A Randomized Intervention Trial to Reduce the Lending of Used Injection Equipment Among Injection Drug Users Infected With Hepatitis C

Mary H. Latka, PhD, Holly Hagan, PhD, Farzana Kapadia, PhD, Elizabeth T. Golub, PhD, Sebastian Bonner, PhD, Jennifer V. Campbell, MSPH, Micaela H. Coady, MPH, Richard S. Garfein, PhD, Minya Pu, MS, Dave L. Thomas, MD, Thelma K. Thiel, and Steffanie A. Strathdee, PhD

Objectives. We evaluated the efficacy of a peer-mentoring behavioral intervention designed to reduce risky distributive injection practices (e.g., syringe lending, unsafe drug preparation) among injection drug users with hepatitis C virus (HCV) infection.

Methods. A randomized trial with a time-equivalent attention-control group was conducted among 418 HCV-positive injection drug users aged 18 to 35 years in 3 US cities. Participants reported their injection-related behaviors at baseline and at 3- and 6-month follow-ups.

Results. Compared with the control group, intervention-group participants were less likely to report distributive risk behaviors at 3 months (odds ratio [OR] = 0.46; 95% confidence interval [CI] = 0.27, 0.79) and 6 months (OR = 0.51; 95% CI = 0.31, 0.83), a 26% relative risk reduction, but were no more likely to cite their HCV-positive status as a reason for refraining from syringe lending. Effects were strongest among intervention-group participants who had known their HCV-positive status for at least 6 months. Peer mentoring and self-efficacy were significantly increased among intervention-group participants, and intervention effects were mediated through improved self-efficacy.

Conclusions. This behavioral intervention reduced unsafe injection practices that may propagate HCV among injection drug users. (*Am J Public Health.* 2008;98:853–861. doi:10.2105/AJPH.2007.113415)

Hepatitis C virus (HCV) infection is an important public health problem, with an estimated global prevalence of 3%[1] and a prevalence rate ranging from 65% to 95% among injection drug users.[2–10] HCV may cause liver cirrhosis and hepatocellular carcinoma; only 15% to 20% of infected individuals spontaneously recover without treatment.[11] As a result of limited efficacy, tolerability, and availability,[12–17] treatment has not substantially reduced the burden of HCV, although improved treatment provision to injection drug users may reduce the burden more effectively.

The combined effects of high HCV prevalence among injection drug users, a persistently infectious carrier state, high transmissibility, and lack of an effective vaccine call for interventions intended to change behaviors among injection drug users both with and without HCV infection. One study showed promise in reducing unsafe injection behaviors associated with HCV acquisition (receptive risk),[18] but we know of no studies that have evaluated the efficacy of an intervention focused on reducing behaviors that can transmit HCV (i.e., distributive risk behaviors). We report the results of a randomized, controlled trial evaluating a 6-session intervention aimed at reducing distributive risk behaviors among injection drug users with HCV infection.

METHODS

Participants

The Study to Reduce Intravenous Exposures (STRIVE) was conducted from 2002 through 2004 in Baltimore, Maryland; New York City; and Seattle, Washington. Participants were primarily individuals who were not eligible for a multisite study that enrolled HCV- and HIV-antibody-negative injection drug users.[18,19] (Individuals were recruited from those not eligible for the multisite study to save costs; all eligible individuals were required to test HCV antibody positive.) Injection drug users were also referred from other studies.

To be eligible, individuals had to be aged 18 to 35 years, to have used injection drugs within 6 months of screening, to have plans to live in the area for 12 months, to have a documented HCV-antibody-positive and HIV-antibody-negative serostatus, to be willing to provide a blood sample for liver function and HCV–RNA testing, and to be able to complete assessments and group sessions in English. On the basis of HCV serostatus, 829 individuals from the main referring trial were eligible, along with 123 individuals referred from other studies.

Study Design and Data Collection

The study was an unblinded, 2-armed, randomized trial of a behavioral intervention with an attention-control component (study methods have been described elsewhere[19]). Briefly, prior to randomization, participants received counseling before and after HIV and HCV testing according to the guidelines of the Centers for Disease Control and Prevention, were referred for free hepatitis A and B virus vaccinations, and in a separate individualized counseling session, were referred for HCV-related medical care.

Two randomization schemes were used as necessary throughout the study: individual or group. To minimize attrition between randomization and the first study visit, randomization occurred immediately before the first group session; however, convening a sufficient number of injection drug users on the day of that session was challenging. Therefore, on the day of the first session, individuals were randomized if more than 9 participants attended, the entire group was randomly assigned to 1 of the study interventions if 5 to 9 participants

attended (i.e., group randomization), and randomization was rescheduled if fewer than 5 participants attended. Use of these 2 randomization methods did not affect the results (data not shown).

