HHS Public Access

Author manuscript

Int J Drug Policy. Author manuscript; available in PMC 2022 August 01.

Published in final edited form as:

Int J Drug Policy. 2021 August ; 94: 103198. doi:10.1016/j.drugpo.2021.103198.

Association of Skin Infections with Sharing of Injection Drug Preparation Equipment among People Who Inject Drugs

Raagini Jawa, M.D., M.P.H.[1], **Michael D. Stein, M.D.**[2,3], **Bradley Anderson, Ph.D.**[3], **Jane M. Liebschutz, M.D., M.P.H.**[4], **Catherine Stewart**[2], **Kristina T. Phillips, Ph.D.**[5], **Joshua A. Barocas, M.D.**[1,6]

[1]Section of Infectious Diseases, Boston Medical Center, Boston, MA USA

[2]Boston University School of Public Health, Boston, MA

[3]Behavioral Medicine and Addictions Research, Butler Hospital, Providence, RI

[4]Division of General Internal Medicine, Center for Research on Health Care, University of Pittsburgh, Pittsburgh, PA

[5]Center for Integrated Health Care Research, Kaiser Permanente Hawaii

[6]Boston University School of Medicine, Boston, MA

Abstract

Background: Sharing needles and injection drug preparation equipment (IDPE) among people who inject drugs (PWID) are well-established risk factors for viral transmission. Shared needles and IDPE may serve as bacterial niduses for skin and soft tissue infections (SSTI). Given the rising rates of SSTI in PWID, we investigated the association of needle and IDPE sharing on incidence of SSTI in a cohort of PWID.

Methods: Inpatient PWID (N=252) were recruited to a randomized controlled trial of an intervention aimed at reducing infections. The primary outcome was self-reported incidence of SSTI one-year post-hospitalization. In this secondary analysis, we assessed two variables: 1) sharing of IDPE alone, 2) sharing needles with or without IDPE, and compared these groups separately to persons who reported no sharing of needles or IDPE via a mixed-effects negative binomial regression model to estimate the effect of baseline sharing behavior on SSTI during follow-up via incidence rate ratios (IRR).

Corresponding Author: Raagini Jawa MD MPH, 801 Massachusetts Ave, 2nd floor, Boston, MA 02118, Phone: 603-966-8608, raagini.jawa@bmc.org.

Author Contributions: Dr. Jawa conceived of the study concept and drafted the manuscript. Dr. Barocas advised on all aspects of the study and contributed to manuscript preparation and revisions. Dr. Anderson conducted statistical analyses and reviewed drafts of the manuscript. Drs. Stein, Phillips, and Liebschutz, and Ms. Stewart advised on all aspects of the study and contributed to manuscript preparation and revisions. All authors approved the final version for publication.

Declaration of interests and Ethics Approval

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Results: Participant characteristics: 38 years [mean], 58% male, 60% White, 90% primarily injected opioids, 1.58 (± 2.35) mean SSTI in the year prior to baseline. In terms of sharing behavior, 29% didn't share needles or IDPE, 13% shared IDPE only, and 58% shared needles with or without IDPE three months prior to baseline. After adjusting for co-variables, PWID who shared IDPE alone had a 2.2 fold higher IRR of SSTI (95%CI 1.27; 3.85, $p = 0.005$) and PWID who shared needles with or without IDPE had a 3.31 fold higher IRR of SSTI (95%CI 2.04; 5.37, $p < 0.001$), compared to those who did not share any equipment. The number of SSTI at baseline was associated with an IRR of 1.20 of SSTI during follow-up (95%CI 1.09; 1.32, $p < 0.001$).

Conclusions: In this cohort of hospitalized PWID, we found a significant association between baseline sharing of IDPE alone and of sharing of needles with or without IDPE with one-year incidence of SSTI.

Keywords

injection drug use; bacterial infections; skin infection; injection equipment; harm reduction

INTRODUCTION

As the United States (U.S.) drug and overdose epidemic has expanded, skin and soft tissue infections (SSTI) among people who inject drugs (PWID) have nearly doubled between 2000 and 2010 (Ciccarone, Unick, Cohen, Mars, & Rosenblum, 2016). More than one-third of people who have ever injected drugs report a current or recent SSTI (Larney, Peacock, Mathers, Hickman, & Degenhardt, 2017) and nearly 75% report ever having a SSTI (Binswanger et al., 2008; Kerr, Tyndall, Li, Montaner, & Wood, 2005). Abscesses and cellulitis are the most common reasons PWID seek medical care (Murphy et al., 2001; Palepu et al., 2001) or are hospitalized (Bassetti, Hoffmann, Bucher, Fluckiger, & Battegay, 2002; Marks et al., 2013). Left inadequately treated or untreated, these infections pose a significant risk for invasive bacterial infections such as infective endocarditis, osteomyelitis, and necrotizing fasciitis, all of which increase morbidity, mortality, and healthcare costs (Gordon & Lowy, 2005; Salmon et al., 2009).

