METHADONE TREATMENT AND HIV AND HEPATITIS B AND C RISK REDUCTION AMONG INJECTORS IN THE SEATTLE AREA

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ABSTRACT Drug treatment has the potential to reduce incidence of blood-borne infections by helping injection drug users (IDUs) achieve abstinence or by decreasing the frequency of injection and sharing practices. We studied the associations between retention in methadone treatment and drug use behaviors and incidence of hepatitis B and C in a cohort of IDUs in the Seattle, Washington, area. Data on IDUs entering methadone treatment at four centers in King County, Washington, were collected through face-to-face interviews using a standardized questionnaire at baseline and 12-month follow-up between October 1994 and January 1998. Blood specimens were obtained and tested for human immunodeficiency virus (HIV) and hepatitis B and C. Drug treatment status at follow-up was analyzed in relation to study enrollment characteristics and potential treatment outcomes, including injection risk behaviors, cessation or reduced frequency of injection, and incidence of hepatitis B and C. Of 716 IDUs, 292 (41%) left treatment, 198 (28%) disrupted (left and returned) treatment, and 226 (32%) continued treatment throughout the 1-year follow-up period. Compared to those who left treatment, subjects who disrupted or continued were less likely to inject at follow-up (odds ratio [OR] = 0.5, 95% CI 0.3–0.7; and OR = 0.1, 95% CI 0.1–0.2, respectively). Among the 468 (65%) subjects who continued injecting, those who continued treatment injected less frequently, were less likely to pool money to buy drugs (OR = 0.5, 95% CI 0.3–0.8) and inject with used needles (OR = 0.5, 95% CI 0.2–0.8) compared to those who left treatment. Cooker or cotton sharing was not associated with retention in treatment, but hepatitis B incidence was lowest among those who continued treatment. The results of this study suggest drug use risk reduction is more likely to be achieved by those who remain in drug treatment and by those who stop injecting, but that those who drop out and return and those who continue to inject while in treatment

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may also benefit. This supports the role of consistent drug treatment in an overall harm-reduction strategy.

KEY WORDS HBV, HCV, HIV, Injection Drug Use, Methadone Treatment, Prevention.

INTRODUCTION

Injection drug use continues to remain an important route of transmission for human immunodeficiency virus (HIV), accounting for almost one-third of all acquired immunodeficiency syndrome (AIDS) cases reported in the US and a rapidly rising number of infections in eastern Europe and Asia.[1,2] Des Jarlais et al.,[3,4] however, reported a substantial decrease in HIV incidence and prevalence among injection drug users (IDUs) in New York City in the 1990s, and several studies have noted declines in risky injection practices in the US and elsewhere that are thought to have resulted in lower HIV transmission rates among specific IDU populations.[5–9] Hepatitis B (HBV) and hepatitis C (HCV) prevalence and incidence, on the other hand, continue to remain high among IDUs in many areas where HIV prevalence has remained low or has decreased,[5,10,11] and residual injection and sexual risk behaviors suggest that work remains to be accomplished to control transmission of blood-borne viruses.

Drug treatment has been an important component of HIV prevention for many years, and methadone treatment has been associated with reduction in risky drug use and sexual behaviors, as well as lower HIV prevalence and incidence.[12–21] Less is understood about the effect of methadone treatment on HBV and HCV transmission, and two studies did not show reduced HCV incidence among methadone treatment participants. Selvey et al.[22] reported an HCV seroconversion rate of 11 per 100 person-years among methadone clients and no association between duration of methadone treatment and seroconversion. A study by Crofts et al.[23] found no differences in HCV seroconversion rates between Melbourne, Australia, IDUs in methadone maintenance treatment versus those not in treatment. This raises questions regarding the contribution of drug treatment to HBV and HCV control and to reductions in injection risk behaviors.