After the first session, the remaining 5 sessions were scheduled on different days within the same week to minimize contamination. Randomization procedures were conducted in accordance with accepted practices[20]; gender blocking was used during individual randomization.

Prior to the intervention and at 3 and 6 months after the intervention, audio computer-assisted self-interviews were used to collect data on the participants. Along with psychosocial correlates of risk behavior, participants' sociodemographic characteristics, injection practices, alcohol use, and HCV-related health care were assessed. As a means of minimizing response bias, all assessments were completed prior to counseling without facilitators present.[21,22] Except where noted, all behaviors refer to the 3 months preceding the study visit.

Intervention Procedures

Participants were randomized to either a "peer mentoring" (intervention) or a video-discussion (control) group. Each intervention consisted of 6 sessions 2 hours in length, held twice weekly. Except for the first session, in which 2 additional facilitators conducted both interventions simultaneously, all sessions were led by the same 2 trained facilitators, who followed scripted manuals. Control-group participants watched a docudrama television series about injection drug users and then took part in a facilitated group discussion focusing on family, education, self-respect, relationships, violence, parenting, and employment. Participants who sought information about risk reduction or health care were referred to a resource table.

The peer mentoring intervention delivered risk reduction information by training participants to mentor other injection drug users about reducing HCV transmission risks. The intervention was guided by social cognitive theory,[23,24] which posits that social situations in which individuals enact new behaviors can facilitate and sustain behavior change.[25,26] We anticipated that injection drug users with HCV infection would be credible peer mentors in terms of their ability to advise other injection drug users about the risks of unsafe injection practices.

The intervention group trained participants to engage in peer mentoring that emphasized setting examples to close peers through their own safer injection practices. We hypothesized that this approach would reduce participants' distributive injection risk behaviors by prompting them to talk about, initiate, and model safer injection behaviors. The peer mentoring role also provided participants with a new prosocial identity that was expected to reinforce their motivation to practice safer behaviors.[27]

The intervention was delivered through activities that required minimal literacy and covered information about HCV pathology, HCV-related health care encounters, skills useful in reducing distributive injection behaviors, and methods necessary to effectively communicate with other injection drug users about HCV (the intervention manual is available from the authors on request).[19] Content was delivered through demonstrations, games, discussions, and videos specifically developed by the team and through videos provided by the Hepatitis Foundation International.[28] In the fifth session, intervention-group participants conducted street outreach about HCV prevention in communities frequented by injection drug users; study facilitators monitored and coached participants during these outreach activities.

Because the aim of the intervention was to limit the spread of HCV from infected injection-drug users, it required a shift from historical prevention messages focused on acquisition risk. To illustrate that pathogens could be transmitted through the sharing of drug preparation equipment, we used fake drugs and paraphernalia "contaminated" with a dye (representing HCV) visible only under ultraviolet lighting to develop a video depicting a typical drug preparation scenario. The injection scene was first depicted with natural light and then repeated under ultraviolet lighting, which illustrated how all injection equipment can become contaminated (and transmit viruses) even when a used syringe is not lent to another individual.[19]

Primary Distributive Risk Reduction Message

We used a harm-reduction approach to promote distributive risk reduction options among participants who might continue to inject drugs, while emphasizing that ceasing drug use was the healthiest option. We presented these options in a hierarchical manner without attaching absolute risk to any level. Rather, we explained that transmission risks decreased for behaviors lower down a "risk ladder" that promoted the following behaviors: (1) not lending a used syringe (bleached or unbleached) for injection purposes; (2) not preparing drugs with a syringe or paraphernalia contaminated with HCV, which could transmit HCV to others in the absence of syringe lending[29–31]; (3) not lending used paraphernalia (e.g., cookers in which drugs are mixed, cottons used to filter drugs, or syringe rinse water); and (4) refraining from illicit drug use, injection or otherwise.

Outcomes

To reflect the multimodal harm-reduction message, we derived a single primary-outcome variable comprised of the following: (1) not lending one's used syringe, (2) not preparing drugs with a syringe one had previously used (unsafe drug preparation that could contaminate the injection), (3) not sharing drug preparation equipment (cookers, cottons, or rinse water), and (4) not injecting drugs. Syringe lending was measured according to frequency of passing a used syringe to another. Unsafe drug preparation was measured according to frequency of dividing up drugs with a syringe one had previously used. These 2 variables had 7 response options (always through never) that were combined when data were sparse.

Three questions inquiring about frequency of using cookers, cottons, or rinse water with or before someone else were used to assess sharing of drug preparation equipment; these questions were combined into a single dichotomized variable (any or no sharing). A question focusing on types of drugs injected, in which "have not injected" was one possible response option, was used to determine whether participants had refrained from using injection drugs (this variable was dichotomously coded: injected or did not inject).