Given that most SSTI arise at recent injection sites, infections likely occur when commensal organisms such as bacteria or fungi are introduced into the skin from either contamination of injection equipment and/or the drug solution during the preparation, handling, or through the injection process (Raff & Kroshinsky, 2016). To decrease the incidence of SSTI, it is critical to understand the risk factors of non-sterile injection hygiene and practice so as to deploy appropriate public health interventions (Ball, Puka, et al., 2019). Studies have shown numerous socio-demographic and injection risk factors for SSTI among PWID including female gender, unstable housing, frequent injecting, injection of non-powder substances, drug contamination and non-sterile injection practices such as infrequent skin cleaning, licking or reuse of needles, or extra-vasal injections (Dahlman et al., 2017; Fink, Lindsay, Slymen, Kral, & Bluthenthal, 2013; Gordon & Lowy, 2005; Hope, 2010; Hope, Kimber, Vickerman, Hickman, & Ncube, 2008; Lloyd-Smith et al., 2005; Lloyd-Smith et al., 2008; Smith, Robinowitz, Chaulk, & Johnson, 2015). These infections can also arise from the use of contaminated injection equipment including needles and injection drug preparation equipment (IDPE) which includes rinse water, filters, cottons, and cookers. Cross sectional

studies have shown an association between needle sharing and prior SSTI (Dahlman et al., 2017; Doran et al., 2020). Harm reduction messaging regarding nonsterile needle use has led to declines nationally in needle sharing among PWID (Centers for Disease Control and Prevention, 2020); however, SSTIs remain on the rise suggesting a possible role of IDPE in infections.

Short-acting synthetic opioids such as fentanyl have been associated with higher injection frequency (Geddes, Iversen, Memedovic, & Maher, 2018), receptive syringe sharing (Lambdin et al., 2019) and thus likely lead PWID to share other injection equipment. PWID often re-solubilize residual drugs from used cookers and filters after an initial injection, allowing for multiple injections, sharing with other drug partners, and an increased risk of cross-contaminating IDPE and sterile needles (Ball, Puka, et al., 2019; M. Shah et al., 2020). Multiple studies have shown than sharing IDPE is more prevalent (Abadie, Welch-Lazoritz, Gelpi-Acosta, Reyes, & Dombrowski, 2016; Ball, Puka, et al., 2019; Broz et al., 2014; Koester, Glanz, & Baron, 2005; McCoy, Metsch, Chitwood, Shapshak, & Comerford, 1998; Tran et al., 2020; Zibbell, Hart-Malloy, Barry, Fan, & Flanigan, 2014) and may be perceived as less hazardous than sharing needles by PWID (Koester S., 1994); people who avoid needle sharing frequently report sharing IDPE several times a day (Ball, Puka, et al., 2019).

High frequency IDPE sharing has been shown to contribute to an increased cumulative risk of HIV and HCV compared to those who do not share (Ball, Puka, et al., 2019; Ball, Venner, et al., 2019; Hagan et al., 2001; Roy et al., 2012; S. M. Shah et al., 1996; Zibbell et al., 2015), but relatively little attention has been devoted to studying risk of SSTI. Studies in the United Kingdom and Australia have found that poor coverage of harm reduction services such as sterile injecting supplies contribute to the development of SSTI (Dunleavy, Hope, Roy, & Taylor, 2019; Dwyer et al., 2009; Hope, Ncube, Parry, & Hickman, 2015; Hope, Scott, et al., 2015). Reused IDPE have been shown to have bacterial contamination (Kasper et al., 2019). While sharing needles is associated with SSTI (Dahlman et al., 2017; Lloyd-Smith et al., 2008; Salmon et al., 2009), there is a gap in literature on the extent to which shared IDPE impacts the incidence of SSTI.

Given the rising incidence of SSTI in PWID in the U.S., understanding the risk of sharing IDPE for the development of SSTI is critical and may be useful in tailoring harm reduction interventions, informing clinical practice, and preventing future infections. We investigated the association of baseline needle and IDPE sharing practices on the incidence rate of self-reported SSTI in a cohort of hospitalized PWID followed for a year as part of a clinical trial.

