HCV Infection Prevalence Lower Than Expected among 18–40-Year-Old Injection Drug Users in San Diego, CA

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ABSTRACT *San Diego, California shares the world's busiest land border crossing with Tijuana, Mexico—a city where 95 % of injection drug users (IDUs) test hepatitis C virus (HCV) antibody-positive. Yet, little is known about the prevalence and risk behaviors for HCV among IDUs in San Diego. In 2009–2010, 18–40-year-old IDUs in San Diego County completed a risk assessment interview and serologic testing for HCV and HIV infection. Recruitment involved respondent-driven sampling, venue-based sampling at a syringe exchange program, and convenience sampling. Correlates of HCV infection were identified by multivariable logistic regression. Among 510 current IDUs, 26.9 % (95 % CI 23.0–30.7 %) and 4.2 % (95 % CI 2.4–5.9 %) had been infected with HCV and HIV, respectively. Overall, median age was 28 years; 74 % were male; 60 % white and 29 % Hispanic; and 96 % were born in the U.S. Median years of injecting was 6; 41 % injected daily; 60 % injected heroin most often; 49 % receptively shared syringes and 68 % shared other injection paraphernalia; and only 22 % reported always using new syringes in the past 3 months. Two thirds had ever traveled to Mexico and 19 % injected in Mexico. HCV infection was independently associated with sharing injection paraphernalia (adjusted odds ratio [AOR]=1.69) and SEP use (AOR=2.17) in the previous 3 months, lifetime history of drug overdose (AOR=2.66), and increased years of injecting (AOR=2.82, all P values <0.05). Controlling for recruitment method did not alter results. HCV infection prevalence among IDUs in San Diego was modest compared to other US cities and much lower than Tijuana. Given that known individual-level HCV risk factors were common in San Diego, the city's lower HCV prevalence might be due to differences in social and structural factors between the cities.*

KEYWORDS *Hepatitis C virus, Injection drug use, Risk behaviors, Prevalence, Human immunodeficiency virus, Border region*

INTRODUCTION

While 1.3–1.9 % of the general U.S. population has hepatitis C virus (HCV) infection, prevalence estimates among injection drug users (IDUs) are substantially

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higher nationally (14–89 %) and in California (23–75 %).^{1–7} Older age and longer injecting duration could account for the higher upper bounds of these estimates; however, two U.S. studies^{8,9} reported finding 33 and 36 % of IDUs under 25 years old were HCV infected and several non-U.S. studies found a much higher prevalence even among IDUs in this age group.¹⁰ In 2007, 48 % of individuals with incident HCV in the U.S. reported injection drug use, which continues to be the leading risk factor for infection.^{11,12} Parenteral exposures through unhygienic injection practices among IDUs, such as sharing of syringes and drug preparation equipment (cooker, cotton, and rinse water), have been identified as the primary risk factors for HCV infection.^{6,13–15} Furthermore, duration and frequency of injection are strongly associated with HCV infection, with recently initiated IDUs being at an increased risk of seroconversion.^{2,5,16}

Just south of the busiest land border crossing in the world, and only 20 miles from downtown San Diego, California sits the Mexican city of Tijuana, Baja California where an estimated 95 % of IDUs are HCV antibody (anti-HCV)-positive.^{17,18} IDUs have been studied in several California counties, with rates upwards of 70–75 % found in Los Angeles,³ Fresno,⁴ and Sacramento,¹⁹ to 35 % in San Francisco¹³ and 32 % in Riverside.⁴ To date, however, the only published estimate of HCV infection among the estimated 21,326 IDUs²⁰ in San Diego comes from a small study in 2001 finding that 38 % of IDUs tested in a sexually transmitted diseases clinic screened anti-HCV positive.²¹ Given the high HCV prevalence in Tijuana, we were interested to know whether HCV infection prevalence was similar in San Diego. To better characterize IDUs in San Diego, we conducted a cross-sectional study to estimate the prevalence and identify correlates of HCV infection among young adult IDUs.

