

# Sharing of Injection Drug Preparation Equipment Is Associated With HIV Infection: A Cross-sectional Study

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**Background:** Sharing needles/syringes and sexual transmission are widely appreciated as means of HIV transmission among persons who inject drugs (PWIDs). London, Canada, is experiencing an outbreak of HIV among PWIDs, despite a large needle/syringe distribution program and low rates of needle/syringe sharing.

**Objective:** To determine whether sharing of injection drug preparation equipment (IDPE) is associated with HIV infection.

**Methods:** Between August 2016 and June 2017, individuals with a history of injection drug use and residence in London were recruited to complete a comprehensive questionnaire and HIV testing.

**Results:** A total of 127 participants were recruited; 8 were excluded because of failure to complete HIV testing. The remaining 35 HIV-infected (cases) and 84 HIV-uninfected (controls) participants were assessed. Regression analysis found that sharing IDPE, without sharing needles/syringes, was strongly associated with HIV infection (adjusted odds ratio: 22.1, 95% confidence interval: 4.51 to 108.6,  $P < 0.001$ ).

**Conclusions:** Sharing of IDPE is a risk factor for HIV infection among PWIDs, even in the absence of needle/syringe sharing. Harm reduction interventions to reduce HIV transmission associated with this practice are urgently needed.

**Key Words:** HIV transmission, injection drug use, prescription opioid injection

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## INTRODUCTION

HIV transmission among persons who inject drugs (PWID) accounts for 9% of all new HIV infections globally and thus remains a major public health challenge.<sup>1,2</sup> The control of HIV outbreaks among PWID generally depends on a multipronged approach of needle/syringe distribution,<sup>3,4</sup> opiate substitution therapy (with methadone or buprenorphine),<sup>5</sup> and provision of antiretroviral therapy.<sup>6,7</sup> Such multipronged interventions were effective in mitigating large HIV outbreaks among PWID in New York City, United States; Vancouver, Canada; and France.<sup>6</sup> However, despite aggressive outbreak control measures, HIV transmission among PWIDs has continued across Europe and North America in recent years.<sup>8</sup> A critical component to outbreak control is an understanding of all mechanisms of transmission, so that appropriate control measures can be implemented. Sharing of needles and/or syringes has been recognized for many years as a major means of HIV transmission,<sup>9</sup> while the role of sexual transmission has also been appreciated.<sup>10</sup> Whether other means of transmission may be occurring among PWIDs is unknown.

London, Canada, has experienced an HIV outbreak among PWIDs in recent years.<sup>11</sup> This HIV outbreak is unusual because it is occurring in a setting with the second largest needle/syringe distribution program in Canada; it is the largest program in the country on a per-capita basis.<sup>12</sup> More than 2.5 million needles/syringes were distributed across London in 2015, among a total population of 370,000, followed by more than 3 million in 2016.<sup>12</sup> Thus, needle/syringe sharing was believed to be less common in London, which provided an opportunity to explore the impact of other factors associated with injection drug use on HIV transmission.

In some centers, sharing of injection drug preparation equipment (IDPE; ie, cookers and filters) has been identified as the primary risk factor for hepatitis C virus transmission among PWID.<sup>13–16</sup> Recent studies have shown that sharing of IDPE is more common than sharing of needles/syringes,<sup>13,17–20</sup> and that HIV has been detected in used

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IDPE.<sup>21,22</sup> Heating of IDPE with a lighter to sterilize it before sharing has been proposed as a harm reduction approach.<sup>23</sup>

The 3 most commonly used drugs injected in London were hydromorphone controlled-release, hydromorphone immediate-release, and crystal methamphetamine.<sup>24</sup> Hydromorphone controlled-release use is associated with performing multiple drug washes. A wash refers to a process performed to extract residual drug after the initial aspiration. PWID add water to a previously used cooker and filter with residual drug and then place a needle into the filter to aspirate the solution. Performing multiple drug washes from the same IDPE increases the opportunities for sharing. The objectives of this study were to investigate the hypothesis that HIV transmission could occur among PWIDs through IDPE sharing.