METHODS

Study design

We conducted a prospective cohort study using data from the Skin and Needle Hygiene Intervention (SKIN) trial to examine the association between shared IDPE and incident SSTI.

Study participants

Hospitalized active PWID (N=252) were recruited from a large, academic safety-net hospital in Boston from January 2014 to June 2018. Participants completed a 90-minute baseline assessment and were then randomized to either the SKIN intervention (which included psychoeducation, motivational interviewing (MI), and skills training for skin cleaning and needle hygiene) or to usual care (Phillips, Stein, Anderson, & Corsi, 2012; Stein et al., 2020). Participants completed follow-up assessments of study outcomes (bacterial infections) up to 12 months post-hospitalization. Recruited individuals met the following eligibility criteria: 1) were 18 years or older, 2) reported injection drug use at least three times in the week prior to hospitalization, 3) did not report current psychosis or suicidality, 4) were able to speak English or otherwise provide consent, 5) could provide the names for at least two contact persons, and 6) did not plan to move out of Boston in the next year. The study was approved by the Boston University Medical Center Institutional Review Board.

Study Measures

For this analysis, baseline and follow-up data were used. The baseline interview included questions on age, years of education, employment status, and homelessness. In order to capture the diverse racial and ethnic background in our cohort, we included a question assessing self-identified race and ethnicity defined as people who identify as Latin American in the U.S (i.e, LatinX). Other questions assessed the frequency of injection drug use 90 days prior to baseline defined as the number of days injected times the average number of times a person injected on injection days. The Addiction Severity Index (ASI) Drug Module was used to assess the drugs (heroin, cocaine, other opiates, and methamphetamine) used and injected in the past 90 days (McLellan et al., 1992). Lifetime history of serious bacterial infections was defined as a composite of ever having had endocarditis, sepsis, osteomyelitis, or septic arthritis.

The primary dependent variable was incidence rate of self-reported SSTI at follow-up assessments at 1 week, and 1, 3, 6, 9, 12 months following initial hospitalization. The following SSTI definition was provided: “Skin infections include abscesses (red, hard-ish, infected lumps that contain pockets of pus), ulcers (open infected sores that look like a crater), and cellulitis (a more widespread skin infection) that occur at the injection site.”

We assessed two different independent variables from baseline enrollment: 1) sharing of IDPE only, 2) sharing needles with or without IDPE, and compared these groups separately to persons who reported not sharing IDPE or needles. These baseline variables were constructed using questions from three assessment measures: Bacterial Infections Risk Scale for Injectors (BIRSI) (Phillips, Anderson, Herman, Liebschutz, & Stein, 2017; Phillips & Stein, 2010), the HIV Risk Assessment Battery Drug sub scale (RAB) (Metzger, 1993) and Texas Christian University HIV/AIDS Risk Assessment (TCU) (Simpson, 1997). The RAB and TCU assess HIV risk, while the BIRSI examines high-risk practices associated with SSTI and other bacterial infections among PWID.

Sharing IDPE: Respondents were asked the number of times they had shared rinse water, cookers, and cottons/filters three months prior to baseline. A summed composite was used, with any value greater than zero denoting IDPE sharing.

Sharing Needles with or without IDPE: To establish participants who shared needles with or without IDPE, responses for four items were included: 1) injection with someone else's used needle, 2) the number of times they had used someone else's non-sterilized needles or syringes, 3) the number of times they had divided or shared drugs with others by "frontloading" (a method of sharing drugs by transferring contents from one syringe to another), and 4) any IDPE sharing (as defined above), in the three months prior to baseline. A summed composite was used, with any positive answer or value greater than zero denoting needle sharing with or without IDPE sharing.

Statistical analysis

We present descriptive statistics to summarize sample characteristics. We used a mixed-effects negative binomial regression model to estimate the effect of baseline sharing behavior on SSTI rates during follow-up. Co-variables included indicator variables for time of follow-up, treatment arm, age, gender, dichotomized race/ethnicity, number of SSTI reported at baseline, and total number of injections in the 3-months prior to baseline. Using the number of SSTI since last interviewed, we calculated the difference between the dates of the relevant follow-ups as the exposure variable. All confidence interval estimates and tests of significance were based on the robust Huber-White variance estimator. We used the Wald X^2 statistic to test the overall effect of sharing behavior. We report incidence rate ratios (IRR) and 95% confidence interval (CI) estimates. A p-value of <0.05 was considered statistically significant. All statistical analyses were performed in Stata 15.1 (StataCorp, 2019).