METHODS

Study Population and Eligibility

Between March 2009 and June 2010, IDUs were recruited to participate in the Study to Assess Hepatitis C Risk among IDUs in San Diego. Individuals were eligible to participate if they were 18–40 years old, injected illicit drugs at least once within the previous 6 months, were currently residing in San Diego County, and agreed to serologic testing. After eligibility screening and informed consent, a behavioral risk assessment was conducted followed by venipuncture and pre-test counseling for HCV and HIV testing. Participants were asked to return 2 to 3 weeks later to receive test results and post-test counseling. Those who tested positive for HIV or HCV were referred for medical services and care. All participants were also offered referrals for drug treatment, medical care, and social services. This study was approved by a University of California San Diego institutional review board.

Recruitment

Three recruitment methods were employed: respondent-driven sampling (RDS), venue-based sampling, and convenience sampling. RDS is a chain referral sampling method that uses mathematical modeling to produce prevalence estimates that are unbiased by the fact that initial participants or “seeds” are selected non-randomly.^{21–24} Participants were given \$10 for each new participant (maximum = 3) they recruited using RDS coupons given to their IDU peers. Venue-based recruiting consisted of inviting syringe exchange program (SEP) clients to participate

in the study when they came to exchange syringes. SEP clients were referred to a study van parked adjacent to the SEP van or to the study office for eligibility screening and enrollment. Convenience sampling involved outreach workers who encountered IDUs in known high-drug-use neighborhoods. Outreach workers passed out recruitment cards and posted flyers in bars, clubs, coffee houses, and other establishments frequented by IDUs. Current study participants were also encouraged to inform their peers about the study. Unlike RDS, no incentives were given to study participants in the venue-based and convenience samples for recruiting their peers.

Data Collection

After eligibility screening and informed consent, behavioral data were collected using audio computer-assisted self-interviewing (ACASI) technology—a system that displays assessment questions on a computer monitor while participants can optionally listen to an audio recording of the questions played simultaneously through headphones. The participants then enter their responses directly on the computer.

Sociodemographic variables collected by ACASI included age, gender, race/ethnicity, country of birth, Spanish language proficiency, education, source of income, housing stability, and lifetime history of incarceration. The source of most income over the 6 months prior to assessment was analyzed by re-categorizing an original variable to group together similar sources as follows: (1) regular jobs (used as the reference category in statistical analysis), (2) other legal sources (i.e., informal or temporary work, recycling, panhandling, public assistance or disability, and money from family or friends), and (3) illegal sources (i.e., theft, robbery, selling drugs or syringes, running or touting drugs, running a shooting gallery, and trading sex for money). Housing stability was assessed by asking participants where they slept most of the time over the prior 6 months and were grouped into similar categories as follows: (1) stable housing (i.e., living in one's parents' or in one's own house or apartment, living in one's spouse's or sexual partner's house or apartment, or a family or friend's house or apartment—the reference category) and (2) unstable housing (i.e., migrant worker camp, workplace, rented room, car or other vehicle, abandoned building, shelter or welfare residence, jail, halfway house, on the streets, shooting gallery, or in a medical care facility).

Substance use and injection practices were also assessed. Lifetime variables included: ever attending a drug treatment program (excluding 12-step programs such as Alcoholics or Narcotics Anonymous), age of first injection, number of years of injecting (log transformed for logistic regression analysis), history of overdose (worded, “By overdosing we mean taking so much drug that you stopped breathing or your heart stopped.”), history of injecting in Mexico or with a Mexican resident in the U.S., and total number of skin abscesses. Current practices, defined as past 3 months, included: frequency of alcohol use, total number of injections, drug type injected most frequently, number of injection partners, shooting gallery use, receptive needle sharing, injection paraphernalia sharing (including cooker, cotton, and rinse water), SEP use, most common source of new syringes, and frequency of injection with a new syringe. The effect of police interference in drug use was investigated by asking participants, “How fearful are you that police are going to arrest you or interfere with your drug use,” “In the last 3 months, has police presence affected where you buy drugs,” and “In the last 3 months, has police presence affected where you use drugs?”

