of the chronic use of tobacco and alcohol (Pacula 1997). However, the correlation between legal and illegal

drug use in our model was substantial, and our estimate of their associated correlation coefficient rejected independence ($p < .01$).

The dependent variable of the second stage is the binary indication of ER use in the past year, V. Whether a correlation exists or not between the unobservable determinants of being a CDU and the unobservable determinants of visiting an ER is subject to dispute. Hence, the sign of the correlation will be estimated through the parameter θ, which is the product of the standard deviation and the correlation coefficient.

The second-stage regression is estimated twice. The first estimation ignores the possibility of any correlation (i.e., $\theta = 0$), and the second estimation corrects for the possibility of correlation ($\theta \neq 0$). The variables used to describe the individual's utilization of an ER are mainly demographic: age, age-squared, race (white, black), high school graduate, work status (full/part work), marital status (married), income (annual personal income), Medicaid eligibility, and geographic region (rural). Because some clinical conditions could influence ER use, we also included measures of panic disorder (panic), anxiety disorder (anxiety), and depression.

We recognize that chronic cigarette use and chronic alcohol use can influence the probability of ER use. However, as discussed previously, strong collinearity between chronic illicit drug use, chronic alcohol use, and chronic cigarette use preclude us from including all measures in our model. In addition, we recognize the possibility of influences from a potentially endogenous variable, private health insurance. However, given the inability to account for endogeneity bias associated with both private health insurance and chronic illicit drug use, we chose to control for the endogeneity associated with being a CDU because this is the variable of interest. Since we recognize that the endogeneity of private health insurance in this context is uncertain, we estimate the models by including a dummy variable that indicates the presence of private health insurance. Private health insurance in these specifications has an insignificant influence on the individual's probability of visiting an ER. In addition, the other explanatory variables in the model are robust to the inclusion of private health insurance.

The variables noted in this section are traditionally used in health service demand and drug use prediction models (Rosenzweig and Schultz 1983). For the remainder of this section, we postulate regarding the expected direction of influence that these variables will have on ER care. One of the major influences on an individual's need for healthcare is the deterioration of his or her health stock that comes with time (Rosenzweig and Schultz 1983). Given this idea, the variables age and age-squared are predicted to exhibit a

positive influence, indicating that older persons will use more ER services with increases in their probability of illicit drug use as age increases (as measured by age-squared). We believe that our empirical model should estimate a negative relationship between education and a person's use of ER services. Logically, the more educated the individual, the more likely that he or she will recognize the need for healthcare. However, because people may view their health problems as a need for traditional primary healthcare services, they may be less likely to use an ER. Another influence on an individual's utilization of ER services is the ability to pay for them. Ability to pay is measured in our model by income and Medicaid eligibility. We expect to see a positive influence from both income and Medicaid eligibility on ER utilization. In addition, in the male regressions, veteran status will influence the access of individuals to an ER, since veterans have privileges with Department of Veterans Affairs (VA) hospitals. Residing in a rural area may decrease accessibility and, therefore, the probability of an ER visit for both females and males.

Clinical conditions such as depression, panic disorder (panic), and anxiety disorder (anxiety) are associated physical symptoms that could prompt an individual to seek medical treatment. Periods of depression are associated with weight loss or gain and with suicide attempts. An individual who suffers from panic disorder and anxiety disorder may experience "attacks" associated with shortness of breath, dizziness, choking, chest pain, heart palpitations, and other symptoms that could prompt the individual to go to an ER for help (American Psychiatric Association 1994). Therefore, we believe that these clinical conditions will be associated with a higher probability of ER use.

RESULTS

Stage One

Table 2 reports the results of the first-stage regression for females and males. In the female sample we find that age, ethnicity (white), and number of moves each have a positive and significant influence on the probability that the respondent is a CDU. The directions of influence for ethnicity (white and black) and number of moves are the same for the male sample; age exhibits the opposite sign. Significant negative influences on the probability that female subjects are CDUs were former drug use, increases in age (age-squared), marital status (married), and the less frequent witnessing intoxicated individuals (risk intox) or drug sales in their neighborhood (risk sale). For males, estimates of less risk of seeing drug sales in their neighborhood (risk sale) and marital status (married) were the only negative and significant

Table 2: First-Stage Probit Estimates for Probability of Being a CDU

	Females (N=5,374)	*Males (N=4,177)*
	Estimate (Std. Error)	*Estimate (Std. Error)*
Constant	−1.8574*	−0.4617
	(0.4247)	(0.3277)
Former drug user	−1.8404*	1.9879*
	(0.1636)	(0.5534)
Veteran	—	0.2015*
	—	(0.0746)
Age	0.0925*	−0.0376*
	(0.0238)	(0.0164)
Age-squared/100	−0.1748*	0.0292
	(0.0369)	(0.0227)
White	0.6507*	0.3081*
	(0.0741)	(0.0630)
Black	0.1235	0.4291*
	(0.0801)	(0.0739)
Married	−0.4297*	−0.1131**
	(0.0636)	(0.0577)
High school graduate	0.0290	−0.0769
	(0.0719)	(0.0634)
Number of moves	0.1209*	0.0543**
	(0.0293)	(0.0279)
Full/Part work	−0.0026	−0.1468**
	(0.0614)	(0.0685)
Annual personal income	0.0402	0.1679*
	(0.0773)	(0.0608)
Rural	−0.2139*	0.0317
	(0.0769)	(0.0649)
Risk intox	−0.1159*	−0.0105
	(0.0282)	(0.0264)
Risk sale	−0.1061*	−0.0609**
	(0.0301)	(0.0292)