King County, Washington, is located on the Puget Sound in the northwestern part of the US. The population of 1.7 million includes those living in Seattle, the county's largest city. There are an estimated 10,000–15,000 IDUs in King County, most of whom are opiate users. During the time of this study, there were 1,750 methadone treatment slots in the county, most of which were occupied, and those on waiting lists for methadone treatment numbered in the hundreds. In this study, we examined the associations between retention in methadone treat-

ment and drug use behaviors and incidence of HIV and hepatitis B and C infection.

METHODS

Subjects and Data Collection

Data on IDUs entering methadone treatment were collected as part of the RAVEN (Risk Activity Variables, Epidemiology, and Networks) Study, a longitudinal study of injectors recruited at in- and out-of-treatment settings in the Seattle-King County area. The drug treatment center component was part of a multisite study of risk behaviors and HIV prevalence and incidence; the study was funded by the Centers for Disease Control and Prevention. Eligibility criteria included injection of illicit drugs in the past 12 months, age 14 years or older, working knowledge of English or Spanish, and recent admission to the specific drug treatment facility. A random numbers scheme was used to select study participants from among IDUs entering treatment at all four methadone treatment facilities in King County between October 1994 and January 1997. Trained study interviewers administered a standardized questionnaire; provided counseling for prevention of HIV, HBV and HCV infections, and other blood-borne and sexually transmitted diseases; and collected a blood sample at the baseline and 1-year follow-up visits. Participants were informed of their test results and offered referral to appropriate health and social services, including hepatitis B vaccination. The questionnaire included sociodemographic characteristics and drug use, sexual practice, and general health behaviors. The reference periods for the behavioral questions were 1 month prior to baseline and follow-up, 6 months prior to baseline, and the interval between baseline and follow-up. This analysis focused on behaviors at baseline and at follow-up and included behaviors in the month prior to those study visits. Participants were paid $10 for completing the baseline visit and $25 for completing the follow-up visit. An active follow-up program included contacting participants by mail or telephone 6 weeks, 3 months, and 6 months after the enrollment visit to update locator information and searching treatment and jail records and death certificate databases to find lost participants or identify deaths among study subjects.

Laboratory Testing

The Public Health—Seattle-King County Laboratory performed serological testing for this study. Sera were screened for anti-HIV using enzyme immunoassay (EIA, Abbott Laboratories; Abbott Park, IL), and positive results were confirmed using Western blot (Novopath HIV-1 Immunoblot, Bio-Rad; Hercules, CA). Test-

ing for anti-HCV was by a third-generation enzyme immunoassay (EIA; Abbott Laboratories), and repeat testing was used to confirm positive results. For HBV, sera were tested first for anti-HBc (HBV core antibodies) using an EIA (corzyme) (Abbott Laboratories); all positive specimens were further tested for HBsAg (HBV surface antigen), also using an EIA (auszyme monoclonal) (Abbott Laboratories).

Analysis

This analysis included subjects recruited at drug treatment agencies who had injected in the month before study enrollment and completed their 1-year follow-up visit. Drug treatment status at follow-up was ascertained by self-report at the follow-up interview; the date of admission was verified through review of drug treatment records. Treatment status was classified as follows: (1) "left treatment" included those who had left treatment after enrollment and were not in treatment at the follow-up study visit; (2) "disrupted treatment" included those who had left drug treatment at least once during follow-up, but who were re-enrolled at their follow-up visit; and (3) "continued treatment" included those who remained in treatment throughout the follow-up period. Transient living status was defined as not having a permanent residence, but living in someone else's house or apartment, a hotel, a shelter, or on the street. The number of weekly injections was estimated based on the reported weekly frequency of injection of different drugs.