## METHODS

### Design and Recruitment

A cross-sectional study was conducted between August 15, 2016, and June 1, 2017. Cases were defined as HIV-infected individuals (HIV+), and controls were defined as individuals who were HIV uninfected (HIV-). The primary exposure of interest was IDPE sharing. Inclusion criteria were age >17 years, residence in London-Middlesex county, and reported injection drug use within the last 3 months. Eligible participants were recruited from multiple sites: (1) local needle exchange clinic; or (2) consecutive patients admitted to 1 of 2 local hospitals with a diagnosis of injection drug use-associated endocarditis. Participants at the needle exchange clinic were identified by the harm reduction material distribution staff. Consecutive patients admitted with injection drug-associated endocarditis were identified by the attending infectious disease specialist (all 5 attending ID specialists who worked at these sites participated).

### Data Collection

Participants completed a detailed questionnaire regarding injection behaviors. Routine HIV testing was performed using rapid diagnostic tests at the safe-injection site and fourth generation testing at the hospital sites. Race was based on self-reported status. Participants received a \$10 CAN (\$7.50 US) coffee gift card for participating. Written informed consent was obtained from all participants. The study was approved by the Research Ethics Board at Western University. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.<sup>25</sup>

### Sample Size Calculation

Based on a previous study that found 40% prevalence of sharing IDPE among PWIDs,<sup>15</sup> we estimated an exposure prevalence of 20% in controls and 50% in cases, corresponding to an odds ratio of 4.0. A minimum of 33 cases and 66 controls were needed to detect the association between

sharing IDPE and HIV status, with 80% power, a 2-tailed alpha of 5%, and the continuity correction.<sup>26</sup>

### Statistical Analysis

Analyses were conducted using SAS 9.4 (SAS Institute Inc. Cary, NC). Univariable logistic regressions were used to compare characteristics of HIV-infected and HIV-uninfected patients. A multivariable logistic regression was conducted to estimate the independent effect of the primary exposure of interest (ie, IDPE sharing). If the addition of any sociodemographic variable (listed in Table 1) demonstrated a confounding influence (>10% change in the IDPE sharing parameter estimate) or interaction with the IDPE sharing variable, or if it was a significant independent predictor itself, it was retained in the multivariable model. Variables that met these criteria included employment; housing; lesbian, gay, bisexual, transgender, and queer (LGBTQ); and men who have sex with men (MSM). Only housing and MSM were retained in the multivariable model as a result of multicollinearity with employment and LGBTQ variables, respectively. Two-tailed tests were used, and significance was defined as  $P < 0.05$ .

## RESULTS

One hundred forty-seven individuals were approached, and 127 agreed to participate in the study. Of the 27 patients approached at the hospital to participate, 4/27 (15%) declined and 23/27 (85%) participated. Similarly, 16/120 (13%) of the patients approached at the safe-injection site declined and 104/120 (87%) participated. Eight participants were excluded because of failure to perform the HIV test. The remainder were divided into cases (HIV+;  $n = 35$ ) and controls (HIV-;  $n = 84$ ). A total of 9/35 (26%) HIV cases were new diagnoses. Cases and controls were similar with regard to age, sex, race, housing, employment, and recent endocarditis (Table 1). There was no difference in the proportion of participants recruited from the hospital sites and those recruited at the safe-injection site in the case and control groups.

Unadjusted (Table 1) and adjusted (Table 2) models showed that HIV infection was strongly and consistently associated with sharing IDPE among PWIDs. HIV infection was associated with MSM status, although the association was weaker than sharing IDPE. Sharing needles/syringes in the absence of IDPE sharing was not associated with HIV status. Removing either MSM status or housing status from the regression model did not change the results. Barriers and negative beliefs about heating IDPE preparation before use were reported by 80% (20/25) of cases, compared with only 56% (36/64) of controls ( $\chi^2 = 4.346$ ;  $P = 0.04$ ).

Participants reported performing multiple drug washes more frequently when injecting hydromorphone controlled-release compared with other locally used drugs. Multiple drug washes were reported when using hydromorphone controlled-release [93/97 (96%); 31/31 HIV+ and 62/66 HIV-] in comparison with hydromorphone immediate-release [41/84 (49%); 12/20 HIV+ and 29/64 HIV-;  $P < 0.001$ ] and crystal methamphetamine [19/92 (21%); 9/29 HIV+ and 10/63 HIV-;  $P < 0.001$ ].

