PREVALENCE AND CORRELATES OF HEPATITIS C AMONG INJECTION DRUG USERS: THE SIGNIFICANCE OF DURATION OF USE, INCARCERATION, AND RACE/ETHNICITY

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The study examined associations between hepatitis C (HCV) seropositivity and a lifetime history of jail or correctional facility incarceration among injection drug users. The sample consisted of 351 injection drug users recruited in inner-city neighborhoods of Baltimore. Multiple logistic regressions were fit to assess associations between HCV seropositivity and a lifetime history of incarceration for the total sample and stratified by race. Analyses demonstrated HCV nearly two times greater for whites than African Americans. In addition, HCV was 2.6 times greater in participants incarcerated in correctional facilities and HCV was 7.4 times greater in participants reporting more than 5 years of injection drug use compared to participants reporting less than 1 year of injection drug use. The study findings suggest that incorporating systematic HCV screening, prevention, and treatment programs within correctional systems represents a vital yet under-utilized strategy to reduce HCV transmission in society as a whole.

INTRODUCTION

In the United States (U.S.), estimates of hepatitis C virus (HCV) infection among the general population range between 2.7 million and 3.9 million, making HCV the most common blood-borne infection among Americans (Alter & Mast, 1994). A number of studies have identified drug-related, sexual, and other drug-related risk

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factors associated with HCV infection. Risk factors deemed to be associated with HCV infection include injection drug use, sexual contact with a steady partner infected with HCV, tattooing and ear piercing, intranasal cocaine use, multiple sexual partners, infants born to infected mothers, organ transplantation and occupational exposure to blood among health care workers (Alter, 1997; Alter & Mast, 1994; Centers for Disease Control, 2008). Furthermore, injection drug use is one of the strongest risk factors for HCV infection (Centers for Disease Control, 2008). Not surprisingly, recent studies have identified heightened HCV seropositivity among incarcerated populations, presumably as risk behaviors associated with transmission are also associated with incarceration (Macalino et al., 2004; Macalino, Vlahov, Dickinson, Schwartzapfel, & Rich, 2005; Solomon, Flynn, Muck, & Vertefeuille, 2004). Epidemiologic studies estimate HCV prevalence among inmates in the United States to be between 16% and 41% (Macalino et al., 2004; Macalino et al., 2005; Reindollar, 1999; Solomon et al., 2004; Vlahov, Nelson, Quinn, & Kendig, 1993). Additionally, more than 7 million inmates of U.S. jails and correctional facilities are released annually (Hammett, Harmon, & Rhodes, 2002). When considered in light of the substantial numbers of inmates who are returned to society each year, many of whom are likely to be infected with HCV, the social and economic costs associated with the continued absence of systematic HCV screening, prevention, and treatment efforts in correctional settings is evident.

While there is a growing base of research describing heightened HCV prevalence among incarcerated populations, few studies have examined associations between HCV infection and incarceration among drug using populations. For example, extant research has not evaluated the extent to which differing levels of incarceration, such as short-term jail stays versus longer-term incarceration in correctional facilities and prisons, are associated with variations in HCV prevalence. Such information may help to improve efforts to develop and implement infectious disease prevention and treatment programs within correctional systems. A related gap in the literature concerns racial/ethnic differences in HCV prevalence. General population studies have shown HCV prevalence among African Americans to be higher than that of whites (Fleckenstein, 2004; Pyrsopoulos & Jeffers, 2007; Rawls & Vega, 2005). However, three studies conducted with inmates in Texas (Baillargeon et al., 2003), Maryland (Solomon et al., 2004), and California (Ruiz et al., 1999), each found HCV prevalence to be highest among whites. It is important to delineate whether and why racial differences in HCV exist for incarcerated populations in order to develop suitable prevention and treatment programs for vulnerable sub-populations. Higher rates of disease among specific subgroups (e.g., racial) may result in differences in risk behaviors (e.g., needle and works sharing) in which they engage and need to be targeted.
This study initially examined associations between HCV prevalence, racial/ethnic status, and incarceration history among injection drug users. Secondly, we sought to examine whether relationships between HCV infection and incarceration history would differ between African American and white injection drug users.