We report results based on both the combined and constituent variables.

Three secondary outcomes were also assessed. A single dichotomously coded item assessed whether participants had refrained from lending syringes because they had HCV. Participation in drug treatment since the prior study visit was a dichotomized variable that included biomedical treatment (methadone maintenance, detoxification, therapeutic communities) and support groups (e.g., Narcotics Anonymous). A single item was used to measure frequency of injecting oneself using a used syringe.[32]

Potential Mediators and Moderators

Variables were identified as possible moderators or mediators on the basis of hypothesized associations or effects observed during analyses. Moderating effects (baseline conditions affecting the strength or direction of intervention effects[33]) were examined with respect to participants' baseline self-efficacy for safe injection practices (high or low) and the period of time they had known their HCV status (6 months or less vs more than 6 months). Mediation effects (referring to the process through which an intervention occurs[34]) were examined with respect to peer mentoring (yes or no) and self-efficacy for safe injection (high or low), both measured during follow-up.

Self-efficacy for safe injection was measured with a 6-item scale (Cronbach $\alpha=0.92$) developed for this study. Items measured professed confidence in one's ability to avoid sharing syringes and paraphernalia under challenging circumstances; 4 response options ("absolutely sure I can avoid sharing" through "absolutely sure I cannot avoid sharing") were assessed. We measured peer mentoring by inquiring about "peer mentoring on one's own," which reflected our intervention message of advising familiar peers. Peer mentoring content was measured through determining whether participants had shared information on HIV and HCV. We assessed the length of time (6 months or fewer vs more than 6 months) participants had been aware of their HCV-positive status by inquiring about the month and year of their first positive result; if participants could not recall the month, the seasonal midpoint was used.

Message Retention and Contamination

All participants were asked whether they recalled PALMS (Pick an appropriate time and place, Ask open-ended questions, Lend from your experience, Make appropriate suggestions for where they are at, Share information, don't preach), a mnemonic used in the intervention for conducting peer mentoring nondefensively. Those answering affirmatively were asked to select its definition from a list, and proportions of correct responses were calculated. As a means of assessing participants' propensity to offer affirmative responses, all participants were asked about a meaningless mnemonic (FEAT).

Statistical Analysis

We used an intention-to-treat approach in which participants were assessed according to the group to which they were randomized. When appropriate, values were imputed for data missing as a result of skip patterns. The Fisher exact test and χ^2 test (for categorical variables), the Cochran–Armitage trend test (for ordinal variables), and the Wilcoxon rank sum test (for continuous variables) were used in comparing intervention-group and control-group participants at baseline and the 2 follow-ups. Baseline characteristics of those present versus absent at each follow-up visit were also compared.

To adjust for covariates, we used logistic regression (for dichotomous outcomes) and proportional odds models (for ordinal outcomes) in postintervention between-group comparisons. A score χ^2 test was conducted to evaluate the proportional odds assumption that intervention effects were constant across outcome response categories. Separate models were built for outcomes at 3 and 6 months. The following potential confounders were examined: age, gender, race/ethnicity, length of time participants had known their HCV serostatus, recruitment city, cohort size at randomization, factors associated with retention, baseline values for outcomes, and time to follow-up assessment. Covariates were retained if they were significant at .05 or if their inclusion markedly changed the measure of association. The ratio of the predicted probabilities for the primary outcome variable was calculated to provide an estimation of the intervention effect.

As a means of examining moderating effects, odds ratios (ORs) for the main association (between intervention and outcome) were calculated within strata of potential modifiers, and point estimates and the significance of the interaction term were examined. Mediators were required to meet the dual criteria of being associated with the intervention and being independently associated with the outcome. To assess mediation, we calculated ORs for each of these 2 associations for each variable.

RESULTS

Of the 630 participants who completed the baseline assessment, 418 were randomized to the intervention (n=222) or control (n=196) group. Almost half (47%) were recruited in Baltimore, and approximately one quarter each were recruited in New York City (28%) and Seattle (25%). Forty-five cohorts were formed: 20 by randomizing individuals and 25 through group randomization (mean number of participants in the individual- and group-assigned cohorts were 12 and 7, respectively). Session attendance rates, which ranged from 70% to 83%, did not differ significantly by group.

Retention

On average, participants were assessed at 3.0 and 6.2 months after the date of the last intervention session for their cohort. Overall retention rates, which were 66% and 80% at the 3- and 6-month visits, respectively, did not differ by study arm. Eighty-six percent of participants completed at least 1 follow-up assessment.