Sexual behaviors examined included: sexual orientation (lesbian/gay/homosexual, bisexual vs. straight/heterosexual), history of sexually transmitted infections (STI),

exchanging sex for money or drugs over the past 3 months, and number of sexual partners in the past 3 months. History of HIV and HCV testing prior to the current study was also assessed.

HIV and HCV Testing

Following the behavioral assessment and pre-test counseling, participants had blood drawn for HCV and HIV testing. HCV antibody testing was performed using the Abbott AxSYM microparticle enzyme immunoassay (EIA) Abbott Laboratories, Chicago, IL). Repeatedly reactive specimens with a sample/cutoff ratio ≥ 10.0 were considered anti-HCV positive; specimens with sample/cutoff ratios between 1.0 and 10.0 received supplemental testing using recombinant immunoblot assays (Ortho Diagnostics, Raritan, NJ).²⁵ Samples were also assessed for the presence of HCV and HIV using nucleic acid testing ([NAT] American Red Cross Blood Services National Testing Laboratory, St. Louis, MO). Participants testing HCV NAT-positive were considered HCV infected, regardless of anti-HCV status, and those who were HCV NAT-positive but anti-HCV negative were considered to have acute infection. If the HIV NAT was positive, samples were tested for HIV antibodies (OraQuick ADVANCE® Rapid Test kit). HIV rapid test positive samples were subsequently tested with a sensitive/less-sensitive enzyme immunoassay ([S/LS-EIA] Blood Research Institute, San Francisco, CA) to determine recent infection. Samples that tested positive for HIV on NAT or antibody assays were considered HIV positive; those that were NAT-positive but antibody negative, or S/LS-EIA negative were considered to have acute HIV infection.

Statistical Analysis

The objectives of this analysis were to describe the HCV prevalence and characteristics of IDUs in San Diego, and to identify factors associated with HCV infection. The dependent variable for this analysis was HCV infection (anti-HCV or HCV NAT-positive). Independent variables investigated as potential correlates of HCV infection included sociodemographic characteristics, substance use and injection risk behaviors, and sexual behaviors. Since most injection risk variables were assessed for the past 3 months, all analyses were restricted to those who had injected drugs in the past 3 months. Variables were analyzed using medians for continuous measures, and frequencies and percentages for categorical variables. Differences by HCV status were examined using chi-square tests for categorical variables and Wilcoxon rank sum tests for continuous variables. Logistic regression was used to assess the bivariate and multivariable associations of selected factors with HCV infection. All variables found to be significant ($P < 0.10$) through bivariate analysis were considered for inclusion in multivariable analysis. Backward stepwise logistic regression was performed, and factors that were statistically significant ($P < 0.05$) in multivariable analysis remained in the final model. Odds ratios (OR) and adjusted odds ratios (AOR) with 95 % confidence intervals (CI) are reported to show the strength and direction of these associations.

RESULTS

Of the 608 IDUs screened, 566 were eligible to participate in the study, and 510 (90 %) had injected in the past 3 months and complete data available for this analysis. Overall, the prevalence of HCV infection was 26.9 % (95 % CI 23.0–30.7 %) and HIV was 4.2 % (95 % CI 2.4–5.9 %). Five (3.6 %) of the 137 HCV-

positive IDUs had acute infection (i.e., NAT positive and anti-HCV negative). The median age was 28 years (interquartile range [IQR] 24–33); 74 % were male; 60 % non-Hispanic white and 29 % Hispanic; 96 % were born in the U.S.; and the median duration of injecting was 6 years (IQR 2–11) (Tables 1 and 2). Sixty-seven