METHODS

The present study sample was collected as part of the U.S. site of the NEURO-HIV Epidemiologic Study, an epidemiological examination of neuropsychological, social, and behavioral risk factors of HIV, and hepatitis A, B, and C among injection and non-injection drug users with sites in the U.S., South Africa, and Russia. To be eligible for the study, participants had to report using injection or non-injection drugs during the previous 6 months, and be aged 15-50 years. Non-injection drug users were not included in the present study, because HCV seroprevalence in this population was low. Because we sought to examine associations between HCV seropositivity and incarceration status stratified by race/ethnicity, the present study sample was limited to African American and white participants and did not include subjects of Hispanic, Asian, Native American, or mixed race ethnicities ($n = 18$). The resulting study sample of 351 injection drug users was comprised of African American ($n = 136$; 38.8%) and white ($n = 215$; 61.2%) participants with 60.4% ($n= 212$) of the sample being male. Further summarizes of sample characteristics are presented in Table 1.

Full approval of the study protocol by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board in 2001 has since received annual reviews and approval. Expert clinicians who underwent extensive training, including formal course work in HIV epidemiology and prevention, seminars on psycho-diagnostic and neuropsychological assessment, and weekly team meetings and supervision, conducted all participant interviews and counseling sessions.

PARTICIPANT SAMPLE SELECTION

Enrollment included multiple recruitment strategies, such as street outreach, advertisements in local newspapers, outreach at local needle exchange sites, as well as referrals from enrolled participants, and social service agencies. Informed consent obtained at the outset of the baseline assessment also addressed permission for follow-up contacts. Participant incentives included $45 for the baseline assessment, $10 for locator visits, and $55 for follow-up assessments.

DATA COLLECTION

The baseline assessment was comprised of a standardized face-to-face HIV-Risk Behavior Interview, a battery of neuropsychological tests focusing mainly on executive functions, attention, and general intellectual functioning, a blood draw, and
urine sample collection. Tests of HIV, hepatitis A, hepatitis B, and hepatitis C used blood samples drawn by expert phlebotomists. Urinalysis tested for recent use of cannabinoids, opiates, cocaine, amphetamine, methamphetamine, methadone, PCP, barbiturates, benzodiazepines, tricyclic antidepressants, MDMA, and oxycodone. Risk-reduction counseling provided to participants was pertinent to HIV/AIDS, viral hepatitis, and other STDs as well as referral information to community-based drug treatment and social services.

MEASURES

The HIV-Risk Behavior Interview was originally adapted from a similar interview used for the REACH study. The interview consisted of questions on demographics and medical, educational, and neurodevelopment histories, including STDs and detailed behavioral information about drug use, sexual practices, social networks, and community violence (Strathdee & Sherman, 2003). Demographic variables collected via self-report included gender, age, education, and race. Participants self-reported their race/ethnicity and were categorized as African American; Asian or Pacific Islander; Hispanic or Latino; Native American; White; or multiple racial backgrounds.

Derived categories of education level included participants who had some high school, a general equivalency degree (GED), a high school diploma, or some college experience, with participants having no high school education as the referent group. The interview obtained data on lifetime incarceration status, distinguishing between jail incarceration and incarceration in correctional facilities or prisons. Typically, the length of a jail stay in Maryland during the study period was between one and 30 days, while the length of stay in a correctional facility or prison was typically for a period of months or longer. Further variables of interest included duration of injection dmg use, which was also collected via self-report. Participants were grouped into 3 categories of injection dmg use duration: less than 1 year of use, 1-5 years and greater than 5 years of injection dmg use (Galeazzi, Tufano, Barbierato, & Bortolotti, 1995; Garfein, Vlahov, Galai, Doherty, & Nelson, 1996; Hagan et al., 2007).