RESULTS

Baseline descriptive and drug use characteristics are noted in Table 1. Overall, 90% of participants reported their primary injection drug was opiates with a mean of 357.7 (± 414.0) injections in the 90 days prior to baseline (Table 1). On average, participants reported 1.58 (± 2.35) SSTI in the year prior to baseline. Approximately half (50.8%) of participants were randomized to the active SKIN intervention arm. At baseline, 28.6% of participants reported not sharing needles or IDPE, 13.1% reported sharing IDPE only, and 58.3% reported sharing needles with or without IDPE.

After adjusting for month of assessment, treatment arm, SSTI prior to baseline, and demographic characteristics, baseline IDPE sharing behavior was significantly associated with number of incident SSTI. Compared to those who did not share equipment, PWID who shared IDPE had a 2.21 (95%CI 1.27; 3.85, p = 0.005) times higher incidence rate of SSTI (Table 2). Relative to persons who did not share, the incidence rate of SSTI was about 3.31 (95%CI 2.04; 5.37, p < 0.001) times higher for those who shared needles with or without IDPE. The IRR of SSTI at follow-up was 1.50 (95%CI 0.88; 2.55, p = 0.13) for persons who shared needles with or without IDPE than those who shared only IDPE.

Number of SSTI reported at baseline was associated positively with the rate of infections during follow-up (IRR = 1.20, 95%CI 1.09; 1.32, $p < 0.001$). The rate of SSTI reported at follow-up was not associated significantly with the remaining co-variables.

DISCUSSION

In this study of hospitalized PWID, we detected a higher incidence rate of self-reported SSTI among those who shared IDPE alone or shared needles with or without IDPE compared to those who did not share any equipment. The findings are novel in that they are among the first to demonstrate the impact of shared injecting behaviors – both IDPE and needles - on the incidence rate of SSTI.

Descriptively, we found that participants more commonly reported sharing IDPE alone as compared to sharing needles alone. This is consistent with studies of other PWID populations that showed that IDPE sharing is more common than needle sharing (Abadie et al., 2016; Ball, Puka, et al., 2019; Broz et al., 2014; Koester et al., 2005; McCoy et al., 1998; Zibbell et al., 2014). McCoy et al. (1998) demonstrated that 17.5% of a PWID cohort shared IDPE only, while 8.6% shared needles only (McCoy et al., 1998). Given that PWID report retention of large amounts of non-solubilized drugs in IDPE after the first use, they also are likely to reuse and share IDPE without interval sterilization with products such as bleach (Roy et al., 2016). Additionally, PWID may more commonly share IDPE because it is perceived to be less hazardous (Koester S., 1994) and is considered a less infectious route for bacterial or viral pathogen transmission compared to shared needles (Ball, Puka, et al., 2019).

Persons who shared IDPE alone or needles with or without IDPE at baseline had significantly higher incidence rates of SSTI than persons who did not share equipment. A prior cross-sectional analysis by Dahlman and colleagues demonstrated that sharing needles was associated with a 6-fold increased likelihood of SSTI within the preceding 30 days (Dahlman et al., 2017). Our findings add to this body of literature by suggesting that IDPE sharing alone serves as an infectious risk factor for SSTI and furthermore, is associated with a greater than two-fold incidence of SSTIs. Additionally, when PWID shared needles with or without IDPE, the incident rate of SSTI was three times greater than PWID who did not share. Significantly, clinicians can use these findings to inform practice, emphasizing the importance of avoiding sharing both needles and IDPE as a harm reduction strategy to prevent SSTIs.

PWID with uncleaned skin may introduce bacteria into tissue or intravenously (Raff & Kroshinsky, 2016) and past work has shown that this practice is associated with SSTI risk (Dwyer et al., 2009; Fink et al., 2013; Larney et al., 2017; Smith et al., 2015). The SKIN trial sought to improve skin cleaning and other high-risk injection practices using a brief intervention. Individuals randomized to the intervention significantly increased skin cleaning prior to injecting over follow-up (Phillips et al., 2020). To account for intervention effects, we controlled for intervention group assignment in our final regression model. While the mechanism for incident SSTI among PWID is likely multifactorial, our results suggest that

sharing needles with or without IDPE or IDPE alone can serve as a bacterial nidus for incident SSTI.

Given SSTIs are associated with risk for infective endocarditis, osteomyelitis, and necrotizing fasciitis (Gordon & Lowy, 2005; Salmon et al., 2009), the risk of shared IDPE not only influences the risk of SSTI but also invasive bacterial infections. A recent case–control study among PWID in Ontario, Canada showed that those who did not use sterile IDPE were at nearly six times greater risk for infective endocarditis than those who did (M. Shah et al., 2020). Our findings add to the growing literature that access and use of sterile needles alone is insufficient to reduce injection-related infections; future harm reduction messaging ought to facilitate access and encourage use of sterile IDPE as well.