Outcome variables included injection risk behaviors among those who injected at follow-up, including pooling of money with someone else to buy drugs, use of a drug cooker or filtration cotton after someone else, use of a syringe to divide drugs between two or more IDUs (backloading), and injecting with a needle previously used by someone else; cessation of injection and incidence of HCV and HBV were measured in all subjects. Univariate analyses using chi-square tests were conducted to assess associations between drug treatment status at follow-up and sociodemographic and drug use variables at baseline. Chi-square trends were calculated to determine whether there was an intermediate effect of disrupted treatment on outcomes in both univariate and multivariate analyses. Associations between drug treatment status at follow-up and outcome variables were assessed in multivariate analysis using logistic regression to control for potential confounders. Potential confounders included race, age, incarceration in the 6 months before enrollment, the number of years since first injection, and frequency of weekly injections in the month before baseline, and, for HBV seroconversion, HBV vaccination status at baseline. Monthly income was not ascertained for the full study period and was not considered in the multivariate

model because information on it was missing for a high proportion of participants. With the exception of frequency of weekly injections in the model to assess injection cessation and the specific risk behavior at baseline in each of the risk behavior models, only factors that changed the odds ratio (OR) of interest by 10% or more were retained in the model. Behaviors referred to in the tables and text as "at baseline" or "at follow-up" are behaviors reported to have occurred in the month before that study visit.

RESULTS

Subjects Included in Analysis

A total of 999 systematically selected persons who met initial eligibility criteria agreed to participate in the drug treatment arm of the study between October 1994 and January 1997. The participation rate was 83%, and the 1-year follow-up rate was 84%. After exclusion of data from the second enrollment visit of 4 subjects who entered the study twice, 24 who entered a nonmethadone treatment program at enrollment, 153 who did not complete follow-up, 29 who were in a nonmethadone treatment program at follow-up, and 73 who did not inject in the month before study enrollment, data from 716 subjects were available for this analysis.

Baseline Characteristics

Among the 716 study participants, 44% were enrolled in a 6-month methadone detoxification program, and 56% were enrolled in a methadone maintenance program. There were 41% (292) who left methadone treatment, 28% (198) disrupted treatment, and 32% (226) continued treatment through the 1-year follow-up period (Table I). There was no difference in treatment status at follow-up by whether clients were enrolled in a methadone detoxification or methadone maintenance program at baseline, probably because clients who enter a 6-month methadone detoxification program in the Seattle area often become methadone maintenance clients. The study population was 51% male and 77% white, with a median age of 38 years. Almost half (46%) had some college education, the majority (73%) were unemployed, 55% reported a legal monthly income of $500 or less, one-third did not have a permanent residence, and 35% had been in jail in the past 6 months. Participants who were white, older, had a higher income, and had not been in jail recently were more likely to continue treatment compared to others. A high proportion of African-American (55%) and unemployed participants (46%) left treatment.

The majority of subjects (74%) started injecting 10 years or more before study enrollment and injected at least daily (59%). Polydrug use was common; in

TABLE 1 Baseline Characteristics of the Total Sample and in Relation to Drug Treatment Status at One-Year Follow-up