**TABLE 1.** Characteristics of HIV-Infected and HIV-Uninfected Participants

	Case (HIV+) (n = 35)	Control (HIV-) (n = 84)	Odds Ratio (95% Confidence Interval)
<b>Sharing of injection equipment¶</b>			
None	14 (42%)	61 (73%)	Reference
Only needles/syringes†	4 (12%)	16 (19%)	1.09 (0.32 to 3.76)
Only IDPE‡	10 (30%)	3 (4%)	14.52 (3.53 to 59.77)*
Both IDPE and needles/syringes§	5 (15%)	3 (4%)	7.26 (1.55 to 34.03)*
<b>Sociodemographic factors</b>			
Age	38.4 (10.2)	41.2 (10.5)	1.03 (0.99 to 1.07)
Female	6 (17%)	21 (25%)	0.62 (0.23 to 1.70)
MSM#	5 (18%)	2 (3%)	6.63 (1.20 to 36.60)*
LGBTQ**	3 (12%)	7 (9%)	1.29 (0.61 to 5.39)
Stable housing††	19 (54%)	34 (41%)	1.71 (0.77 to 3.79)
Aboriginal (Ref = white)‡‡	9 (26%)	17 (21%)	1.33 (0.53 to 3.39)
Stable employment§§	2 (6%)	5 (6%)	1.02 (0.19 to 5.53)
Endocarditis	9 (25%)	14 (17%)	1.73 (0.67 to 4.48)
<b>Injection drug use   </b>			
Hydromorphone controlled-release	31 (89%)	66 (79%)	2.11 (0.66 to 6.77)
Hydromorphone immediate-release	20 (57%)	64 (76%)	0.42 (0.18 to 0.96)*
Methamphetamine	27 (77%)	63 (75%)	1.13 (0.44 to 2.85)

MSM defines a behavior while LGBTQ is an umbrella term for sexual and gender identities.

IDPE, injection drug preparation equipment.

\*Statistically significant value ( $P < 0.05$ ).

†“Have you shared a needle or syringe but not shared a cooker or filter or wash within the past 3 months?”

‡“Have you shared cookers or filters or washes but not shared a needle or syringe within the past 3 months?”

§“Have you shared both needles or syringes and also a cooker or filter or wash within the past 3 months.”

||SD.

¶Sharing data available for 33 cases and 83 controls.

#MSM data available for 28 cases and 63 controls.

\*\*LGBTQ (lesbian, gay, bisexual, transgender, and queer) data available for 26 cases and 76 controls.

††Housing data available for 35 cases and 83 controls.

‡‡Race data available for 34 cases and 80 controls.

§§Employment data available for 33 cases and 84 controls.

|||Totals add to >100% as most local PWID inject multiple substances.

**TABLE 2.** Association of HIV Status With Injecting Behavior and Sociodemographic Variables (Adjusted Model)

	Odds Ratio (95% Confidence Interval)
<b>Sharing (Ref = neither)</b>	
Both IDPE and needle/syringes	23.88 (2.36 to 241.82)
Only IDPE*	22.12 (4.51 to 108.59)
Only needle/syringes†	0.91 (0.16 to 5.37)
MSM	11.34 (1.79 to 71.69)
Stable housing	1.83 (0.55 to 6.10)

\*Have you ever shared cookers or filters or washes but not shared a needle or syringe within the past 3 months?.

†Have you shared a needle or syringe, but not shared cookers or filters or washes within the past 3 months?.

significant risk associated with sharing IDPE, as sharing needles/syringes alone was not a significant independent risk factor for HIV infection. Our study occurred in an area with a large and well-used needle and syringe distribution program, which enabled assessment of the impact of IDPE sharing when needle/syringe sharing is relatively infrequent. The low rates of needle/syringe sharing likely allowed the impact of IDPE sharing to be detected. In contrast to our study, a recent HIV outbreak in Indiana demonstrated a 90% rate of needle/syringe sharing among cases and 66% among controls during their outbreak.<sup>27</sup> Therefore, as needle/syringe distribution programs are established, interventions to prevent HIV transmission associated with IDPE sharing will become increasingly important to eliminate further HIV transmission.

As in previous studies,<sup>13,17-20</sup> we found that sharing of IDPE is a regular occurrence. This behavior is likely due to the risk of HIV transmission with IDPE not being widely recognized among PWID. In fact, participants who avoided needle/syringe sharing frequently reported IDPE sharing several times per day. Those who share needle/syringes likely do so very rarely, due to the known significant associated risk of HIV and hepatitis C virus transmission.<sup>8,9,15,28-30</sup> Although the absolute risk of HIV infection associated with a single episode of needle/syringe sharing is higher than that of a single episode of IDPE sharing, the high frequency of IDPE sharing may contribute to a greater cumulative risk. This greater cumulative risk associated with IDPE sharing occurs in populations where needle/syringe sharing is infrequent and sharing IDPE is frequent. We suspect that due to awareness of the risks associated with needle/syringe sharing, individuals may only do so with partners whom they believe are seroconcordant. Given the lack of awareness regarding the risk associated with IDPE sharing, we also suspect that individuals do not avoid this behavior nor do they attempt to serosort with IDPE sharing. Further studies are necessary to confirm these hypotheses.