*Significance at $p \leq .01$; **significance at $p \leq .05$.

variables that were consistent with the female sample. Further, the full/part time variable does influence the probability of being a CDU in the male sample but is not a significant influence in the female sample.

Stage Two

Before continuing with the discussion, we must address identification of the parameters in the second stage. Because we use the same variables in

the first-stage and second-stage estimations, we run the risk of not meeting the conditions for identification of the second stage. To foster identification, we include the measures of access to drug markets as well as frequency of neighborhood sightings of intoxicated individuals and drug sales (risk intox and risk sale) as identifying variables. However, we are unable to offer an overidentification test for these variables. Identification tests that are widely accepted are applicable to efficient estimators (Greene 1997). However, the two-stage estimator is a consistent, but not efficient estimator (Terza 1998b).

Regarding the issue of endogeneity, use of the Hausman (χ^2) test enables us to reject the hypothesis that CDU is an exogenous variable (i.e., that it introduces no endogeneity bias) for both females and males ($p \leq .005$; see Table 3). In both regressions, the exogeneity of CDU is also tested by estimation of the parameter θ, using the two-stage technique. Consistent with the Hausman test, we reject the hypothesis that $\theta = 0$ for both males and females ($p \leq .05$; see Table 3). For both genders, the sign of the correlation is negative, indicating a downward bias on the uncorrected estimates. On further investigation we find this downward bias evident in the lower-point estimates from the uncorrected regressions (see columns 2 and 4 of Table 3). Because we reject exogeneity of CDU, we focus on the endogeneity-"corrected" results presented in columns 3 and 5 of Table 3.

In both cases, the probability of using ER care increases with chronic drug use (CDU). In the female sample, additional positive and significant influences were estimated by panic and anxiety disorders (panic and anxiety) and by rural residence (rural). However, for the male sample these influences have an insignificant effect on the probability of using an ER. In both the female and male regressions, the probability of making a visit to the ER is negatively associated with having a high school education (high school graduate). In addition, across genders, being eligible for Medicaid (Medicaid) is a positive and significant influence on the probability of visiting an ER. Interestingly, the estimated influence of former drug use (former drug user) differs between the female and male samples: whereas former drug use (former drug user) has a positive influence on the probability of visiting the ER for females, in the male sample the effect is estimated to be negative.

DISCUSSION

The results imply a significantly negative correlation between the unobservable influences on chronic drug use and the probability of visiting an ER

Table 3: Stage Two Estimation of the Probability of Using an ER

	Females (N=5,374)		*Males (N=4,177)*	
Variables	*Uncorrected (Std. Error)*	*Corrected (Std. Error)*	*Uncorrected (Std. Error)*	*Corrected (Std. Error)*
Constant	−0.7849*	−0.9045*	−0.7755*	−1.1828*
	(0.2521)	(0.2845)	(0.2942)	(0.3866)
Former drug user	0.0473	0.1357**	0.0423**	−0.5557**
	(0.0483)	(0.0623)	(0.0666)	(0.2768)
Veteran	–	–	0.1487**	0.1149
	–	–	(0.0694)	(0.0796)
Age	−0.0202	−0.0221	−0.0122	−0.0029
	(0.0122)	(0.0135)	(0.0148)	(0.0176)
Age-squared/100	0.0230	0.0279	0.0048	−0.0052
	(0.0164)	(0.0181)	(0.0200)	(0.0239)
White	0.1518*	0.1089	0.2386*	0.2491**
	(0.0552)	(0.0642)	(0.0594)	(0.0701)
Black	0.1757*	0.1516**	0.1575**	0.1018
	(0.0582)	(0.0650)	(0.0704)	(0.0835)
Married	−0.1076**	−0.0634	0.0511	0.0656
	(0.0454)	(0.0518)	(0.0546)	(0.0631)
High school graduate	−0.1159**	−0.1253**	−0.1300**	−0.1269
	(0.0527)	(0.0593)	(0.0596)	(0.0672)
Annual personal income	0.0911	0.0891	0.0350	0.0191
	(0.0549)	(0.0600)	(0.0572)	(0.0681)
Medicaid	0.3505*	0.3617*	0.4866*	0.5341**
	(0.0581)	(0.0634)	(0.1008)	(0.1148)
Full/Part work	−0.0124	−0.0271	−0.0440	0.0155
	(0.0488)	(0.0532)	(0.0680)	(0.0773)
Panic	0.1335*	0.1387*	0.2862	0.3117
	(0.0201)	(0.0220)	(0.1959)	(0.2137)
Depression	0.2274	0.2228	0.0514	−0.0046
	(0.1940)	(0.2013)	(0.2290)	(0.2584)
Anxiety	0.6343**	0.6776**	0.3356	0.3283
	(0.3298)	(0.3017)	(0.3184)	(0.3590)
Rural	0.0999	0.1376**	0.0215	0.0078
	(0.0531)	(0.0593)	(0.0608)	(0.0689)
CDU	0.1976*	0.8880*	0.0034	0.9539**
	(0.0676)	(0.3286)	(0.0631)	(0.4449)
Marginal effect of CDU	+6%*	+30%*	+0.1%	+36%**
Theta		−0.3848**		−0.5269**
		(0.1723)		(0.2398)
Hausman (χ^2; df = 18)†		58.4427		48.6717