TABLE 1 Bivariate analysis of sociodemographic characteristics by HCV status among 18–40-year-old IDUs in San Diego, California, 2009–2010

Variable ^a	Total N (%) ^b	HCV(+) N (%) ^c	Odds Ratio (95 % CI)	P value ^d
Total	510 (100.0)	137 (26.9)		
Recruitment method				0.0637
RDS	79 (15.7)	15 (19.0)	1.00	
SEP	216 (42.9)	69 (31.9)	2.00 (1.07–3.76)	
Street outreach	209 (41.5)	53 (25.4)	1.45 (0.76–2.76)	
Age (years), Median (IQR)	28 (24–33)	30 (26–35)	1.08 (1.05–1.12)	<0.0001
Gender				0.7111
Female	130 (26.0)	34 (26.2)	1.00	
Male	370 (74.0)	103 (27.8)	1.09 (0.69–1.71)	
Race				0.0083
White	278 (59.7)	73 (26.3)	1.00	
Hispanic	137 (29.4)	44 (32.1)	1.33 (0.85–2.08)	
Black	32 (6.3)	2 (6.3)	0.19 (0.04–0.80)	
Other	19 (4.6)	3 (15.8)	0.53 (0.15–1.86)	
Country of birth				0.7696
U.S.	482 (95.8)	131 (27.2)	1.00	
Mexico	5 (1.0)	2 (40.0)	1.79 (0.30–10.8)	
Other	16 (3.2)	4 (25.0)	0.89 (0.28–2.82)	
Spanish speaking				0.3160
No	385 (78.3)	100 (26.0)	1.00	
Yes	107 (21.8)	33 (30.8)	1.27 (0.79–2.03)	
Education				0.6868
High school degree, GED or higher	370 (73.6)	99 (26.8)	1.00	
≤ 11th grade	133 (26.4)	38 (28.6)	1.09 (0.70–1.70)	
Source of most income in last 6 months				0.0276
Regular job	108 (21.7)	19 (17.6)	1.00	
Other legal sources	307 (61.8)	95 (30.9)	2.10 (1.21–3.64)	
Illegal sources	82 (16.5)	22 (26.8)	1.72 (0.86–3.44)	
Housing status in last 6 months				0.0851
Stable housing	298 (60.0)	72 (24.2)	1.00	
Unstable housing	199 (40.0)	62 (31.2)	1.42 (0.95–2.12)	
Ever incarcerated				0.0340
No	113 (22.5)	22 (19.5)	1.00	
Yes	389 (77.5)	115 (29.6)	1.74 (1.04–2.90)	
Ever tested for HCV	234 (51.2)	65 (27.8)	0.71 (0.46–1.09)	0.1214
Ever tested for HIV	355 (73.4)	105 (29.6)	0.66 (0.41–1.06)	0.0863
Tested HIV (+) via the study	21 (4.2)	6 (28.6)	1.12 (0.42–2.94)	0.8246

^aAll substance and injection risk behaviors refer to the past 3 months, unless otherwise indicated

^bColumn percentages. Totals may vary by subgroup due to missing data

^cRow percentages represent prevalence of HCV within the groups

^dP values are based on chi-square tests, non-parametric Wilcoxon rank sum tests or Fisher's Exact test, and demonstrate overall significance of differences between HCV status groups by each character

TABLE 2 Bivariate analysis of substance use, injection practices, and police influences by HCV status among 18–40-year-old injection drug users in San Diego, California, 2009–2010