HCV ANTIBODY TESTING

Tests of blood specimens used Ortho-Clinical Diagnostics Inc. HCV Version 3.0 ELISA Test System, an enzyme-linked immunosorbent assay for the detection of antibodies to hepatitis C Virus (Anti-HCV) in human serum and plasma samples. The Ortho® HCV V 3.0 ELISA Test System used recombinant antigens provided by Chiron Corporation.
PREVALENCE AND CORRELATES OF HEPATITIS C

STATISTICAL METHODS

Statistical analysis included the sample of 351 injection drug users who reported African American or white racial/ethnic status. Initially, the association between HCV seropositivity, sociodemographic, injection drug duration and incarceration status variables was evaluated using the total sample. Use of descriptive statistics identified proportions of the sample that tested positive for HCV across the levels of each sociodemographic and incarceration status variable. Analyses of associations included comparisons of participants reporting a lifetime history of jail incarceration only, participants reporting a history of correctional facility/prison incarceration and participants reporting no history of incarceration using simple logistic regressions to compute unadjusted odds ratios.

Multiple logistic regression models were subsequently fit to assess associations between HCV seropositivity, race/ethnic status, and incarceration status with adjustment for gender, age, education and duration of injection drug use. Further, a race/ethnicity stratified analysis examined simple and multiple associations between HCV seropositivity and incarceration status for African American and white participants, separately. All statistical analyses were computed using SAS version 9.1 (SAS 9.1 2002-2003).

RESULTS

Sixty-nine percent of the sample was positive for HCV ($n = 243$). Eighteen percent ($n = 64$) of participants reported no lifetime history of any incarceration, 49% ($n = 172$) reported jail incarceration in their lifetime, and 33% ($n = 115$) reported correctional facility incarceration in their lifetime. Among the 115 participants reporting correctional facility incarceration in their lifetime, 92% ($n = 106$) also reported a history of jail incarceration. All participants reported injection drug use, with 55% ($n = 192$) of the sample reporting greater-than 5 years of use. Seventy-six percent of participants reported that heroin by itself was their drug of choice, while 9% reported speedball, and 6% reported cocaine by itself as their drug of choice. Ninety-seven percent of participants reported injecting heroin in their lifetime, and 78% reported injecting heroin in the past 6 months. Seventy-three percent of participants reported injecting speedball in their lifetime, 49% reported injecting speedball in the past 6 months. Seventy-three percent of participants reported injecting cocaine in their lifetime, while 49% reported injecting cocaine in the past 6 months. Approximately one-quarter ($n = 90; 26$%) of participants reported graduating from high school, with most (40%) participants reporting having some high school education.

Table 1 summarizes the distributions of incarceration and demographic variables and their associations with HCV prevalence. The unadjusted results indicate that when compared with drug users having no high school education, graduating from
Latimer, Hedden, Moleko, Floyd, Lawson, Melnikov, Severtson, Cole

High school [odds ratio (OR) = 0.3, 95% CI = 0.1, 0.9] and having some college experience (OR = 0.2, 95% CI = 0.1-0.6) produced a protective effect against HCV infection. Without adjustment, the prevalence of HCV was significantly greater among injection drug users with a history of correctional facility incarceration (83%) (OR = 2.9, 95% CI = 1.5-5.9), when compared to drug users with no lifetime incarceration (61%). Also without adjustment, duration of injection drug use was highly associated with HCV status. Specifically, participants reporting one-to-five years of injection drug use were twice as likely to test positive for HCV (OR = 2.2, 95% CI = 1.2, 4.3), compared to participants reporting less than 1 year of injection drug use. The odds of HCV were greater for participants reporting greater than 5 years of injection drug use (OR = 7.6, 95% CI = 4.1, 14.3).

Adjusting for gender, age, education, lifetime incarceration status and injection drug duration, whites were twice as likely to test positive for HCV when compared to African Americans (adjusted odds ratio [AOR] = 2.0, 95% CI = 1.0-3.9). The significance of the association between a correctional facility stay and HCV infection was maintained with adjustment (AOR = 2.6, 95% CI = 1.2, 6.1). Additionally, when

