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ORIGINAL PAPER

# HIV, Hepatitis C, and Abstinence from Alcohol Among Injection and Non-injection Drug Users

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**Abstract** Individuals using illicit drugs are at risk for heavy drinking and infection with human immunodeficiency virus (HIV) and/or hepatitis C virus (HCV). Despite medical consequences of drinking with HIV and/or HCV, whether drug users with these infections are less likely to drink is unclear. Using samples of drug users in treatment with lifetime injection use (n = 1309) and non-injection use (n = 1996) participating in a large, serial, cross-sectional study, we investigated the associations between HIV and HCV with abstinence from alcohol. About half of injection drug users (52.8 %) and 26.6 % of non-injection drug users abstained from alcohol. Among non-injection drug users, those with HIV were less likely to abstain [odds ratio (OR) 0.55; adjusted odds ratio (AOR) 0.58] while those with HCV were more likely to abstain (OR 1.46; AOR 1.34). In contrast, among injection drug users, neither HIV nor HCV was associated with drinking. However, exploratory analyses suggested that younger injection drug users with HIV or HCV were more likely to drink, whereas older injection drug users with HIV or HCV were more likely to abstain. In summary, individuals using drugs, especially non-injection users and those with HIV, are likely to drink. Age may modify the risk of drinking among injection drug users with HIV and HCV, a finding requiring replication. Alcohol intervention for HIV and HCV infected drug users is needed to prevent further harm.

**Keywords** HIV · Hepatitis C · Drug use · Alcohol

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## Introduction

Individuals using illicit opioids, cocaine, and amphetamines are at high risk for premature mortality due to overdose, suicide, trauma, and infectious diseases such as human immunodeficiency virus (HIV) and hepatitis C virus (HCV) [1]. Many drug users also engage in heavy or problematic drinking [2, 3], which is associated with psychosocial problems [4, 5], poorer quality of life [5], and risky injection behaviors [6] in this population. Heavy drinking among drug users is therefore an important problem for an already at-risk population that requires clinical attention [2, 3].

Heavy drinking is especially harmful for drug users infected with HIV or HCV. For those with HIV, heavy drinking can compromise liver function [7], medication adherence [8], and may impact immune function [9]. For those with HCV, heavy drinking can exacerbate HCV-induced liver damage [10–14]. Also, despite HCV-infected heavy drinkers being arguably most in need of HCV medication due to more advanced liver damage, heavy drinking is sometimes considered a contraindication for HCV treatment [15, 16]. However, whether drug users with HIV or HCV are more likely to limit drinking due to these risks remains unclear. Several studies not focused on drug users [17–23] and one study in injection drug users [24]

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suggest that individuals with HIV drink as much or more than those without HIV. Although some studies not targeting drug users show that HCV patients reduce drinking after being informed that they have HCV [25, 26], others show that they are still more likely to drink [27] and have alcohol use disorders [28] than those without HCV. Current injection drug users with HCV are also more likely to drink heavily than those without HCV [29], but treatment-seeking opioid users with HCV drink the same [30] or less [31] than those without HCV. Together, these studies suggest that HIV does not inhibit drinking, but that HCV may inhibit drinking, particularly in treatment-seeking drug users. However, existing studies of HIV, HCV, and drinking in drug users have focused on homogeneous subgroups who exclusively use opioids, or who inject drugs, neglecting those using alternate routes of administration (e.g., oral, intranasal) and those using other substances (e.g., cocaine, amphetamines). Although injection drug users have traditionally been viewed as most at risk for HIV and HCV, non-injection drug users also have elevated rates of HIV [32] and HCV [33], making their drinking habits also of great importance. Whether findings from injection drug users also apply to non-injection drug users is unknown. Therefore, deliberate separate study of both injection and non-injection drug users (abusing a range of substances including but not limited to opioids) in studies of infectious disease and drinking is important in order to provide a more thorough understanding of the associations of HIV and HCV with alcohol use in a wider range of the drug-using population.

Among drug users with these infectious diseases, alcohol has the greatest potential for harm among those who are HIV/HCV co-infected. In addition to the drinking-related risks associated with each individual infection, HIV accelerates HCV-induced liver damage [34, 35], which is further worsened by heavy drinking [7]. Because of the heightened risk of drinking for co-infected patients, several studies have examined the associations between HCV infection and drinking within the HIV population. Results of these studies are inconsistent, with most studies showing that those co-infected with HCV drink more [36–38], and one study suggesting that they drink less [39]. However, no studies have examined the relationship between HIV/HCV co-infection and drinking among drug users specifically, particularly drug users in treatment. Studying interactive effects of HIV and HCV on drinking among injection and non-injection drug users could help integrate the largely separate and somewhat inconsistent literatures on drinking by HIV and HCV status in drug users.