Variable ^a	Total <i>N</i> (%) ^b	HCV (+) <i>N</i> (%) ^c	Odds ratio (95 % CI)	<i>P</i> value ^d
Total	510 (100.0)	137 (26.9)		
Frequency of alcohol use				0.1537
Never	83 (16.6)	29 (34.9)	1.00	
Less than daily	322 (64.4)	79 (24.5)	0.61 (0.36–1.02)	
At least once daily	95 (19.0)	27 (28.4)	0.74 (0.39–1.39)	
Ever in drug treatment				0.3520
No	195 (39.6)	49 (25.1)	1.00	
Yes	297 (60.4)	86 (29.0)	1.21 (0.81–1.83)	
Age of first injection, Median (IQR)	20 (17–25)	19 (16–24)	0.96 (0.92–0.99)	0.0085
Duration of injecting (years), Median (IQR)	6 (2–11)	9 (6–15)	1.12 (1.08–1.15)	<0.0001
Total injections per 10 injections, Median (IQR)	120 (36–252)	168 (72–336)	1.01 (1.00–1.02)	
Frequency of injection				0.0003
Less than daily	293 (59.4)	62 (21.2)	1.00	
At least once daily	200 (40.6)	72 (36.0)	2.10 (1.40–3.13)	
Drug injected most frequently				0.0044
Methamphetamine alone	182 (40.9)	38 (20.9)	1.00	
Heroin alone	258 (53.2)	88 (34.1)	1.96 (1.26–3005)	
Heroin with cocaine or methamphetamine	35 (7.2)	6 (17.1)	0.78 (0.30–2.03)	
Crack/cocaine alone	10 (2.1)	1 (10.0)	0.42 (0.05–3.43)	
Lifetime history of overdose				<0.0001
No	358 (71.9)	71 (19.8)	1.00	
Yes	140 (28.1)	64 (45.7)	3.40 (2.23–5.19)	
Number of injection partners, Median (IQR)	2.0 (1–3)	2.0 (1–3)	0.98 (0.95–1.02)	0.7560
Shooting gallery use				0.0018
No	455 (92.1)	116 (25.5)	1.00	
Yes	39 (7.9)	19 (48.7)	2.78 (1.43–5.38)	
Receptive syringe sharing				0.0156
No	251 (50.7)	56 (22.3)	1.00	
Yes	244 (49.3)	78 (32.0)	1.64 (1.10–2.44)	
Injection paraphernalia sharing				0.0135
No	162 (31.8)	32 (19.8)	1.00	
Yes	348 (68.2)	105 (30.2)	1.76 (1.12–2.75)	
Used syringe exchange program (SEP)				0.0019
No	265 (53.2)	57 (21.5)	1.00	
Yes	233 (46.8)	79 (33.9)	1.87 (1.26–2.79)	
Most common source of new syringes				0.0383
SEP	130 (26.8)	47 (36.2)	1.00	
Someone else who used the SEP	38 (7.8)	10 (26.3)	0.63 (0.28–1.41)	
On the street	52 (10.7)	15 (28.9)	0.72 (0.36–1.44)	
Friend or Family Member	192 (39.6)	49 (25.5)	0.61 (0.37–0.98)	
Other unsafe sources	7 (1.4)	2 (28.6)	0.71 (0.13–3.78)	
Other safe source	66 (13.6)	9 (13.6)	0.28 (0.13–0.61)	