<table>
<thead>
<tr>
<th>Table 1: Associations of HCV Infection among Injection Drug Users</th>
<th>Baltimore, 2001-2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>N (%) or Mean (SD)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>212 (60.4)</td>
</tr>
<tr>
<td>Female</td>
<td>139 (39.6)</td>
</tr>
<tr>
<td>Age</td>
<td>32.0 (7.3)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>136 (38.7)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>215 (61.3)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>No high school</td>
<td>37 (10.5)</td>
</tr>
<tr>
<td>Some high school</td>
<td>140 (39.9)</td>
</tr>
<tr>
<td>GED</td>
<td>37 (10.5)</td>
</tr>
<tr>
<td>High school graduate</td>
<td>90 (25.7)</td>
</tr>
<tr>
<td>Some College</td>
<td>47 (13.4)</td>
</tr>
<tr>
<td>Lifetime Incarceration</td>
<td></td>
</tr>
<tr>
<td>No Incarceration</td>
<td>64 (18.2)</td>
</tr>
<tr>
<td>Jail only</td>
<td>172 (49.0)</td>
</tr>
<tr>
<td>Correctional facility</td>
<td>115 (32.8)</td>
</tr>
<tr>
<td>Injection Drug Status</td>
<td></td>
</tr>
<tr>
<td>&lt; 1 Year of Injection</td>
<td>70 (19.9)</td>
</tr>
<tr>
<td>1-5 Years of Injection</td>
<td>89 (25.4)</td>
</tr>
<tr>
<td>&gt;5 Years of Injection</td>
<td>192 (54.7)</td>
</tr>
</tbody>
</table>

AOR: adjusted odds ratio; CI: confidence interval; OR: odds ratio.

*p < .05, **p < .01

Age was divided by 5 for the logistic regression analysis; therefore, odds ratios are interpreted for 5 year increments.
PREVALENCE AND CORRELATES OF HEPATITIS C

compared against drug users having no high school education, having some college experience (AOR = 0.3, 95% CI = 0.1-1.0) produced an independent protective effect against HCV infection.

ANALYSIS STRATIFIED BY RACE/ETHNICITY

Only duration of injection drug use remained statistically significant among African Americans after adjusting for all other covariates in the multiple logistic regression model. Compared to African American participants who reported less than 1 year of drug use, participants who reported greater than 5 years of injection drug use were about 13 times more likely to test positive for HCV, (AOR = 13.3; 95% CI = 4.5, 39.5), adjusting for gender, age, education, and lifetime incarceration.

Though not identical, the pattern of results among white participants was similar to that of the entire sample (Table 2). Namely, when compared against whites having no high school education, whites having some college exhibited significantly lower HCV infection prevalence. Correctional facility stay and longer duration of injection drug use in both the unadjusted and adjusted models were associated with higher HCV prevalence. In adjusted models, injectors with a history of correction facility stay were nearly 15 times more likely to test positive for HCV when compared to injectors with no history of incarceration (AOR = 14.7, 95% CI = 2.9, 79.5). Drug