Compared with those who did not return at the 3-month visit, those who returned were slightly older (mean age: 27 vs 26 years; $P=.07$); otherwise, the 2 groups were similar with respect to demographic characteristics and baseline injection risks. Those who returned for the 6-month visit were more likely than those who did not to be women (26% vs 16%; $P=.06$), to have known their HCV status for at least 6 months ($P=.03$), and to have experienced HCV-like symptoms at baseline ($P=.03$); they were less likely to have undergone previous alcohol abuse treatment (36% vs 61%; $P=.04$) and reported injecting less frequently at baseline ($P=.05$).

Sample Characteristics

There were no significant between-group differences in baseline demographic characteristics, drug use practices, or stage of readiness for drug treatment; however, those in the intervention group were slightly more likely to have known their HCV status for at least 6 months (55% vs 45%; $P=.06$; Table 1). On average, participants were aged 26.5 years; 77% were male, and 57% were White.

Unadjusted Outcomes and Covariates

At both follow-ups, participants in the intervention as well as the control group reported significantly reduced syringe lending and sharing of drug preparation equipment relative to baseline (Table 2). However, participants in the 2 groups did not differ from each other at either follow-up in terms of the likelihood that they would refrain from lending a syringe because of their HCV-positive status, the frequency at which they injected themselves with a used syringe (acquisition risk), or their drug treatment status.

Participants in the intervention group reported significantly greater self-efficacy for safer injection as well as peer mentoring at both follow-ups (Table 2). Among the participants who reported engaging in peer mentoring, more than 75% reported talking about HIV or HCV (data not shown). Intervention-group participants reported more peer mentoring episodes than did control-group participants (mean: 4 vs 1; $P<.001$; data not shown). At both follow-ups, almost three quarters of the intervention group recalled the intervention mnemonic PALMS (Table 2). Approximately one third of participants reported remembering the false mnemonic FEAT, and intervention-group participants were more likely to respond affirmatively at both follow-ups.

TABLE 1—Demographic Characteristics, Injection Risk Behaviors, and Covariates at Baseline, by Group: Study to Reduce Intravenous Exposures, April 2002 to May 2004

	Intervention Group (n = 222)	Control Group (n = 196)	P
Sociodemographic characteristics			
Age, y, mean (SD)	27 (4)	26 (4)	.35
Men, No. (%)	170 (76.5)	149 (76.0)	.91
Race/ethnicity, No. (%)			.80
Hispanic	56 (25.2)	55 (28.1)	
Black	15 (6.8)	13 (6.6)	
White	126 (56.8)	111 (56.6)	
Other	25 (11.3)	17 (8.8)	
More than high school education, No. (%)	118 (53.1)	111 (56.6)	.53
Homeless in past 6 mo, No. (%)	91 (41.6)	93 (47.9)	.20
Aware of positive HCV status more than 6 mo, No. (%)	109 (55.3)	81 (45.5)	.06
Drug use and injection risk behaviors in past 3 mo			
Aged ≥18 y at first injection, No. (%)	158 (72.1)	130 (66.6)	.24
Drug(s) injected most often, No. (%)			.98
Heroin alone	130 (61.3)	114 (61.0)	
Heroin and cocaine	61 (28.8)	52 (27.8)	
Powder or crack cocaine alone	14 (6.6)	14 (7.5)	
Other	7 (3.3)	7 (3.7)	
Injected at least daily, No. (%)	156 (70.3)	134 (68.4)	.59
Injection behaviors, No. (%)			
Lent a used needle	99 (48.9)	86 (46.0)	.61
Shared drug preparation equipment[a]	157 (73.7)	143 (74.9)	.82
Refrained from injection drug use	2 (0.9)	3 (1.5)	.67
Currently in treatment for drug abuse,[b] No. (%)	125 (57.3)	114 (58.8)	.84
Covariates			
Self-efficacy for safer drug use, No. (%)[c]			.24
Absolutely sure I cannot avoid sharing	14 (6.6)	11 (5.8)	
Pretty sure I cannot avoid sharing	32 (15.1)	43 (22.6)	
Not sure I can avoid sharing	92 (43.4)	78 (41.1)	
Pretty sure I can avoid sharing	74 (34.9)	58 (30.5)	
Stage of readiness to quit drug use,[d] No. (%)			.56
Precontemplation	36 (16.2)	26 (13.3)	
Contemplation	113 (50.9)	98 (50.0)	
Determination	46 (20.7)	52 (26.5)	
Action or maintenance	27 (12.2)	20 (10.2)	

Note. HCV = hepatitis C virus.
[a]Defined as using a cooker, filter cotton, or rinse water to prepare drugs before or with another injector.
[b]Defined as any biomedical or support group treatment (e.g., Narcotics Anonymous) within past 3 months.
[c]Rounded average from each of 6 scale items.
[d]On a 29-item scale with 5 response options.