		Treatment Status at One-Year Follow-up			
	Total N (%)	Left Treatment n (%)	Disrupted Treatment n (%)	Continued Treatment n (%)	*P*
Total	716 (100.0)	292 (40.8)	198 (27.7)	226 (31.6)	
Sociodemographic characteristics					
Sex					ns
Male	366 (51.1)	157 (42.9)	103 (28.1)	106 (29.0)	
Female	350 (48.9)	135 (38.6)	95 (27.1)	124 (34.3)	
Race/ethnicity					<.01
White	547 (76.5)	201 (36.7)	166 (30.3)	180 (32.9)	
Black	105 (14.7)	58 (55.2)	16 (15.2)	31 (29.5)	
Other	63 (8.8)	32 (50.8)	16 (25.4)	15 (23.8)	
Age (years)					<.01
<25	39 (5.4)	13 (33.3)	16 (41.0)	10 (25.6)	
25–34	167 (23.3)	67 (40.1)	62 (37.1)	38 (22.8)	
35–44	368 (51.4)	156 (42.4)	90 (24.5)	122 (33.2)	
≥45	142 (19.8)	56 (39.4)	30 (21.1)	56 (39.4)	
Education					ns
<High school	154 (21.5)	69 (44.8)	44 (28.6)	41 (26.6)	
High school/GED	234 (32.7)	101 (43.2)	60 (25.6)	73 (31.2)	
Some college/college graduate	327 (45.7)	122 (37.3)	93 (28.4)	112 (34.3)	
Employed					ns
No	290 (72.5)	134 (46.2)	69 (23.8)	87 (30.0)	
Yes	110 (27.5)	37 (33.6)	32 (29.1)	41 (37.3)	
Monthly legal income					.01
$0	75 (18.9)	40 (53.3)	22 (29.3)	13 (17.3)	
≤$500	144 (36.3)	62 (43.1)	32 (22.2)	50 (34.7)	
$501–1,000	93 (23.4)	40 (43.0)	27 (29.0)	26 (28.0)	
≥$1,000	85 (21.4)	28 (32.9)	18 (21.2)	39 (45.9)	
Transient living status					ns
No	474 (66.2)	185 (39.0)	129 (27.2)	160 (33.8)	
Yes	242 (33.8)	107 (44.2)	69 (28.5)	66 (27.3)	
Jail past 6 months					<.01
No	465 (64.9)	175 (37.6)	121 (26.0)	169 (36.3)	
Yes	251 (35.1)	117 (46.6)	77 (30.7)	57 (22.7)	
Drug use behaviors					
Years since first injection					<.01
<10	188 (26.3)	68 (36.2)	73 (38.8)	47 (25.0)	
10+	528 (73.7)	224 (42.4)	125 (23.7)	179 (33.9)	

(continued)

TABLE I Continued

	Total N (%)	Treatment Status at One-Year Follow-up: Left Treatment n (%)	Disrupted Treatment n (%)	Continued Treatment n (%)	P
Weekly injections					ns
Less than daily	287 (40.6)	97 (33.8)	92 (32.1)	98 (34.1)	
1–3 times/day	196 (27.7)	58 (29.6)	68 (34.7)	70 (35.7)	
≥4 times/day	224 (31.7)	75 (33.5)	91 (40.6)	58 (25.9)	
Pooled money to buy drugs					ns
No	269 (38.0)	101 (37.5)	83 (30.9)	85 (31.6)	
Yes	438 (62.0)	187 (42.7)	113 (25.8)	138 (31.5)	
Used cooker or cotton after someone else					ns
No	316 (44.8)	125 (39.6)	101 (32.0)	90 (28.5)	
Yes	389 (55.2)	163 (41.9)	94 (24.2)	132 (33.9)	
Backloaded					ns
No	455 (64.8)	189 (41.5)	127 (27.9)	139 (30.5)	
Yes	247 (35.2)	99 (40.1)	67 (27.1)	81 (32.8)	
Injected with used needles					ns
No	486 (68.9)	194 (39.9)	145 (29.8)	147 (30.2)	
Yes	219 (31.1)	91 (41.6)	51 (23.3)	77 (35.2)	
Serology results					
Anti-HIV					ns
Negative	701 (98.7)	286 (40.8)	191 (27.2)	224 (32.0)	
Positive	9 (1.3)	3 (33.3)	4 (44.4)	2 (22.2)	
Anti-HBc					.03
Negative	232 (33.1)	85 (36.6)	79 (34.1)	68 (29.3)	
Positive	468 (66.9)	197 (42.1)	114 (24.4)	157 (33.5)	
Anti-HCV					ns
Negative	80 (11.4)	26 (32.5)	31 (38.7)	23 (28.7)	
Positive	623 (88.6)	258 (41.4)	163 (26.2)	202 (32.4)	
Vaccination history					
Prior hepatitis B vaccination					ns
No	581 (86.3)	235 (40.4)	158 (27.2)	188 (32.4)	
Yes	92 (13.7)	35 (38.0)	29 (31.5)	28 (30.4)	