We therefore examined the main and interactive effects of HIV and HCV on abstinence from alcohol in a large, serial, cross-sectional sample of treatment-seeking drug users reporting past 6-month use of heroin, cocaine, or (in fewer cases) amphetamines [32]. Separate models were run for individuals with a history of injection drug use versus no history of injection use. Additional models incorporated control for demographic covariates. Finally, exploratory models assessed moderating effects of age.

## Methods

### Participants and Procedures

The sample consisted of 3305 patients from detoxification and methadone maintenance programs in New York city who participated from 2000–2014 in an ongoing, large, serial cross-sectional study of HIV risk factors in drug users [32]. Inclusion criteria for the larger study required participants to have reported injection or non-injection use of heroin, cocaine, and/or amphetamines within the past 6 months [40]. The 3305 patients included in the current analyses are those with definitive results from HIV and HCV blood tests, as well as responses to self-report questions regarding lifetime injection drug use history and drinking.

Of these patients, 1309 (39.6 %) reported a lifetime history of injection drug use, whereas 1996 (60.4 %) reported no history of injection drug use. Both groups were primarily male, minority, in early-to-mid-adulthood, and without a high school degree (see Table 1). The injection drug use group was younger ($t[1, 3296] = 9.46$, $p < 0.0001$) and more predominantly male (Fisher's exact test, $p < 0.01$). While members of the injection drug use group were more likely to be Latino/Latina, members of the non-injection drug use group were more likely to be black ($\chi^2[3] = 749.76$, $p < 0.0001$). The non-injection drug use group evidenced a higher rate of HIV ($\chi^2[1] = 5.51$, $p < 0.05$), whereas the injection group evidenced a much higher rate of HCV ($\chi^2[1] = 1148.24$, $p < 0.0001$).

### Measures

#### *HIV and Hepatitis C Virus (HCV) Status*

After pre-test counseling, blood samples were collected and tested for HIV and HCV. Samples were tested for HIV using a commercial, enzyme-linked immunosorbent assay test with western blot confirmation (BioRad Genetic Systems HIV-1-2 + 0 EIA and HIV-1 Western Blot, BioRad Laboratories, Hercules, CA), and for HCV antibody with the Ortho HCV enzyme immunoassay 3.0 (Ortho-Clinical Diagnostics, Inc., Raritan, NJ) [41].

**Table 1** Demographic and medical characteristics of injection and non-injection drug using samples

| | Injection drug users (n = 1309) M (SD) | Non-injection drug users (n = 1996) M (SD) | Differences between groups *t* test |
|---|---|---|---|
| Age | 40.1 (10.0) | 43.1 (7.9) | $t(1, 3296) = 9.46$, $p < 0.0001$ |
| Years of education | 11.2 (2.1) | 11.3 (2.1) | $t(1, 3301) = 1.55$, $p = 0.12$ |
| | % | % | Fisher/Chi squared test |
| Gender | | | |
| Male | 81.9 | 77.3 | Fisher's exact[a], $p < 0.01$ |
| Female | 17.9 | 22.4 | |
| Transgender | 0.2 | 0.3 | |
| Ethnicity | | | |
| Black | 18.6 | 64.5 | $\chi^2[3] = 749.76$, $p < 0.0001$ |
| Latino/Latina | 47.9 | 26.9 | |
| White | 30.1 | 6.2 | |
| Other | 3.4 | 2.4 | |
| HIV status | | | |
| Positive | 10.8 | 13.5 | $\chi^2[1] = 5.51$, $p < 0.05$ |
| HCV status | | | |
| Positive | 68.7 | 11.5 | $\chi^2[1] = 1148.24$, $p < 0.0001$ |

Injection versus non-injection drug use distinction is based on any lifetime history of injection drug use

[a] Indicates the use of Fisher's exact test due to inadequate sample size in certain cells

*Alcohol Consumption*

Participants were asked to report on their typical weekly consumption of beer, wine, and hard liquor in the past 6 months. Each beverage type was assessed separately, and for each, participants were asked to report their typical number of drinks per week. For the present study, participants were characterized as either drinkers (at least one drink of any type in a typical week) or abstainers (no drinks in a typical week). Abstention was chosen as the outcome of interest because there is no established "safe" alcohol consumption level for HIV or HCV.