TABLE 2 *Continued*

Variable ^a	Total N (%) ^b	HCV (+) N (%) ^c	Odds ratio (95 % CI)	P value ^d
Frequency of injection with a new syringe				0.0050
Always	110 (21.6)	18 (16.4)	1.00	
Less than always	400 (78.4)	119 (29.8)	2.16 (1.25–3.75)	
Lifetime travel to Mexico				0.1288
Never traveled to Mexico	161 (33.3)	43 (26.7)	1.00	
Traveled to but did not inject in Mexico	229 (47.4)	56 (24.5)	0.89 (0.56–1.41)	
Traveled to and injected in Mexico	93 (19.3)	33 (35.5)	1.51 (0.87–2.62)	
Ever injected in Mexico				0.0496
No	390 (80.8)	99 (25.3)	1.00	
Yes	93 (19.3)	33 (35.5)	1.60 (1.00–2.62)	
Ever injected with IDU from Mexico in the U.S.				0.2065
No	290 (90.9)	78 (26.9)	1.00	
Yes	29 (9.1)	11 (37.9)	1.66 (0.75–3.67)	
Lifetime number of abscesses				<0.0001
<4	407 (84.1)	97 (23.8)	1.00	
≥4	77 (15.9)	38 (49.4)	3.11 (1.88–5.14)	
Fearful of police interference during drug use				0.7054
No	149 (30.2)	39 (26.2)	1.00	
Yes	345 (69.8)	96 (27.8)	1.09 (0.70–1.68)	
Location of drug purchase affected by police				0.1200
No	293 (59.6)	74 (25.3)	1.00	
Yes	199 (40.5)	63 (31.7)	1.37 (0.92–2.04)	
Location of drug use affected by police				0.0675
No	308 (62.4)	76 (24.7)	1.00	
Yes	186 (37.7)	60 (32.3)	1.45 (0.97–2.17)	

^aAll substance and injection risk behaviors refer to the past 3 months, unless otherwise indicated

^bColumn percentages. Totals may vary by subgroup due to missing data

^cRow percentages represent prevalence of HCV within the groups

^dP values are based on chi-square tests or non-parametric Wilcoxon rank sum tests and demonstrate overall significance of differences between HCV status groups by each variable

percent of IDUs reported traveling to Mexico and 19 % overall reported injecting drugs in Mexico.

Compared to HCV-negative IDUs in bivariate analysis, HCV-positive IDUs were significantly older (median 30 vs. 27 years; $P<0.01$) and were more likely to be ever incarcerated, have irregular legal sources of income and been recruited via the SEP (Table 1). The groups did not differ by gender, country of birth, ability to speak Spanish, education, or history of HCV/HIV testing. HCV-positive IDUs were younger when they began injecting (median 19 vs. 21 years old; $P<0.05$), had been injecting longer (median 9 vs. 5 years; $P<0.01$), and were more likely to have a history of overdose or have four or more abscesses in their lifetime (Table 2). Over

the past 3 months, compared to HCV-negative IDUs, HCV-positive IDUs had injected more times (median 168 vs. 96; $P<0.05$) and were more likely to inject daily, inject heroin alone or in combination with other drugs (vs. no heroin use), inject in a shooting gallery, receptively share needles, share injection paraphernalia, use an SEP, and inject with new syringes less than always (Table 2). In addition, HCV-positive IDUs were slightly more likely to report that police presence affected their choice of location for drug use. HCV status was not associated HIV infection.

Sexual variables examined included sexual orientation (75.6 % straight/heterosexual, 11.3 % homosexual, 13.1 % bisexual), number of sexual partners in the past 3 months (median=1, IQR [1–3]), lifetime history of STI diagnosis (17.8 %), and exchanging sex for money or drugs in the past 3 months (27.2 %); none of which differed significantly by HCV infection status (all P values>0.1; data not shown).

Age, age of first injection, and years of injecting were associated with HCV infection in bivariate analysis; however, to avoid problems of collinearity, only years of injecting was considered for entry in multivariable analysis. In multivariable analysis (Table 3), HCV infection was independently associated with years of injecting (AOR=2.82, $P<0.01$), sharing injection paraphernalia (AOR=1.69, $P=0.04$) and obtaining most syringes from an SEP (AOR=2.17, $P<0.01$) in the previous 3 months, and ever overdosing on drugs (AOR=2.66, $P<0.01$).