TABLE 2: ASSOCIATIONS OF HCV INFECTION AMONG INJECTION DRUG USERS BY ETHNICITY

Baltimore, 2001-2004

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>African American (N=110)</th>
<th>GED</th>
<th>Correction facility (N=215)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N (%) or Mean (SD)</td>
<td></td>
<td>N (%) or Mean (SD)</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>69 (50.7) 65.2 1.0</td>
<td>13 (9.6) 69.2 0.3 (0.1, 2.7)</td>
<td>13 (0.6, 3.3) 1.6 (0.8, 3.4)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>67 (49.3) 70.2 1.3 (0.6, 2.6)</td>
<td>24 (11.1) 83.3 1.1 (0.3, 4.8)</td>
<td>21 (4.1, 10.2)</td>
</tr>
<tr>
<td>Age 36.6 (5.4) N/A 1.3 (0.9, 1.8)</td>
<td></td>
<td>1.0 (0.6, 1.5) 29.1 (0.8) N/A</td>
<td>1.2 (1.0, 1.5) 1.0 (0.7, 1.3)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No high school</td>
<td></td>
<td>10 (7.3) 90.0 1.0</td>
<td>90 (41.9) 76.7 0.7 (0.2, 2.2)</td>
<td>1.3 (0.4, 4.4)</td>
</tr>
<tr>
<td>Some high school</td>
<td></td>
<td>50 (36.8) 68.0 0.2 (0.1, 2.0)</td>
<td>24 (11.1) 83.3 1.1 (0.3, 4.8)</td>
<td>2.1 (0.4, 10.2)</td>
</tr>
<tr>
<td>GED 13 (9.6) 69.2 0.3 (0.1, 2.7)</td>
<td></td>
<td>0.2 (0.1, 2.6) 0.3 (0.1, 3.2)</td>
<td>46 (21.4) 56.5 0.3 (0.1, 1.1)</td>
<td>0.6 (0.2, 2.3)</td>
</tr>
<tr>
<td>High school graduate</td>
<td></td>
<td>44 (32.4) 65.9 0.2 (0.1, 1.9)</td>
<td>46 (21.4) 56.5 0.3 (0.1, 1.1)</td>
<td>0.6 (0.2, 2.3)</td>
</tr>
<tr>
<td>Some college</td>
<td></td>
<td>19 (13.9) 57.9 0.2 (0.1, 2.5)</td>
<td>28 (13.0) 50.0 0.2 (0.1, 0.8) 1.0 (0.1, 1.5)</td>
<td></td>
</tr>
<tr>
<td>Lifetime Incarceration</td>
<td></td>
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<tr>
<td>No Incarceration</td>
<td></td>
<td>20 (14.7) 65.0 1.0</td>
<td>44 (20.5) 59.1 1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Jail only</td>
<td></td>
<td>51 (37.5) 62.8 0.9 (0.3, 2.7)</td>
<td>121 (56.2) 63.6 1.3 (0.6, 2.7)</td>
<td>1.4 (0.6, 3.2)</td>
</tr>
<tr>
<td>Correctional facility</td>
<td></td>
<td>65 (47.8) 72.3 1.4 (0.5, 4.1)</td>
<td>50 (23.2) 96.0 15.6 (3.3, 72.6) 14.7 (2.7, 79.5)</td>
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<tr>
<td>Injection Duration</td>
<td></td>
<td></td>
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<tr>
<td>&lt; 1 Year of Injection</td>
<td></td>
<td>26 (19.1) 26.9 1.0</td>
<td>44 (20.4) 47.7 1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>1-5 Years of Injection</td>
<td></td>
<td>19 (14.9) 47.4 2.4 (0.7, 8.5)</td>
<td>70 (32.6) 64.3 1.8 (0.8, 4.0)</td>
<td>2.1 (0.9, 4.9)</td>
</tr>
<tr>
<td>&gt; 5 Years of Injection</td>
<td></td>
<td>91 (66.9) 85.3 13.8 (4.9, 38.9) 13.2 (4.5, 39.5)</td>
<td>101 (47.0) 84.2 5.6 (2.5, 12.9) 4.6 (1.8, 12.9)</td>
<td></td>
</tr>
<tr>
<td>AOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.</td>
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</table>

*N = 110, 215; OR = 1.0; CI = 1.0-1.0. *p < .05, **p < .01

AOR = adjusted odds ratio; CI, confidence interval; OR, odds ratio.

†Age was divided by 3 for the logistic regression analysis; therefore, odds ratios are interpreted for 3 year increments.

FALL 2009 899
users with five-or-more years of injection were nearly five times more likely to test positive for HCV when compared to drug users with less-than one year of injection drug use (AOR=4.6, 95% CI=1.8, 12.0).

DISCUSSION

Our study findings are consistent with a large base of research documenting high rates of HCV among incarcerated populations (Macalino et al., 2005). The overall rates of HCV prevalence associated with various levels of incarceration found in our study are higher than rates of HCV found in extant studies of general populations of incarcerated adults. In these studies, rates of HCV prevalence ranged from 16% to 41% (Macalino et al., 2005; Macalino et al., 2004; Reindollar, 1999; Solomon et al., 2004; Vlahov et al., 1993).