### Analysis Plan

Logistic regressions (SAS Proc Logistic [42]) were used to determine the main and interactive effects of HIV and HCV in predicting abstention from alcohol, separately in injection and non-injection drug users. First, we conducted a logistic regression with HIV, HCV, and HIV-by-HCV interaction as predictors of abstention among injection drug users, unadjusted for control covariates (Model 1), and with demographic control covariates included (age, sex, race, education) (Model 2). In the case of non-significant interactions, models were repeated omitting the unnecessary interaction term, to generate main effect ORs. Second, we repeated these procedures in the non-injection drug using sample. Third, due to higher rates of problem drinking among younger adults [43], we conducted exploratory analyses to determine whether HIV and HCV statuses interacted with age in predicting drinking status in injection and non-injection drug using samples. This was done by removing the continuous age covariate from controlled models, and adding a new dichotomized age variable, as well as two interaction terms (HIV by age group; HCV by age group) to all models.

## Results

### Abstention in Injection and Non-injection Drug Users

Approximately half (52.8 %) of drug users with a history of injection drug use and a quarter (26.6 %) of drug users with no history of injection drug use reported abstaining from alcohol. Among injection drug users, the level of abstinence was 55.5 % among patients with neither HIV nor HCV, 49.7 % among patients with HIV, 52.0 % among patients with HCV, and 51.6 % among HIV/HCV co-infected patients. Among non-injection drug users, the level of abstinence was 27.0 % among patients with neither HIV nor HCV, 18.2 % among patients with HIV, 32.2 % among

patients with HCV, and 21.4 % among HIV/HCV co-infected patients.

### HIV and HCV Status and Abstention from Drinking in Injecting and Non-injecting Drug Users

Among lifetime injection drug users, there were no significant main or interactive effects of HIV and HCV in Model 1 or Model 2. Given the non-significant HIV-by-HCV interactions, models were repeated omitting the unnecessary interaction terms, with main effect ORs for HIV and HCV presented in Table 2. In the unadjusted models, both HIV and HCV were unrelated to abstinence from alcohol [HIV: OR 0.89; 95 % confidence interval (CI) 0.62, 1.26; HCV: OR 0.91; 95 % CI 0.72, 1.15]. The same was true in the model adjusted for demographic characteristics (HIV: AOR 1.04; 95 % CI 0.72, 1.51; HCV: AOR 1.04; 95 % CI 0.81, 1.34).

Among non-injection drug users, there were significant and marginally significant main effects of HIV and HCV, but no significant HIV-by-HCV interactions for Models 1 and 2. Given the non-significant HIV-by-HCV interactions, models were repeated without the interaction terms, with main effect ORs for HIV and HCV presented in Table 2. In the unadjusted model, an HIV infection was associated with a significantly reduced likelihood of abstinence (OR 0.55; 95 % CI 0.39, 0.76), whereas an HCV infection was associated with an increased likelihood of abstinence (OR 1.46; 95 % CI 1.08, 1.97). When models were adjusted for demographic covariates, HIV remained significant while HCV approached but did not reach significance (HIV: AOR 0.58; 95 % CI 0.41, 0.81; HCV: AOR 1.34; 95 % CI 0.98, 1.84).

### Exploratory Analyses of Infection, Age, and Drinking in Injection and Non-injection Drug Users

Among lifetime injection drug users, age evidenced a marginal interaction with HIV ($\chi^2[1] = 3.81$, $p = 0.05$) and a significant interaction with HCV ($\chi^2[1] = 7.58$, $p < 0.01$) in predicting abstinence in the uncontrolled model. Specifically, in the younger sample, neither HIV nor HCV significantly predicted abstinence, but both associations showed trends towards significance in the direction of less abstinence among those infected (HIV: OR 0.56, 95 % CI 0.30, 1.05; HCV: OR 0.79, 95 % CI 0.58, 1.07) (see Table 3). In contrast, in the older sample, HCV but not HIV predicted abstinence, and both associations were in the direction of more abstinence among those infected (HIV: OR 1.20, 95 % CI 0.78, 1.86; HCV: OR 1.67, 95 % CI 1.08, 2.56). In the interaction model controlling for demographics, age evidenced significant interactions with both HIV ($\chi^2[1] = 4.45$, $p < 0.05$) and HCV ($\chi^2[1] = 6.93$, $p < 0.01$) in predicting abstinence. As in the uncontrolled models, in the younger sample, both associations showed trends towards significance in the direction of less abstinence among those infected (HIV: AOR 0.57, 95 % CI 0.30, 1.08; HCV: AOR 0.78, 95 % CI 0.57, 1.07), and in the older sample, both associations were in the direction of more abstinence among those infected, but only HCV was significant (HIV: AOR 1.32, 95 % CI 0.84, 2.06; HCV: AOR 1.61, 95 % CI 1.04, 2.50).