DISCUSSION

This study found that young adult IDUs in San Diego had a moderate HCV infection prevalence (27 %) compared to other U.S. cities (38–97 %) ^{2,3,6,7,10} and much lower than in Tijuana, Mexico (95 %). ¹⁷ However, large proportions of San Diegan IDUs reported risk factors for HCV and other blood-borne viral infections, including receptive needle sharing (49 %), injection paraphernalia sharing (68 %), and injecting with used syringes (78 %); although, only injection paraphernalia sharing was independently associated with HCV infection in multivariable analysis. This is consistent with other studies finding that syringe sharing is reported less often than sharing other paraphernalia, ^{6,14} possibly due to less awareness of infection risk from paraphernalia sharing than syringe sharing. While injecting in Mexico was associated with increased HCV prevalence in univariate analysis, it did not remain significant in the final multivariable model.

The lack of association with syringe sharing could be due to socially desirable response bias. Since prevention messages against syringe sharing are more prevalent than messages advising against paraphernalia sharing, the likelihood of bias

TABLE 3 Multivariable logistic regression analysis of factors associated with HCV infection among 18–40-year-old injection drug users in San Diego, California, 2009–2010

Variable	Adjusted odds ratio ^a	95 % Confidence interval	<i>P</i> value
Duration of injecting (years) ^b	2.82	(2.06–3.84)	<0.001
Shared injection paraphernalia in last 3 months	1.69	(1.01–2.82)	0.044
Used syringe exchange program in last 3 months	2.17	(1.38–3.40)	0.001
Lifetime history of overdose	2.66	(1.67–4.22)	<0.001

^aOdds ratios were adjusted for all other variables in the model

^bLog transformed to normality

associated with the latter would be less. Alternatively, IDUs may selectively share syringes with partners whom they know or presume are uninfected with HCV or HIV, but are less selective about sharing other paraphernalia because they are unaware of the risks from sharing contaminated paraphernalia.

Similar to prior studies,^{26,27} we found that IDUs who obtained most of their syringes from an SEP were more likely to be HCV infected. This finding is not surprising given that SEP clients have been reported to inject more frequently than IDUs who do not use the SEP.^{26,28} Another possible explanation is that SEP client's need for syringes might not be fully met. San Diego has only one SEP, which operates out of a mobile van in two neighborhoods for only 3 h/week in each location and requires a one-to-one exchange. Thus, IDUs who rely on SEPs for clean syringes rarely obtain enough syringes to use a new one for every injection. Other studies have also found that SEP clients have lower incomes and higher risk for HCV infection.^{26,29} Although almost half (43 %) of the participants were recruited directly from the SEP, we did not find a significant association between HCV and recruitment method after controlling for other factors. In addition, controlling for method of recruitment did not significantly alter our findings (data not shown).

Consistent with other studies,³⁰ overdose history was associated with HCV infection. Although we observed a high prevalence of heroin use (60 %) and daily injection (41 %), controlling for these factors did not eliminate the association between HCV and overdose. In addition, having a history of incarceration or attending drug treatment—both common in this sample—have been found to be associated with overdose among IDUs in other studies.^{31,32} One explanation for this association is that after a period of abstinence during incarceration or drug treatment, IDUs who use again have reduced tolerance to the drug and inject too much. Future studies obtaining greater detail on the circumstances surrounding overdose may provide explanations for the association between HCV and overdose.

Approximately two thirds of the IDUs reported ever traveling to Mexico, of whom 29 % reported injecting in Mexico, raising concerns about their being at greater risk of exposure to HCV and other blood-borne pathogens than IDUs who do not inject in Mexico. Another way that HCV can be spread from Mexican IDUs to San Diegan IDUs occurs when Mexican IDUs cross the border into San Diego, since one study found that 15 % of Mexican IDUs had a history of crossing the border into California in 2005³³ and 9 % of the San Diegan IDUs in our study had injected with IDUs from Mexico in the U.S. in the past 6 months. Similarly, a study of Puerto Rican IDUs in New York City found that recent migrants were significantly more likely to report receptive syringe sharing (AOR=2.44) in the past year, compared to U.S.-born IDU and that these cultural norms may have been acquired before coming to the U.S.³⁴ These findings suggest that greater understanding of cultural norms around injection drug use among migrants is needed to develop effective interventions for IDUs.