Adjusted Outcomes

In comparison with the control group, distributive risk behaviors as a whole were reduced in the intervention group at both 3 months (OR=0.46; 95% confidence interval [CI]=0.27, 0.79) and 6 months (OR=0.51; 95% CI=0.31, 0.83; Table 3). The ratios of predicted probabilities for the combined distributive risk outcome were 0.74 (95% CI=0.59, 0.95) and 0.71 (95% CI=0.55, 0.90) at 3 and 6 months, respectively. At 3 months, all of the behaviors making up the composite outcome were at significantly lower levels in the intervention group, but only sharing drug-preparation equipment was significant at 6 months.

There were no differences between groups at either follow-up in the proportion refraining from lending syringes because of their HCV-positive status or in the use of drug treatment (Table 3). Intervention-group participants were less likely to have injected themselves with used syringes at the 3-month ($P=.01$) but not the 6-month ($P=.42$) follow-up; this result was caused by control-group

TABLE 2—Unadjusted Comparisons of Self-Reported Distributive Risk Behaviors, Potential Mediators, and Message Retention at 3- and 6-Month Follow-Ups: Study to Reduce Intravenous Exposures, April 2002 to May 2004

	3-Month Follow-Up			6-Month Follow-Up		
	Intervention Group, No. (%)	Control Group, No. (%)	*P*	Intervention Group, No. (%)	Control Group, No. (%)	*P*
Primary outcome: distributive risk						
Combined distributive risk[a]	61 (44.2)	73 (59.3)	.02	64 (37.4)	78 (53.1)	.007
Frequency of lending used syringe to others[b]			.23			.89
Rarely or never	112 (88.9)	95 (82.6)		153 (92.2)	127 (91.4)	
Sometimes	11 (8.7)	16 (13.9)		4 (2.4)	6 (4.3)	
Always or almost always	3 (2.4)	4 (3.5)		9 (5.4)	6 (4.3)	
Frequency of preparing drugs with a syringe previously used by oneself[b]			.21			.43
Rarely or never	111 (88.1)	92 (80.0)		147 (89.6)	116 (84.9)	
Sometimes	9 (7.1)	16 (13.9)		7 (4.3)	15 (10.8)	
Always or almost always	6 (4.8)	7 (6.1)		10 (6.1)	8 (5.8)	
Frequency of sharing drug preparation equipment with or before someone else	57 (40.7)	70 (54.7)	.03	62 (35.4)	72 (47.4)	.03
Refrained from injection drug use	34 (24.5)	12 (9.6)	.002	60 (34.1)	35 (22.6)	.03
Secondary outcomes						
Refrained from lending syringe because of HCV-positive status	58 (69.0)	55 (68.7)	.98	57 (67.0)	46 (60.5)	.39
Any drug treatment since most recent study visit	85 (59.4)	82 (63.6)	.53	111 (63.1)	100 (65.4)	.73
Frequency of injecting oneself with used syringe[b]			.17			.82
Rarely or never	123 (87.9)	98 (78.4)		154 (88.5)	131 (87.3)	
Sometimes	10 (7.1)	20 (16.0)		10 (5.7)	10 (6.6)	
Always or almost always	7 (5.0)	7 (5.6)		10 (5.7)	9 (6.0)	
Potential mediators						
Self-efficacy for safer drug use[c]			.001			.02
Absolutely sure I cannot avoid sharing	5 (3.7)	15 (12.2)		10 (6.0)	16 (11.1)	
Pretty sure I cannot avoid sharing	19 (14.0)	27 (22.0)		18 (10.7)	25 (17.4)	
Pretty sure I can avoid sharing	50 (36.8)	40 (32.5)		73 (43.5)	57 (39.6)	
Absolutely sure I can avoid sharing	62 (45.6)	41 (33.3)		67 (39.9)	46 (31.9)	
Engaged in peer mentoring	75 (53.6)	30 (24.8)	<.001	54 (30.8)	30 (19.6)	.02
Message retention and contamination						
Remembered hearing "PALMS"[d]	102 (71.8)	14 (11.1)	<.001	120 (70.6)	19 (12.2)	<.001
Correctly identified PALMS definition from a list[e]	59 (88.0)	2 (66.6)	.04	59 (95.2)	3 (37.5)	<.001
Remembered hearing "FEAT"[f]	33 (22.7)	10 (7.7)	.008	60 (33.5)	15 (9.6)	<.001

Note. HCV = hepatitis C virus. All variables refer to preceding 3 months unless otherwise specified. The Cochran–Armitage trend test was used for ordinal variables; The Fisher's exact test was used for dichotomous variables.