On average, more than fifty percent of participants reported sharing needles with or without IDPE. Despite the fact that most of our study participants were based in the greater Boston area where there are surrounding syringe service programs (SSPs) and pharmacies selling needles, they visited the SSP on average only 11 times in a 3-month period. Even in a region with access to harm reduction services, sharing behavior is impacted by systemic barriers to harm reduction engagement due to limited locations and hours of SSPs (Whiteman et al., 2020), stigma (Rivera, DeCuir, Crawford, Amesty, & Lewis, 2014), homelessness, lack of advanced injecting planning and preparation, and injecting during acute withdrawal (Phillips, 2016; Phillips, Altman, Corsi, & Stein, 2013). Even though we analyzed the infectious impact of sharing, we suspect that these same structural barriers may contribute to equipment reuse which too has been associated with history of SSTI (Wright et al., 2020). Given the magnitude of risk of SSTI from sharing of IDPE, along with expanding access to sterile supplies, it is critical to support the longitudinal endeavor of hygienic injection practice with practical training and effective risk reduction education that reinforces the importance of not sharing IDPE and needles over time. Presently, modeling studies in the U.S. suggest that there are over 220 counties in 26 states that are most vulnerable to HIV and HCV outbreaks among PWID given risk of unsterile injection drug use (Van Handel et al., 2016) and similarly at grave risk of SSTI. These vulnerable communities ought to be prioritized as target sites for federal SSP expansion so as to mobilize increased resources for needles and IDPE.

Furthermore, the legalization of safe injection facilities (SIFs) in the U.S. could provide a safe environment with sterile injection equipment where PWID can bring in previously obtained drugs and inject in the presence of medical staff. SIFs reduce HIV and HCV transmission by preventing needle-sharing (Bravo et al., 2009; Kerr, Kimber, Debeck, & Wood, 2007) and may also reduce seriousness of SSTI (Lloyd-Smith et al., 2010), and are therefore a cost-effective approach in averting complications from drug injection (Irwin et al., 2017). When SIFs are packaged with other harm reduction interventions such as opioid agonist therapy and naloxone, their beneficial impact has been shown to be additive (Irvine et al., 2019). Despite their numerous benefits, no sanctioned SIFs currently exist in the United States. Many political and philosophical barriers continue to impede implementation of harm reduction services, education, and provision of supplies in communities.

Among our cohort, 61% had an injection related index hospitalization (Stein et al., 2020), which is consistent with other work examining reasons for hospital admissions among PWID (Marks et al., 2013). Furthermore, our hospitalized cohort included over 40% female PWID, a higher proportion than most community based studies among PWID (Iversen, Page, Madden, & Maher, 2015). An acute hospitalization can serve as important touchpoints in which people – women in particular—can receive treatment in a safe space (Fairbairn, Small, Shannon, Wood, & Kerr, 2008). It is also an opportunity for clinicians to educate PWID on evidenced-based harm reduction strategies (Thakarar, Nenninger, & Agmas, 2020), providing sterile needles and IDPE kits, and linkage to community organizations with sterile supplies (Sharma, Lamba, Cauderella, Guimond, & Bayoumi, 2017). During an acute hospitalization, clinicians can review the risk of sharing IDPE and needles on the incidence of SSTI and find patient-centered practical strategies to reduce infectious complications of injection drug use. An example of a harm reduction strategy aimed at IDPE reuse could be to “cook your wash,” where clinicians can recommend heating cookers with remaining drug residual before aspiration, which has been shown to reduce HIV activation (Ball, Venner, et al., 2019) and bacterial contaminant burden (Kasper et al., 2019). Finally, a hospitalization can provide the opportunity to link PWID to medications for opioid use disorder or addiction treatment so as to reduce incidence of SSTI and frequency of injecting (Dunleavy et al., 2017; Liebschutz et al., 2014).