Individual categories may not sum to totals because of exclusion of subjects with missing values.
ns = not significant at $P < .05$.

addition to heroin injection, 42% also reported injecting heroin and cocaine together (speedballs), and 23% reported injecting cocaine alone. Cocaine injection was not associated with treatment status at follow-up (data not shown). Two-thirds reported pooling of money with other injectors to buy drugs. Over half

had used cookers or filtration cottons after someone else, one-third had shared a syringe to divide drugs (backloading), and one-third reported injecting with used needles. Study subjects who had injected for more than 10 years were more likely to continue treatment versus those who had injected fewer than 10 years. HIV prevalence was 1%, and HBV and HCV prevalence was 67% and 89%, respectively. There were 14% who reported prior HBV vaccination.

Univariate Analysis of Behaviors and Serologies at Baseline and Follow-up

A total of 468 study participants (65%) reported injecting at follow-up. There was a marked difference in reducing or stopping injection between the treatment status groups. Injecting in the last month was reported by 83% of those who left treatment, 70% of those who disrupted treatment, and 40% of those who continued treatment (Table II) (P trend < .01). Among those who left treatment, the mean number of weekly injections was unchanged between baseline and follow-up (mean = 17) (Figure). In contrast, among those who had disrupted treatment, the average weekly injections decreased by 56% (from 18 to 8), and among those who continued treatment, injections decreased by 80% (from 17 to 3) ($P < .01$). Baseline injection risk behaviors were not related to treatment status at follow-up (Table I); for instance, subjects who reported injection with a syringe used by another injector were not more or less likely to remain in treatment than those who did not share syringes. As shown in Table II, treatment status at follow-up was associated with certain injection behaviors at follow-up among subjects who continued to inject. Fewer of those who continued treatment reported pooling of money to buy drugs (46%) and injection with used needles (24%) compared to those who left treatment (63% and 35%, respectively). Backloading was also less common among those who continued treatment (28%) versus those who left treatment (36%). Use of cookers or cottons after someone else, however, did not differ by treatment status.

Considering the low HIV prevalence in this study population, it was not surprising that no new HIV infections were observed during the 1-year follow-up period. Incidence of HBV was 6% and HCV was 9%. All 7 HCV seroconverters and 13 of the 14 HBV seroconverters reported injecting during follow-up. There was a significant trend toward lower HBV incidence by treatment status ($P < .05$) (Table II). Among those who left treatment, HBV incidence was 11% compared to 4% in those who disrupted treatment and 3% in those who remained in treatment. Only 13% of participants without serological markers of hepatitis B infection at baseline reported previous HBV vaccination, and only 13 additional subjects reported receiving vaccination during the follow-up period. There was also a

TABLE II Associations Between Drug Use Behaviors and Hepatitis B and C Infection at Follow-up by Treatment Status at Follow-up