[a]Includes how often lent used syringe, shared drug preparation equipment, divided drugs with syringe used by oneself (any risk behaviors vs none). Those who did not report injecting drugs were also included in the no-lending category.

[b]Combined levels of more than half of the time, half of the time, and less than half of the time.

[c]Scores are the rounded averages from 6 items of this scale.

[d]PALMS was a mnemonic taught in the intervention condition that summarized communication techniques that could be used during peer mentoring.

[e]Among those who reported remembering what PALMS meant.

[f]FEAT was a mnemonic invented for the assessment and was not used during the intervention; it was included to assess individuals' propensity for answering affirmatively.

participants becoming less risky in their behavior over time.

Moderators and Mediators

There was no difference in the association between intervention and distributive risk at either 3 or 6 months after stratification by baseline self-efficacy (Table 4). However, the association was modified by the length of time participants had known their HCV-positive status. At 3 months, intervention effects were significantly stronger among those who had known their HCV-positive status for at least 6 months (OR=0.24; 95% CI=0.11, 0.52); at the 6-month assessment, the association continued to be stronger among those who had known their HCV status 6 to 12 months (OR=0.35; 95% CI=0.17, 0.72), but it was not significant among those who had known their status for more than 12 months. The interaction term was significant only at 3 months (*P*=.02).

At 3 months, postintervention self-efficacy was positively associated with the intervention and inversely associated with distributive risk behaviors, thus mediating intervention effects (Table 4); however, these results were not sustained at 6 months.

TABLE 3—Adjusted Effects of Peer Mentoring Intervention on Injection Risk Behaviors: Study to Reduce Intravenous Exposures, April 2002 to May 2004

	3 Months		6 Months	
	OR (95% CI)	*P*	OR (95% CI)	*P*
Distributive risk behaviors				
Combined distributive risk among those continuing to inject drugs[a]	0.46 (0.27, 0.79)	.004	0.51 (0.31, 0.83)	.006
Frequency of lending used syringe to others[b]	0.48 (0.21, 1.05)	.07	0.93 (0.40, 2.15)	.87
Frequency of preparing drugs with a syringe previously used by oneself[c]	0.41 (0.19, 0.90)	.03	0.61 (0.30, 1.23)	.17
Sharing drug preparation equipment[d]	0.47 (0.27, 0.82)	.008	0.55 (0.33, 0.92)	.03
Refraining from injection drug use[e]	3.59 (1.65, 7.83)	.001	1.60 (0.96, 2.68)	.07
Secondary outcomes				
Refraining from lending syringe because of HCV-positive status[f]	1.33 (0.65, 2.72)	.44	1.49 (0.74, 2.98)	.26
Any drug treatment since previous study visit[g]	0.94 (0.52, 1.69)	.84	1.10 (0.65, 1.87)	.72
Frequency of injecting self with used syringe[h]	0.38 (0.17, 0.82)	.01	0.75 (0.37, 1.52)	.42

Note. OR = odds ratio; CI = confidence interval; HCV = hepatitis C virus. All variables refer to preceding 3 months unless otherwise specified, use the "no" or lower values as the referent, and were adjusted for length of time participants had known their HCV status at baseline. Ordinary logistic regression was used for dichotomous dependent variables; proportional ORs were used otherwise.

[a]Includes lent used syringes, shared drug preparation equipment, divided drugs with syringe used by oneself, and refrained from injection drug use; 3-month model unadjusted; 6-month model adjusted for recruitment site and race.

[b]7 response options ("always" through "never"); 3-month model adjusted for age; 6-month model adjusted for gender.

[c]4 response options ("every time" through "never"); 3-month model adjusted for race; 6-month model adjusted for size of cohort at randomization.

[d]Drug preparation equipment includes sharing cooker, cotton, or rinse water with or before someone; 3-month model adjusted for baseline value of this variable; 6-month model adjusted for baseline value, recruitment site, and race.

[e]Three-month model adjusted for cohort size; 6-month model unadjusted.

[f]Both models unadjusted.

[g]Drug treatment includes biomedical or behavioral program; 3-month model adjusted for baseline value of this variable and recruitment site; 6-month model adjusted for baseline value, recruitment site, and age.

[h]3 response options (rarely/never, sometimes, always/almost always); 3-month model adjusted for dichotomized baseline value of this variable; 6-month model adjusted for race.

Intervention effects were not mediated by peer mentoring.