Several limitations warrant discussion. First, there are likely multiple steps that lead to SSTI in the administration of injection drugs and while we were able to control for several demographic and injecting behavioral risk factors, we were unable to measure them all such as type of drug used, presence of a drug contaminant, extra-vasal injections or licking of needles. Second, the number of incident SSTI were based on self-report (Darke, Kaye, & Ross, 2001), and under-reporting of risk behaviors cannot be excluded (Des Jarlais et al., 1999; Greenfield, Bigelow, & Brooner, 1995; Macalino, Celentano, Latkin, Strathdee, & Vlahov, 2002). Next, since this cohort was recruited from hospitalized PWID at a single urban treatment center in U.S., we may have included PWID more likely to have underlying health conditions that predispose them to infections or make them more likely to seek professional medical treatment, and therefore our findings may not generalize to the experience of SSTI in the PWID population as a whole (Salmon et al., 2009). Another limitation of this analysis is the inability to present changes in the extent of SSTI over time in the IDPE sharing group. This is an area that requires further research. Finally, we recognize that sharing behaviors can change over time and are contingent on many variables such as periods of access to harm reduction supplies, changes in preferred drug use, and access to substance use disorder treatment, thus causation between limited periods of drug use and incidence of SSTI cannot necessarily be inferred.

In conclusion, in this cohort of hospitalized active PWID, we detected a significant association between baseline sharing of IDPE only, or needles with or without IDPE and rate of SSTI during the year following discharge. Our results suggest the importance of ongoing access to injection equipment for PWID via expansion of SSPs and the urgent need to develop effective harm reduction risk education messages that stress the importance of using a new needle and new IDPE with each injection episode to minimize the risk of SSTI.

ACKNOWLEDGEMENTS

Role of Funding Source: This work was supported by the National Institute on Drug Abuse (R01DA034957 to M.D.S.; K01DA051684 to J.A.B; and R25DA033211 to R.J.), National Institute of Allergy and Infectious Diseases to (R25DA033211 and T32AI052074 to R.J). Neither NIDA nor NIAID had a further role in study design, in the collection, analysis and interpretation of data, or in the decision to submit the paper for publication.

References:

Abadie R, Welch-Lazoritz M, Gelpi-Acosta C, Reyes JC, & Dombrowski K (2016). Understanding differences in HIV/HCV prevalence according to differentiated risk behaviors in a sample of PWID in rural Puerto Rico. Harm Reduct J, 13, 10. doi:10.1186/s12954-016-0099-9 [PubMed: 26956029]

Ball LJ, Puka K, Speechley M, Wong R, Hallam B, Wiener JC, … Silverman MS (2019). Sharing of Injection Drug Preparation Equipment Is Associated With HIV Infection: A Cross-sectional Study. J Acquir Immune Defic Syndr, 81(4), e99–e103. doi:10.1097/QAI.0000000000002062 [PubMed: 31021986]

Ball LJ, Venner C, Tirona RG, Arts E, Gupta K, Wiener JC, … Silverman MS (2019). Heating Injection Drug Preparation Equipment Used for Opioid Injection May Reduce HIV Transmission Associated With Sharing Equipment. J Acquir Immune Defic Syndr, 81(4), e127–e134. doi:10.1097/QAI.0000000000002063 [PubMed: 31021987]

Bassetti S, Hoffmann M, Bucher HC, Fluckiger U, & Battegay M (2002). Infections requiring hospitalization of injection drug users who participated in an injection opiate maintenance program. Clin Infect Dis, 34(5), 711–713. doi:10.1086/338876 [PubMed: 11807681]

Binswanger IA, Takahashi TA, Bradley K, Dellit TH, Benton KL, & Merrill JO (2008). Drug users seeking emergency care for soft tissue infection at high risk for subsequent hospitalization and death. J Stud Alcohol Drugs, 69(6), 924–932. doi:10.15288/jsad.2008.69.924 [PubMed: 18925351]

Bravo MJ, Royuela L, De la Fuente L, Brugal MT, Barrio G, Domingo-Salvany A, & Itinere Project, G. (2009). Use of supervised injection facilities and injection risk behaviours among young drug injectors. Addiction, 104(4), 614–619. doi:10.1111/j.1360-0443.2008.02474.x [PubMed: 19215603]

Broz D, Wejnert C, Pham HT, DiNenno E, Heffelfinger JD, Cribbin M, … National, H. I. V. B. S. S. S. G. (2014). HIV infection and risk, prevention, and testing behaviors among injecting drug users -- National HIV Behavioral Surveillance System, 20 U.S. cities, 2009. MMWR Surveill Summ, 63(6), 1–51.