Included in Individual Analysis: Behavior or Infection at Follow-up	Treatment Status at One-Year Follow-up: Left Treatment n (%)	Disrupted Treatment n (%)	Continued Treatment n (%)	*P* Trend
Injected at baseline (n = 716)				
Injected at follow-up				
No	49 (17.1)	59 (30.1)	135 (60.3)	
Yes	238 (82.9)	137 (69.9)	89 (39.7)	
OR (95% CI)	1.0	0.5 (0.3–0.7)	0.1 (0.1–0.2)	<.01
AOR (95% CI)*	1.0	0.5 (0.3–0.7)	0.1 (0.1–0.2)	<.01
Injected at baseline and follow-up (n = 468)				
Pooled money to buy drugs				
No	88 (37.4)	62 (47.0)	48 (53.9)	
Yes	147 (62.6)	70 (53.0)	41 (46.1)	
OR (95% CI)	1.0	0.7 (0.4–1.0)	0.5 (0.3–0.8)	<.01
AOR (95% CI)†	1.0	0.7 (0.4–1.1)	0.5 (0.3–0.8)	<.01
Used cookers or cottons after someone else				
No	95 (40.3)	61 (46.9)	39 (43.8)	
Yes	141 (59.7)	69 (53.1)	50 (56.2)	
OR (95% CI)	1.0	0.8 (0.5–1.2)	0.9 (0.5–1.4)	.40
AOR (95% CI)†	1.0	0.8 (0.5–1.3)	0.7 (0.4–1.2)	.16
Backloaded				
No	150 (64.4)	96 (73.3)	63 (71.6)	
Yes	83 (35.6)	35 (26.7)	25 (28.4)	
OR (95% CI)	1.0	0.7 (0.4–1.1)	0.7 (0.4–1.2)	.12
AOR (95% CI)†	1.0	0.6 (0.4–1.0)	0.6 (0.3–1.0)	.03
Injected with used needles				
No	150 (64.7)	106 (79.1)	67 (76.1)	
Yes	82 (35.3)	28 (20.9)	21 (23.9)	
OR (95% CI)	1.0	0.5 (0.3–0.8)	0.6 (0.3–1.0)	.01
AOR (95% CI)†	1.0	0.5 (0.3–0.8)	0.5 (0.2–0.8)	<.01
Anti-HBc-at baseline (n = 221)				
HBV seroconversion				
No	70 (88.6)	71 (96.0)	62 (96.9)	
Yes	9 (11.4)	3 (4.0)	2 (3.1)	
OR (95% CI)	1.0	0.3 (0.1–1.3)	0.3 (0.1–1.3)	.05‡
AOR (95% CI)*	1.0	0.4 (0.1–1.5)	0.3 (0.1–1.3)	.06

(*continued*)

TABLE II Continued

Included in Individual Analysis: Behavior or Infection at Follow-up	Treatment Status at One-Year Follow-up: Left Treatment n (%)	Disrupted Treatment n (%)	Continued Treatment n (%)	*P* Trend
Anti-HCV at baseline (n = 78)				
HCV seroconversion				
No	22 (88.0)	28 (90.3)	21 (95.4)	
Yes	3 (12.0)	3 (9.7)	1 (4.6)	
OR (95% CI)	1.0	0.8 (0.1–4.3)	0.3 (0–3.6)	.38
AOR (95% CI)*	1.0	1.2 (0.2–7.3)	0.4 (0–4.2)	.38

Individual categories may not sum to totals because of exclusion of subjects with missing values.

*Adjusted for number of weekly injections at baseline.

†Adjusted for the same behavior at baseline.

‡$P = .048$ before rounding.

decreasing (not significant) downward trend for HCV seroconversion, with 12% incidence in those who left treatment, 10% in those who disrupted treatment, and 5% in those who continued treatment.

Multivariate Analysis of Outcomes

Table II shows the results of multivariate analysis and also indicates which subjects were included in the multivariate models. After statistical adjustments, cessation of injection at follow-up remained strongly associated with treatment status. Compared to subjects who left treatment, those who disrupted treatment were significantly less likely to report any injections at follow-up (adjusted odds ratio [AOR] = 0.5; 95% CI 0.3–0.7), and those who continued treatment were even less likely to inject at follow-up (AOR = 0.1; 95% CI 0.1–0.2). Pooling of money to buy drugs was also less common among those who continued treatment (AOR = 0.5; 95% CI 0.3–0.8) versus those who left treatment. Compared to those who left treatment, injection with used needles was significantly less likely to be reported by those who had disrupted treatment (AOR = 0.5; 95% CI 0.3–0.8) and those who continued treatment (AOR = 0.5; 95% CI 0.2–0.8). Backloading was also less common among those who disrupted and those who continued treatment compared to those who left treatment, and the test for trend was significant. Cooker or cotton use at follow-up did not vary by treatment status. Both HBV and HCV incidence were lower among those in treatment at follow-up compared those who had left treatment, but only the difference in HBV infection approached statistical significance after adjusting for other factors.