DISCUSSION

To our knowledge, this is the first trial to demonstrate the efficacy of a behavioral intervention motivating injection drug users with HCV infection to curb injection behaviors that can transmit HCV to others. Reductions were observed over short-term as well as longer-term periods, with the rate ratio suggesting at least a 26% reduction in distributive risk, which may translate to a 5% to 10% reduction in HCV prevalence.[35] Although modest, the successes observed here would be an important element in a comprehensive strategy for reducing endemic HCV among injection drug users that combines treatment focusing on reducing the number of individuals with HCV infection and interventions focusing on reducing primary infections among those without HCV.

Over the longer term, the intervention effects were driven more by reductions in drug preparation practices than by reductions in syringe lending. Changes in participants' drug preparation practices may have arisen from their newly acquired awareness of the risks associated with these common behaviors. Syringe lending was less prevalent than unsafe drug preparation at study entry. Furthermore, during group sessions, participants were surprised to learn how unsafe drug preparation practices could spread pathogens to clean equipment and to others in the absence of lending used syringes.

Our findings are similar to those from another behavioral intervention focused on reducing acquisition risk among injection drug users without HCV infection.[18] In both studies, injection risk was reduced over time, risk reduction was greater among intervention-group participants, and the magnitude of relative risk reduction, as measured through a combined outcome, was similar. Regardless of disease status or type of intervention, injection drug users may feel strong pressure to report and enact safer injection behaviors, and a ceiling effect may exist in terms of degree of risk reduction possible, at least in response to the peer-based approaches tested in these trials.

Intervention Mechanisms

Reasons for behavior change among participants did not fully support our hypotheses. Although intervention-group participants embraced peer mentoring, behavior change was mediated only through increased self-efficacy, a finding consistent with social cognitive theory.[36] Explanations for the lack of peer-mentoring mediation may include the need to more strongly emphasize "setting a safer example" when mentoring. Alternatively, this approach may simply not be an appropriate vehicle for engendering altruistic behavior. Lack of statistical power is yet another possible explanation, although the confidence intervals for mediation associations were not remarkably large.

An unanticipated finding was that intervention effects depended on how long participants had known their HCV serostatus. The strongest effects were found among those who had known their serostatus for at least 6 months but not longer than 12 months, suggesting that there may be a "window period" for effectively encouraging injection drug users to curb transmission risks. Participants were often unaware of the significance of an HCV-positive test result, and it may take time for awareness of one's HCV status to be internalized and translated into behavior change. This finding is consistent with studies showing associations between behavior change and the length of time individuals have been HIV positive.[37,38] Because ours is the first intervention (to our knowledge) involving HCV-positive injection drug users that has focused on reducing

TABLE 4—Effects of Self-Efficacy, Length of Time Participants Had Known Their Hepatitis C Virus Status, and Peer Mentoring on the Association Between Intervention and Distributive Risk: Study to Reduce Intravenous Exposures, April 2002 to May 2004

	3-Month Follow-Up			6-Month Follow-Up		
	No.[a]	OR (95% CI)	*P*	No.	OR (95% CI)	*P*
Unadjusted association between intervention and distribution risk	261	0.54 (0.33, 0.89)	.02	318	0.53 (0.34, 0.83)	.005
Moderators						
Self-efficacy at baseline[b]						
High	187	0.54 (0.30, 0.96)	.04	242	0.60 (0.36, 1.00)	.05
Low	65	0.52 (0.19, 1.42)	.20	67	0.40 (0.15, 1.06)	.07
Length of time participants had known their HCV status at baseline						
≤6 months	122	0.90 (0.43, 1.90)[c]	.79	153	0.35 (0.17, 0.72)	.004
>6 months	113	0.24 (0.11, 0.52)[c]	.003	132	0.75 (0.39, 1.42)	.37
Mediators						
Self-efficacy during follow-up						
Association between trial intervention and self-efficacy	259	2.42 (1.40, 4.31)	.003	312	2.00 (1.16, 3.43)	.01
Independent association of self-efficacy with distributive risk[d]	251	0.47 (0.26, 0.85)	.01	302	0.66 (0.38, 1.17)	.15
Peer mentoring						
Association between trial intervention and peer mentoring	261	3.50 (2.06, 5.94)	.001	328	1.82 (1.10, 3.05)	.02
Independent association of peer mentoring with distributive risk[d]	249	1.27 (0.74, 2.19)	.38	314	1.47 (0.88, 2.47)	.14

Note. OR = odds ratio; CI = confidence interval; HCV = hepatitis C virus.
[a]Because of missing data, numbers do not always sum to totals for unstratified results.
[b]Self-efficacy was dichotomized into high ("pretty sure or absolutely sure I can inject safely") vs low ("pretty sure or absolutely sure I cannot inject safely").
[c]Interaction term significant at $P < .05$.
[d]Association controlled for intervention effect.

distributive risks, this result requires further verification.