Ciccarone D, Unick GJ, Cohen JK, Mars SG, & Rosenblum D (2016). Nationwide increase in hospitalizations for heroin-related soft tissue infections: Associations with structural market conditions. Drug Alcohol Depend, 163, 126–133. doi:10.1016/j.drugalcdep.2016.04.009 [PubMed: 27155756]

Dahlman D, Hakansson A, Kral AH, Wenger L, Ball EL, & Novak SP (2017). Behavioral characteristics and injection practices associated with skin and soft tissue infections among people who inject drugs: A community-based observational study. Subst Abus, 38(1), 105–112. doi:10.1080/08897077.2016.1263592 [PubMed: 27897966]

Darke S, Kaye S, & Ross J (2001). Geographical injecting locations among injecting drug users in Sydney, Australia. Addiction, 96(2), 241–246. doi:10.1046/j.1360-0443.2001.9622416.x [PubMed: 11182868]

Des Jarlais DC, Paone D, Milliken J, Turner CF, Miller H, Gribble J, … Friedman SR (1999). Audio-computer interviewing to measure risk behaviour for HIV among injecting drug users: a quasi-randomised trial. Lancet, 353(9165), 1657–1661. doi:10.1016/s0140-6736(98)07026-3 [PubMed: 10335785]

Doran J, Harris M, Hope VD, Wright T, Edmundson C, Sinka K, & Heinsbroek E (2020). Factors associated with skin and soft tissue infections among people who inject drugs in the United Kingdom: A comparative examination of data from two surveys. Drug Alcohol Depend, 213, 108080. doi:10.1016/j.drugalcdep.2020.108080 [PubMed: 32526658]

Dunleavy K, Hope V, Roy K, & Taylor A (2019). The experiences of people who inject drugs of skin and soft tissue infections and harm reduction: A qualitative study. Int J Drug Policy, 65, 65–72. doi:10.1016/j.drugpo.2018.09.001 [PubMed: 30665085]

Dunleavy K, Munro A, Roy K, Hutchinson S, Palmateer N, Knox T, … Taylor A (2017). Association between harm reduction intervention uptake and skin and soft tissue infections among people who inject drugs. Drug Alcohol Depend, 174, 91–97. doi:10.1016/j.drugalcdep.2017.01.020 [PubMed: 28319754]

Dwyer R, Topp L, Maher L, Power R, Hellard M, Walsh N, … Aitken C (2009). Prevalences and correlates of non-viral injecting-related injuries and diseases in a convenience sample of Australian injecting drug users. Drug Alcohol Depend, 100(1-2), 9–16. doi:10.1016/j.drugalcdep.2008.08.016 [PubMed: 19013725]

Fairbairn N, Small W, Shannon K, Wood E, & Kerr T (2008). Seeking refuge from violence in street-based drug scenes: women's experiences in North America's first supervised injection facility. Soc Sci Med, 67(5), 817–823. doi:10.1016/j.socscimed.2008.05.012 [PubMed: 18562065]

Fink DS, Lindsay SP, Slymen DJ, Kral AH, & Bluthenthal RN (2013). Abscess and self-treatment among injection drug users at four California syringe exchanges and their surrounding communities. Subst Use Misuse, 48(7), 523–531. doi:10.3109/10826084.2013.787094 [PubMed: 23581506]

Geddes L, Iversen J, Memedovic S, & Maher L (2018). Intravenous fentanyl use among people who inject drugs in Australia. Drug Alcohol Rev, 37 Suppl 1, S314–S322. doi:10.1111/dar.12668 [PubMed: 29405465]

Gordon RJ, & Lowy FD (2005). Bacterial infections in drug users. N Engl J Med, 353(18), 1945–1954. doi:10.1056/NEJMra042823 [PubMed: 16267325]

Greenfield L, Bigelow GE, & Brooner RK (1995). Validity of intravenous drug abusers' self-reported changes in HIV high-risk drug use behaviors. Drug Alcohol Depend, 39(2), 91–98. doi:10.1016/0376-8716(95)01155-r [PubMed: 8529537]

Hagan H, Thiede H, Weiss NS, Hopkins SG, Duchin JS, & Alexander ER (2001). Sharing of drug preparation equipment as a risk factor for hepatitis C. Am J Public Health, 91(1), 42–46. doi:10.2105/ajph.91.1.42 [PubMed: 11189822]

Hope V (2010). Neglected infections, real harms: A global scoping of injected-related bacterial infections and responses. In The global state of harm reduction 2010-Key issues for broadening the response. London: International Harm Reduction Association. (pp. 89–95).