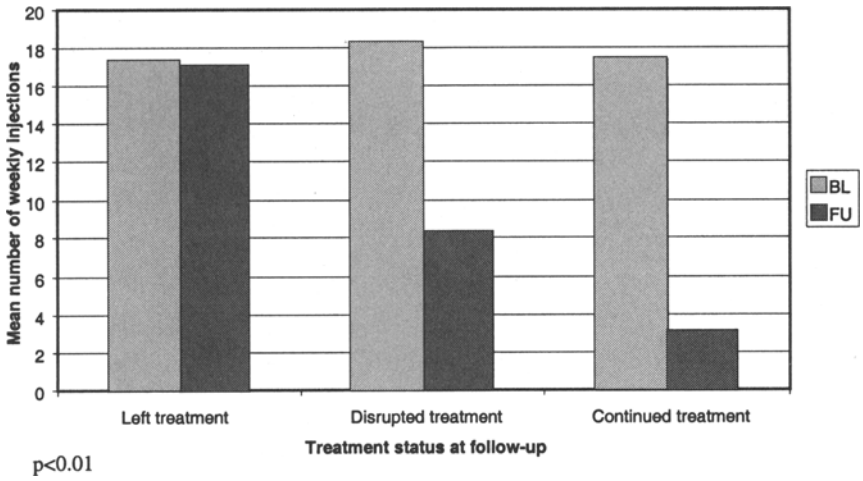

FIGURE Mean number of estimated weekly injections at baseline and 1-year follow-up (n = 468) (BL = baseline; FU = follow-up).

DISCUSSION

We found that drug injection and HIV risk behavior was less likely to occur among study participants who continued or disrupted but re-entered methadone treatment during the 1-year follow-up period. These lower risk behaviors included less frequent injection, cessation of injection, injection with used needles, and buying drugs with other IDUs. Furthermore, the proportion of subjects who stopped injecting and buying drugs with other injectors was highest among those who remained in treatment and lowest among those who left treatment. Among subjects who continued to inject, the greatest reduction in frequency of injections was observed among those who remained in treatment and was the least among those who left treatment. Lower HBV and HCV incidence was observed among those in treatment at follow-up, although the statistically significant trend toward lower incidence of HBV infection was only marginally significant after adjusting for confounders.

Some limitations must be considered in the interpretation of the results of this study. We did not have information on the amount of time in methadone treatment for those who left treatment versus those who disrupted treatment; therefore, we could not relate time in treatment to our outcome variables of interest. Thus, we may only conclude that being in treatment was beneficial in terms of lower risk behavior at the time of follow-up visit. The 1-year follow-up interval also prevented us from evaluating the longer term effects of methadone treatment on injection behaviors and HBV and HCV incidence. Further, just as with other studies using self-report of risk behaviors through face-to-face

interviews, results were subject to recall bias or under-reporting because of the desire to report socially acceptable responses. Recall bias probably had very little effect on reporting since we asked about very recent behaviors. Des Jarlais et al.[24] found that IDUs who were interviewed via self-administered Audio-CASI techniques reported higher levels of risky behaviors than those responding to face-to-face interviews. However, measurement error is likely to have been non-differential and thus would have led to underestimation of the association between treatment status and injection risk behavior. Because it was easier to locate participants who were in treatment at follow-up, the follow-up group over-represents persons in treatment. However, the follow-up rate was high, and study retention did not vary by baseline risk characteristics, so it is unlikely that losses to follow-up would have biased the results. Finally, because injectors who enter methadone treatment have a long injection career and a high prevalence of HBV and HCV, it was difficult to attain sufficient statistical power to evaluate seroconversion.