Among non-injection drug users, age evidenced a marginal interaction with HIV ($\chi^2[1] = 3.10$, $p = 0.08$) and no interaction with HCV ($\chi^2[1] = 1.02$, $p = 0.31$). Both interactions were nonsignificant in the model that included

**Table 2** Main effects of HIV and HCV on abstinence from alcohol among lifetime injection and non-injection drug users

| | Lifetime injection drug users | | Lifetime non-injection drug users | |
|---|---|---|---|---|
| | Model 1<br>No control covariates | Model 2<br>Controlling for demographics[a] | Model 1<br>No control covariates | Model 2<br>Controlling for demographics[a] |
| Abstinence from alcohol | | | | |
| Effect of HIV infection | OR 0.89 | AOR 1.04 | OR 0.55 | AOR 0.58 |
| | 95 % CI 0.62, 1.26 | 95 % CI 0.72, 1.51 | 95 % CI 0.39, 0.76[b] | 95 % CI 0.41, 0.81[b] |
| Effect of HCV infection | OR 0.91 | AOR 1.04 | OR 1.46 | AOR 1.34 |
| | 95 % CI 0.72, 1.15 | 95 % CI 0.81, 1.34 | 95 % CI 1.08, 1.97[b] | 95 % CI 0.98, 1.84 |

These models originally included HIV-by-HCV interaction terms, but these non-significant (and therefore, unnecessary) interaction terms were omitted from the above models. Additional models for subsamples of current and former injection drug users evidenced similar results to that of the lifetime injection drug user sample

*HIV* human immunodeficiency virus, *HCV* hepatitis C virus, *OR* odds ratio, *AOR* adjusted odds ratio, 95 % *CI* 95 % confidence intervals from logistic regressions

[a] Demographics include age, sex, race, and education

[b] Indicates significance at 95 % confidence

**Table 3** Associations between infection status and abstinence from alcohol among younger and older lifetime injection drug users

| | Lifetime injection drug users | | | |
|---|---|---|---|---|
| | Model 1 No control covariates | | Model 2 Controlling for demographics[a] | |
| | Younger | Older | Younger | Older |
| Abstinence from alcohol | | | | |
| HIV | OR 0.56 | OR 1.20 | AOR 0.57 | AOR 1.32 |
| | 95 % CI 0.30, 1.05 | 95 % CI 0.78, 1.86 | 95 % CI 0.30, 1.08 | 95 % CI 0.84, 2.06 |
| HCV | OR 0.79 | OR 1.67 | AOR 0.78 | AOR 1.61 |
| | 95 % CI 0.58, 1.07 | 95 % CI 1.08, 2.56[b] | 95 % CI 0.57, 1.07 | 95 % CI 1.04, 2.50[b] |

The lifetime injection drug use sample includes prior and current injection drug users

*HIV* human immunodeficiency virus, *HCV* hepatitis C virus, *OR* odds ratio, *AOR* adjusted odds ratio, 95 % *CI* 95 % confidence intervals from logistic regressions

[a] Demographics include sex, race, and education

[b] Indicates significance at 95 % confidence

demographic control covariates (HIV: $\chi^2[1] = 1.51$, $p = 0.22$; HCV: $\chi^2[1] = 1.96$, $p = 0.16$). These models were not explored further.

## Discussion

Despite the significant medical risks of drinking associated with HIV and HCV, many drug users with these infections reported regular consumption of alcohol. Drug users with no history of injection use were particularly likely to be drinkers. Injection and non-injection drug users evidenced differing associations between infection status and abstinence from alcohol. Among drug users with a lifetime history of injection drug use, neither HIV nor HCV predicted abstinence. Among drug users with no history of injection drug use, those with HIV were less likely to abstain, whereas those with HCV were more likely to abstain. There were no significant interactions between HIV and HCV in models predicting drinking status in either drug using population. Exploratory analyses suggested that younger injection drug users with either HIV or HCV infection are more likely to drink, whereas older injection drug users with either HIV or HCV are less likely to drink, indicating the need for further study of age effects on drinking among injection drug users with these serious medical conditions.

Infection with HIV was unrelated to abstinence from alcohol in the sample of injection drug users. This result is consistent with a prior study of injection drug users in Baltimore [24]. However, HIV was associated with reduced likelihood of abstinence (i.e., greater risk of drinking) in the sample of non-injection drug users. Although we are not aware of any prior studies assessing the association between HIV and abstinence from alcohol among non-injection drug users, this association between HIV infection and higher likelihood of drinking is consistent with several studies in non-drug using samples [21–23]. This suggests that non-injection drug users with HIV may be particularly at risk for drinking-related medical problems (e.g., impaired liver function, reduced medication adherence).