*Significance at $p \leq .01$; **significance at $p \leq .05$.

†df = Degrees of freedom for male regression. The df for female regressions is equal to df −1 due to the exclusion of veteran.

for females and males (i.e., θ). Although the corrected estimates suggest a downward bias associated with the uncorrected correlation, they do not describe the resulting change in the probability of ER use. For this type of analysis we calculate the marginal effect of the change in chronic drug use status. Given that the chronic drug use variable is binary, the marginal effect of chronic drug use is measured as:

$$E[\bar{X}\beta|D=1] - E[\bar{X}\beta|D=0] = \Phi[\bar{X}\beta|D=1] - \Phi[\bar{X}\beta|D=0] \quad (9)$$

where Φ is the cumulative normal distribution. To acknowledge the importance of correcting for endogeneity, we calculate the marginal effects using both the β vectors that are uncorrected and those that are corrected for endogeneity bias.

Table 3 reports the results of the marginal effect calculations. Of interest is that the uncorrected marginal effects for females and males are 6 percent and 0.1 percent, respectively. Therefore, even if we had ignored the possibility of endogeneity, we find that weekly drug use by females increases their probability of using an ER by 6 percent. For the female sample, when we consider the endogeneity of CDU, the associated change in probability jumps to 30 percent, while in the male sample the associated change increases from an insignificant effect (0.1 percent) to a significant effect (36 percent). This implies an even larger effect of CDU on ER services than the initial uncorrected results would imply.

Considering that in 1994 over 500,000 drug-related emergencies occurred nationwide, the estimated marginal effects of chronic drug use on ER use are understandable (National Center on Addiction and Substance Abuse 1996). Increases in ER use attributable to chronic drug use may be a preventable situation. In fact, the Office of National Drug Control Policy (ONDCP) (1998) states that increased ER use is one of the major contributors to the estimated increase—from $44 to $76 billion—in economic costs of drug use between 1985 and 1991. In addition, the National Center on Addiction and Substance Abuse reports that approximately 20 percent of total Medicaid costs are attributable to CDUs (National Center on Addiction and Substance Abuse 1996). These studies together with our findings suggest that investments in drug abuse prevention and treatment have the potential to save future healthcare costs if these investments are successful in decreasing chronic drug use.

CONCLUSION

This article provides an empirical examination of the association between drug use and ER visits. We first develop a theoretical model of the influence

of drug use on medical care in which drug use is modeled as a hazardous activity predicted to have a positive influence on an individual's demand for medical care in general. Extending this framework to the empirical model, we find that being a CDU has a positive and significant influence on the probability that a person used an ER in the past year.

Through use of a two-stage estimator, we allow for the possibility of correlation between the unobservable determinants of chronic drug use and ER services. Without the correction for endogeneity of drug use, we find significant (for females) but downward-biased estimates of the influence of chronic drug use on ER use. From a policy perspective, it is important to model and estimate the relationship between chronic drug use and ER care accurately. Any bias will produce inaccurate estimates of the marginal effect of chronic drug use on the use of ER services. These inaccurate estimates may cause policymakers to underestimate healthcare costs associated with drug use, thereby disguising the need for treatment services and antidrug campaigns. Furthermore, it might be well for policymakers and healthcare providers to consider designing programs to bring primary care facilities to the location where drug users are more likely to seek access to care: within an ER setting.

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NOTES

1. It is important to note that drug use does not imply drug abuse. Drug abuse is a specific category of mental illness as specified by the Diagnostic Statistical Manual (DSM-IV) (American Psychiatric Association 1994).
2. For a detailed discussion of endogeneity see Greene (1997), Mullahy (1997), and Terza (1998a).
3. We have decided, for the purposes of this article, that a myopic model of utility would be sufficient to estimate the influence of drug use on health services demand.
4. For more detailed information on the sample design and sample selection procedures at each stage of the design, interested readers are referred to Office of

Applied Studies, SAMHSA, *National Household Survey on Drug Abuse, Public Release Codebook* (1996).

5. For the software to execute this methodology, contact Joseph V. Terza at the Pennsylvania State University.

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