Consistent with previous research with drug using and incarcerated populations, whites in our study were significantly more likely than African Americans to test positive for hepatitis C (Baillargeon et al., 2003; Ruiz et al., 1999; Solomon et al., 2004). Past studies either did not control for injection drug use (Baillargeon et al., 2003; Ruiz et al., 1999), or included both non-injectors and injectors (Ruiz et al., 1999; Solomon et al., 2004). In our sample of injection drug users, when controlling for potentially influential covariates such as duration of injection drug use, the odds of HCV infection for whites compared to African Americans increased. Furthermore, the stratified analyses indicate that the duration of injection and type of incarceration differs by race. These differences may explain why HCV is higher among whites compared to African Americans in incarcerated populations, compared to the opposite effect in general populations. That is, although a higher percentage of African Americans reported correctional facility stays compared to whites, whites who reported correctional facility stays had a higher prevalence of HCV infection compared to African Americans, 96.0% versus 72.3% respectively. Whereas HCV infection was similar among whites and African Americans who reported greater than five years of injection drug use (84.2 versus 83.5, respectively), HCV infection was greater in whites compared to African American who reported less than 1 year of injection drug use (47.7 versus 26.9, respectively), and who reported one to five years of injection drug use (64.3 versus 47.4, respectively). Further studies need to delineate why HCV rates are higher among incarcerated whites who report fewer years of injection drug use compared to incarcerated African Americans. That is, future studies may want to control for not only the duration of injection drug use but also the frequency of use and high-risk injection drug use practices (e.g., sharing needles, backloading, etc.). Further, exploration of risk factors for HCV other than injection drug use, such as sexual risk factors, may need to be delineated by race.

Given research conducted in the general population that has shown African Americans to be at greater risk to contract HCV than whites, the higher prevalence
PREVALENCE AND CORRELATES OF HEPATITIS C

of HCV among incarcerated whites than among incarcerated African Americans is noteworthy. The differing base rates of incarceration among African Americans and whites in the United States could be a further explanation for this finding. It is well documented that the U.S. incarcerates a higher proportion of its citizens at a rate 5 to 8 times that of other industrialized nations (Harrison, 2003; Thomas & Sampson, 2005). The rate of incarceration in the United States has increased by more than 200% during the past 20 years, attributable mainly to a growth in the prosecution of drug-related offenses (Macalino et al., 2005). Further, while African Americans comprise 12.3% of the population, they comprise 43.7% of incarcerated individuals (Bonczar & Beck, 1997; Braithwaite & Arriola, 2003). Equally alarming is the one-in-eight rate of incarceration among African American males aged 25–29 years (Bonczar & Beck, 1997). To the extent that incarceration is less likely for whites than African Americans for drug-related offenses, whites who serve sentences may have higher levels of drug use, infectious disease, and pathology than incarcerated African Americans. The stratified findings also have relevance to the prevention of HCV among African American and white populations of drug users. Consistent with extant studies, longer duration of injection drug use was associated with HCV prevalence among African Americans and whites (Hagan et al., 2007). The findings suggest the need for behavioral pharmacological interventions at each level of incarceration (e.g., from detentions and jails to prisons) to reduce the use of illegal substances especially, IDU, which often involves sharing injection equipment among incarcerated populations.

Consideration of several limitations of this study is now discussed. Notably, despite being of comparable size to several studies of adult injection drug users, this sample was relatively small, particularly with respect to the stratified analysis for some variables. Additionally, sufficient representation of ethnic/racial groups other than African American and white in the study sample did not allow for generalization to other ethnicity groups. Further, the cross-sectional data utilized in the present study limits the capacity to infer causal relationships. Future studies will need to evaluate the present study findings in light of incidence data that provide a more precise measure of the nature of an epidemic. Despite these important limitations, the present study design and sampling method provide contributions to the HCV literature, particularly with respect to insights into possible foci of prevention programs targeting African American and white drug users.

Correctional systems throughout the United States do not incorporate systematic HCV screening or prevention programs for inmates (Braithwaite & Arriola, 2003; Hammett et al., 2002). A growing base of empirical research strongly suggests that the absence of such programming represents a lost opportunity to improve public health within society as a whole as well as among inmates and those released from
incarceration. When an estimated 30% to 90% of drug users with a history of incarceration are seropositive for HCV, the utility of providing systematic screening and prevention efforts within jails and correctional facilities is clear. The significance of such programming for the prevention of subsequent HCV transmission in the general population is necessary when considered in light of the estimated 7 million inmates released from jails or correctional institutions annually.

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PREVALENCE AND CORRELATES OF HEPATITIS C

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