Infection with HCV was unrelated to drinking status in the sample of injection drug users, but was associated with increased likelihood of abstinence (i.e., less likelihood of drinking) in the sample of non-injection drug users. The latter association lost significance once several demographic variables were added as control covariates; however, the size of the OR decreased only modestly and still approached significance, suggesting that it may still be meaningful. That HCV is associated with the same or less likelihood of drinking is consistent with prior research on opioid drug users in treatment [30, 31]. This study's consideration of differences between injecting versus non-injecting drug users provides a potential explanation for conflicting findings in past research (which did not specify patients' route of use). The lack of association between HCV infection and drinking status among injection drug users in the present study is alarming, as HCV is associated with severe risks to the liver that make drinking dangerous. This lack of association emphasizes the need for providers to reduce alcohol-related harm among HCV-infected injection drug users in particular. Non-significant interactions between HIV and HCV in models predicting drinking suggested that the associations between HCV and abstinence from alcohol did not differ by HIV status.

Exploratory analyses suggested that age may moderate the effects of HIV and HCV on drinking status in injection drug users. Specifically, young drug users with either HIV or HCV infection may be more likely to drink, whereas older injection drug users with either HIV or HCV may be less likely to drink. Such analyses were post hoc, and

suggest the need for further study of differing response to infection in younger versus older injection drug users with HIV and HCV, which could perhaps explain the lack of main effects of HIV and HCV in the combined sample of injection drug users. However, these trends should be interpreted with caution, because although interactions were significant, conditional ORs for the younger and older injection drug users were largely non-significant and thus the results require replication in other samples before being taken as definitive.

This study is subject to certain limitations. First, we only assess abstinence from alcohol in the current study, and do not assess risky drinking. Guidelines for risky drinking used in the general population are likely not applicable to individuals with serious medical conditions such as HIV and HCV infection. Conducting research using inappropriate risky drinking guidelines is likely to be uninformative or even misleading, making abstinence from alcohol a more appropriate outcome. More research on how to define risky drinking for individuals with HIV and HCV could facilitate additional research in this area, and could clarify how clinicians can best identify high-risk patients. Second, all data were collected at substance use clinics in New York city. It is possible that the association between diagnostic status and alcohol consumption could differ by geographic area or urbanicity. For example, HCV may be less associated with abstinence from alcohol in regions where health education is less consistently available to patients. Therefore, whether results generalize to other geographic regions, and to suburban and rural areas, are important questions that could be evaluated in future research. Third, drinking data are subject to inherent limitations of self-report data, such as the potential for socially desirable responses. Yet, such methodology is used widely, and collecting alternate information on patient drinking (e.g., blood alcohol content, collateral verification) was not feasible. Fourth, results are cross-sectional associations, and therefore we cannot conclusively determine that HIV or HCV directly impacted drinking, as longstanding drinking patterns may have predated (and even influenced the likelihood of) HIV and HCV infection. Yet, drinking with HIV and/or HCV is important regardless of the direction of causality, as it remains associated with numerous risks to the patient. Fifth, the current study is unable to determine whether severity of illness related to drinking, as data collection did not include an objective measure of illness severity. Future studies could examine whether more severely ill patients were more (or conversely, less) likely to abstain from alcohol. Strengths of this study are also notable, including two large samples from an at-risk population, separate attention to injection and non-injection drug users, inclusion of individuals using a range of drugs (not limited to opioids), biological testing for HIV and HCV, and consideration of demographic covariates and age interactions. Also, although results are only shown for groups dichotomized by lifetime injection drug use, when models were run separately for former and current injection drug use subgroups, results were consistent with those of the lifetime injection drug use sample as a whole (results not presented in text), demonstrating robustness of results.

In sum, the current study advances understanding of the associations of HIV and HCV infections with abstinence from alcohol among injection and non-injection drug users. HIV is associated with higher likelihood of drinking in non-injection drug users, a significant concern due to medical risks of drinking with HIV. However, non-injection drug users infected with HCV appeared to understand the need to eliminate drinking, as they were more likely to abstain than their HCV-uninfected peers. Although this is encouraging, the association between HCV and abstinence was not observed among injection drug users, suggesting a particular need to intervene with the drinking of HCV-infected injection drug users. Analyses also suggested that age may be a relevant moderator, although results require replication. In sum, substantial proportions of patients with HIV, HCV, and HIV/HCV co-infection reported regular drinking. Increased clinical and research efforts are needed to determine how best to encourage abstention among these medically ill patients, for whom drinking can significantly hasten disease and threaten survival.

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