In August 2010, Mexico enacted federal legislation decriminalizing possession of small amounts of cocaine, heroin, methamphetamine, marijuana, and other drugs for personal use so resources could be reallocated to address higher-level crimes.³⁵ An unintended consequence of this law identified by critics of decriminalization³⁶ is that it may draw U.S. drug users into Mexico to purchase and use drugs if they perceive a decrease in legal consequences. Reasons for neither injecting in Mexico nor injecting with IDUs from Mexico in the U.S. being associated with HCV infection in this study could be due to sample size as both odds ratios were >1.50, or the lack of sensitivity in our questions to assess characteristics of injection partners and sharing behaviors with

specific partners. It will be important to consider the relationship between Mexican and U.S. IDUs in designing interventions to prevent HCV and HIV transmission between these two populations. Additional research is needed to understand interactions between Mexican and U.S. IDUs and identify effective strategies for prevention of blood-borne infections among IDUs in the border region.

While not significant in the multivariable model, it was notable that 70 % of participants reported fearing police interference during drug use and 40 % reported that the location chosen for drug use was influenced by the police. Qualitative studies show that IDUs perceiving a threat of police interference during drug use will forgo safe injection practices to prevent unfavorable interactions with the police.^{37–39} Further research is needed to assess the impact that policing has on IDUs' injection practices.

Some limitations should be considered when interpreting these findings. All risk behaviors were self-reported. However, to minimize recall bias, we used a short recall period of 3 months for substance use and injection behavior questions. In addition, interviews were conducted using ACASI to minimize reporting bias. This method has been found to reduce socially desirable responding and increase the frequency of reporting high-risk sexual and injection behaviors among IDUs.^{40,41} The study's cross-sectional design precludes establishing temporal relationships between HCV infection and the factors found to be associated with it. Some HCV-positive participants may have been aware of their seropositive status before they enrolled in the study; thus, their recent self-reported behaviors may reflect changes they made to prevent spreading HCV to others causing misclassification that would tend to minimize observed associations between HCV infection and risk behaviors. Finally, the representativeness of our sample to all IDUs in San Diego is uncertain due to the hidden nature of this population and the age restriction (18–40 years). However, three different recruitment methods were used. While the samples were similar across most variables, some differed suggesting that a pooled sample might be more representative than a sample recruited using a single method. Also, given that the median age of our sample was 28 years and younger IDUs typically have shorter injection drug use histories, the prevalence of HCV among all IDUs in San Diego is likely to be higher than the 27 % observed in this study.

Young IDUs in San Diego practice high-risk injection behaviors that place them at increased risk for blood-borne viral infections. The relationship dynamics between IDUs from the U.S. and Mexico need to be further examined to identify opportunities to prevent the spread of HCV from a city with a high prevalence among IDUs to its sister city with a lower prevalence. Interventions should continue to reduce syringe sharing and increase awareness about the risk of HCV transmission through sharing injection paraphernalia. Longitudinal studies are needed to assess the impact of Mexico's new drug policy on IDUs in border regions of neighboring countries.

ACKNOWLEDGMENTS

The authors greatly appreciate the support of the University of California San Diego, Antiviral Research Center for the use of its clinical facilities and HIV/HCV NAT testing; research activities performed by Philippe Duhaime, Maureen Clark, Katherine Banares, Nicholas Aldridge, Carlos Vera, Amanpreet Sandhu, and Amelia Poquette; laboratory guidance provided by DeeDee Pacheco; and the participants who volunteered their time for the study. This study was funded through a contract (#200-2007-21016) from the Centers for Disease Control and Prevention. Support

for additional HIV and HCV testing was provided by grants from the National Institutes of Health (AI36214, AI074621, and AI007384) and the California HIV/AIDS Research Program (RN07-SD-702).

Disclaimer. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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