Counseling regarding the risk of IDPE sharing is potentially an important harm reduction intervention. Free IDPE are routinely distributed with clean syringes/needles in our region and elsewhere. However, sharing of IDPE is still widespread due to the perception of valued drug remaining in the used IDPE.<sup>31</sup> Participants frequently reuse their own syringe/needle, placing it into the shared IDPE and thus contaminating the IDPE for the next user. Using a new syringe/needle with each use to prevent IDPE contamination

**DISCUSSION**

We found that sharing of IDPE among PWID was a strong risk factor for HIV infection. To the best of our knowledge, this is the first study that has demonstrated an association of IDPE sharing with HIV infection in the absence of needle/syringe sharing.

Sharing of needles/syringes has been well established as a risk for HIV infection.<sup>6</sup> We found that sharing both IDPE and needles/syringes was associated with the greatest risk of HIV transmission. However, this finding was likely driven by the

has therefore been suggested for harm reduction. Heating the IDPE before use has been shown to inactivate residual HIV.<sup>23</sup> Our finding that negative attitudes toward heating IDPE before use were associated with HIV infection raise the prospect that encouraging IDPE heating may be an effective harm reduction technique. Studies of a corresponding harm reduction campaign are ongoing.

### Study Limitations

This study is subject to limitations that should be noted. First, as the focus of this study was on HIV transmission associated with injection drug use, some sexual risk factors for HIV were not fully investigated (eg, condomless sex, multiple partners, sex with a known HIV-positive patient, and commercial sex work). No patients were from an HIV-endemic country. Race in our cohort was reported as white or aboriginal because none of our participants were of African or Asian descent. This reflects the local epidemiology of our PWID community. Second, the exposure of interest (ie, IDPE sharing) was identified retrospectively, and so, the possibility of recall bias cannot be ruled out. However, it is notable that cases were no more likely to recall sharing of needles/syringes than controls, and thus, we do not believe that recall bias was leading cases to nonspecifically report more risky behaviors. Third, we did not differentiate between receptive sharing of IDPE (ie, using IDPE after another PWID had used it) and used IDPE donation (ie, giving used IDPE to another PWID). As risk of IDPE sharing was not widely recognized, most respondents in our study could not reliably remember the order of use, and those who reported IDPE sharing generally reported that both activities occurred. Finally, our study question related to “shared IDPE within 3 months” or “shared needles/syringes within 3 months,” to improve the reliability of reporting. We therefore cannot rule out that remote needle/syringe or IDPE sharing behaviors may have been different from recent patterns.

As 74% of HIV-positive cases were aware of their status before the study, it is possible that knowledge of HIV status may have influenced injection practices. However, given that individuals were largely unaware that sharing IDPE is a risk factor for HIV transmission, it is unlikely that HIV status influenced this practice. We demonstrated that percentage of participants reporting sharing of IDPE either alone or along with needle/syringes was increased in the HIV+ cohort. Although it is possible that knowledge of HIV status may have reduced needle syringe sharing, it would not be expected to have increased IDPE sharing, and so, we do not feel that reverse causality could have led to this effect. Furthermore, there is biological plausibility as noted in our accompanying article (Ball et al “Heating IDPE Used for Opioid Injection May Reduce HIV Transmission Associated with Sharing Equipment”), where we demonstrated that hydromorphone controlled-release (which was injected by 89% of our HIV+ patients) prolonged HIV survival within IDPE. Moreover, institution of an intervention to “cook your wash” (ie, heat the contents of the IDPE) was associated with a reduction in HIV incidence (Ball et al), suggesting that sharing the IDPE was important in HIV transmission in our context.

### Public Health Implications

We demonstrated that sharing of IDPE is strongly associated with HIV infection in the absence of needle/syringe sharing. HIV transmission associated with sharing IDPE may represent a novel mechanism of HIV transmission, which has not previously been described. As the popularity of injecting prescription opioids continues to increase,<sup>31,32</sup> the implementation of public health interventions that target IDPE sharing as a potential mechanism of HIV transmission may help to prevent and control future outbreaks.

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