While many studies have demonstrated a decrease in injection frequency among methadone treatment clients,[13,15] findings vary as to whether reductions in risk behaviors are due exclusively to reduction in injection frequency[15]or if it is also reduced among those who continue to inject,[12] as we found for syringe sharing. Methadone treatment has been effective in reducing HIV incidence,[16,20] but not HBV and HCV among drug injectors,[22,23] presumably because of the high efficiency of transmission of these viruses and the high prevalence of infectious hepatitis C carriers. Hepatitis C infection has also been associated with use of used cookers and cottons among injectors who did not inject with used needles,[25] so that even infrequent injection risk behaviors among IDUs in treatment may be sufficient to transmit HCV.

Cessation of injection is clearly the optimal goal of methadone treatment and a highly effective means of preventing parenteral HIV, HBV, and HCV transmission among drug injectors. Unfortunately, only about one-fifth of US heroin injectors currently have access to methadone treatment at any given time, and US methadone treatment clients typically are older, have injected for many years, and have a high prevalence of markers for HBV and HCV.[26] Addiction treatment also may be a long-term process interrupted by several relapse episodes. In our study, persistent injection was reported by the majority of subjects, including almost 40% of those who continued treatment for the entire 1-year follow-up period. Also, as demonstrated in this and other studies,[26,27] successful treatment outcomes and cessation or reduction of risk behaviors were much more common among those who remained in treatment. We found that characteristics

associated with continued treatment included white race, older age, higher monthly income, no recent incarceration, and a longer injection history. In addition, many other factors, such as an individual's reasons for entering drug treatment and such characteristics of the drug treatment programs as cost, may play important roles in retention in treatment and successful outcomes.

These findings raise two important public health issues related to the role of drug treatment. First, as suggested by Koester et al.,[28] even when abstinence is not achieved, drug treatment may be an important means of temporarily reducing drug use and potential harms to drug injectors and their sharing partners. In view of the high HCV infection level in injectors entering methadone treatment, it may be particularly important to initiate injection risk reduction efforts among injectors in treatment to prevent transmission of HCV by those who are seropositive and acquisition of infection by those who are seronegative. Combined with the tendency toward lower HBV and HCV seroconversion rates seen among subjects who remained in treatment in our study, this suggests that comprehensive drug treatment programs may be a natural setting for incorporation of more effective HBV and HCV prevention efforts. Although risk reduction counseling in drug treatment settings may be awkward owing to the emphasis on remaining drug free, methods for offering effective client-focused risk reduction programs and referrals to needle-exchange or outreach programs that do not stigmatize participants must be developed. These efforts must also include a much stronger emphasis on avoidance of cooker and cotton sharing and backloading.

Second, in spite of the availability of hepatitis B vaccine since 1982, self-reported vaccination rates among our study population, as well as other IDU populations,[29] were very low. While the majority of our study population had acquired immunity through infection by the time they entered drug treatment, about 30% remained susceptible, and seroconversions continued to occur during the follow-up period. Hardly any of our study participants accepted referral to a free vaccination, even though we were able to promise a shorter waiting time in the clinic, and transportation was free. Since drug treatment programs have repeated contact with clients over several months, hepatitis B vaccination ought to be incorporated routinely into these programs. This opportunity has not been utilized fully, perhaps because recommending vaccination suggests ongoing risk behavior or resuming risk behavior at some future date.

In summary, the results of this study emphasize the importance of (1) retaining opiate-dependent injectors in methadone treatment; (2) developing strategies to improve enrollment of recent-onset opiate injectors in methadone treatment to help them achieve long-term cessation of drug injection before they acquire

hepatitis B and C; (3) making better use of drug treatment settings to prevent transmission of hepatitis B and C through an increased focus on reduction or cessation of sharing of drug use paraphernalia, particularly cookers or cottons, and use of syringes for backloading; and (4) providing hepatitis B vaccination in treatment settings.

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