Participants in both groups were motivated to less frequently inject themselves with used syringes, at least in the short term, and to refrain from injection drug use altogether—actions that lead to personal health benefits and increase eligibility for HCV therapy.[12,39] However, intervention-group participants were no more likely to refrain from syringe lending because of their HCV-positive serostatus. Although participants may have refrained from syringe lending for other reasons, these behaviors would lower their HIV acquisition risk as well as their HCV transmission risk, suggesting a lack of altruism. This differs from the findings of some studies in which injection drug users with HIV have engaged in altruistic behaviors to protect others.[40] Given that injection drug users as a whole are highly stigmatized, it may be necessary to address the personal needs of injection drug users with HCV infection before motivating their actions on behalf of others.

Strengths and Limitations

Our study's strengths were its randomized design, use of audio computer-assisted self-interviews, and inclusion of an attention-control group to protect against information biases. Limitations were that the study was unmasked and lacked sufficient statistical power to detect small differences and definitively test moderating and mediating effects. Although the overall retention rate was good, retention was suboptimal at 3 months. The study was originally designed to have the power to detect a 35% difference between arms with a target sample size of 750; however, a sample only half this size was enrolled because multiple visits were required to determine eligibility prior to randomization.

Nevertheless, we observed significant differences between groups on all targeted behaviors in the short term, as well as on some hypothesized mechanisms. There was a greater propensity for affirmative responding in the intervention arm, and this bias may have led to overestimation of between-group differences. Alternatively, because the intervention encouraged peer mentoring, there may have been crossover effects among control-group participants, which may have underestimated intervention effects. Given that the trial design required multiple appointments during the enrollment period, the makeup of the select group that was ultimately randomized (predominantly White men) may limit the generalizability of our results. However, the fact that our study was conducted in 3 different cities mitigates this concern to a certain degree. Finally, considering the low 3-month retention rate, significant effects observed at this follow-up could reflect unmeasured confounding.

Conclusions

Our intervention reduced distributive risk behaviors among injection drug users with HCV infection, but behavior change was mediated through self-efficacy as opposed to peer mentoring or altruism. Given the large pool of injection drug users with HCV infection in the United States as well as other countries, more research is needed to identify motivators for behavior change among this group. In the interim, our intervention is a promising one for reducing injection practices that propagate HCV among injection drug users. ■

About the Authors

At the time of the study, Mary H. Latka, Farzana Kapadia, Sebastian Bonner, and Micaela H. Coady were with the Center for Urban Epidemiologic Studies, New York Academy of Medicine, New York, NY. Holly Hagan is with the National Development and Research Institute, Center for Drug Use and HIV Research, New York, NY. Elizabeth T. Golub is with the Department of Epidemiology, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Md. At the time of the study, Jennifer V. Campbell was with the HIV/AIDS Prevention Program, Seattle–King County Department of Public Health, Seattle, Wash. Richard S. Garfein, Minya Pu, and Steffanie A. Strathdee are with the Department of Family

and Preventive Medicine, University of California at San Diego School of Medicine, San Diego. Dave L. Thomas is with the School of Medicine, Johns Hopkins University, Baltimore. Thelma K. Thiel is with the Hepatitis Foundation International, Silver Spring, Md.

Requests for reprints should be sent to Steffanie A. Strathdee, PhD, Division of International Health and Cross Cultural Medicine, University of California School of Medicine, 9500 Gilman Dr, Mailstop 0622, La Jolla, CA 92093 (e-mail: sstrathdee@ucsd.edu).

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Contributors

M.H. Latka wrote and revised the article, was responsible for primary interpretation of results, and was involved in the conceptualization, design, and implementation of the study. H. Hagan was involved in the conceptualization and design of the study and assisted with interpretation and the drafting of the article. F. Kapadia was involved in the conceptualization, design, and implementation of the study and in analysis of data. E.T. Golub was involved in the conceptualization, design, and implementation of the study. S. Bonner was involved in the conceptualization of the study, particularly the development of the behavioral intervention. J.V. Campbell and M.H. Coady made substantial contributions to the design and implementation of the study. R.S. Garfein was involved in the conceptualization and design of the study and in revisions of the article. M. Pu assisted with data analysis and interpretation. D.L. Thomas was involved in the conceptualization and design of the study, particularly with respect to biological specimens, as well as interpretation of results. T.K. Thiel assisted with the conceptualization and development materials used in the behavioral intervention. S.A. Strathdee was involved in the conceptualization of the study and its design and implementation, assisted with interpreting the results, and contributed to drafting and revising the article.

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Human Participant Protection

All study activities were approved by institutional review boards at the participating sites. Participants provided written informed consent and were remunerated according to site-specific guidelines.

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