Hope V, Kimber J, Vickerman P, Hickman M, & Ncube F (2008). Frequency, factors and costs associated with injection site infections: findings from a national multi-site survey of injecting drug users in England. BMC Infect Dis, 8, 120. doi:10.1186/1471-2334-8-120 [PubMed: 18801177]

Hope VD, Ncube F, Parry JV, & Hickman M (2015). Healthcare seeking and hospital admissions by people who inject drugs in response to symptoms of injection site infections or injuries in three urban areas of England. Epidemiol Infect, 143(1), 120–131. doi:10.1017/S0950268814000284 [PubMed: 24568684]

Hope VD, Scott J, Cullen KJ, Parry JV, Ncube F, & Hickman M (2015). Going into the groin: Injection into the femoral vein among people who inject drugs in three urban areas of England. Drug Alcohol Depend, 152, 239–245. doi:10.1016/j.drugalcdep.2015.03.029 [PubMed: 25913887]

Irvine MA, Kuo M, Buxton JA, Balshaw R, Otterstatter M, Macdougall L, … Gilbert M (2019). Modelling the combined impact of interventions in averting deaths during a synthetic-opioid overdose epidemic. Addiction, 114(9), 1602–1613. doi:10.1111/add.14664 [PubMed: 31166621]

Irwin A, Jozaghi E, Weir BW, Allen ST, Lindsay A, & Sherman SG (2017). Mitigating the heroin crisis in Baltimore, MD, USA: a cost-benefit analysis of a hypothetical supervised injection facility. Harm Reduct J, 14(1), 29. doi:10.1186/s12954-017-0153-2 [PubMed: 28532488]

Iversen J, Page K, Madden A, & Maher L (2015). HIV, HCV, and Health-Related Harms Among Women Who Inject Drugs: Implications for Prevention and Treatment. J Acquir Immune Defic Syndr, 69 Suppl 2, S176–181. doi:10.1097/QAI.0000000000000659 [PubMed: 25978485]

Kasper KJ, Manoharan I, Hallam B, Coleman CE, Koivu SL, Weir MA, … Silverman MS (2019). A controlled-release oral opioid supports S. aureus survival in injection drug preparation equipment and may increase bacteremia and endocarditis risk. PLoS One, 14(8), e0219777. doi:10.1371/journal.pone.0219777 [PubMed: 31398210]

Kerr T, Kimber J, Debeck K, & Wood E (2007). The role of safer injection facilities in the response to HIV/AIDS among injection drug users. Curr HIV/AIDS Rep, 4(4), 158–164. doi:10.1007/s11904-007-0023-8 [PubMed: 18366946]

Kerr T, Tyndall M, Li K, Montaner J, & Wood E (2005). Safer injection facility use and syringe sharing in injection drug users. Lancet, 366(9482), 316–318. doi:10.1016/S0140-6736(05)66475-6 [PubMed: 16039335]

Koester S, Glanz J, & Baron A (2005). Drug sharing among heroin networks: implications for HIV and hepatitis B and C prevention. AIDS Behav, 9(1), 27–39. doi:10.1007/s10461-005-1679-y [PubMed: 15812611]

Koester S. HL (1994). "Indirect sharing": additional HIV risks associated with drug injection. AIDS and Public Policy Journal, 9, 100–105.

Lambdin BH, Bluthenthal RN, Zibbell JE, Wenger L, Simpson K, & Kral AH (2019). Associations between perceived illicit fentanyl use and infectious disease risks among people who inject drugs. Int J Drug Policy, 74, 299–304. doi:10.1016/j.drugpo.2019.10.004 [PubMed: 31733979]

Larney S, Peacock A, Mathers BM, Hickman M, & Degenhardt L (2017). A systematic review of injecting-related injury and disease among people who inject drugs. Drug Alcohol Depend, 171, 39–49. doi:10.1016/j.drugalcdep.2016.11.029 [PubMed: 28013096]

Liebschutz JM, Crooks D, Herman D, Anderson B, Tsui J, Meshesha LZ, … Stein M (2014). Buprenorphine treatment for hospitalized, opioid-dependent patients: a randomized clinical trial. JAMA Intern Med, 174(8), 1369–1376. doi:10.1001/jamainternmed.2014.2556 [PubMed: 25090173]

Lloyd-Smith E, Kerr T, Hogg RS, Li K, Montaner JS, & Wood E (2005). Prevalence and correlates of abscesses among a cohort of injection drug users. Harm Reduct J, 2, 24. doi:10.1186/1477-7517-2-24 [PubMed: 16281979]

Lloyd-Smith E, Wood E, Zhang R, Tyndall MW, Montaner JS, & Kerr T (2008). Risk factors for developing a cutaneous injection-related infection among injection drug users: a cohort study. BMC Public Health, 8, 405. doi:10.1186/1471-2458-8-405 [PubMed: 19068133]

Lloyd-Smith E, Wood E, Zhang R, Tyndall MW, Sheps S, Montaner JS, & Kerr T (2010). Determinants of hospitalization for a cutaneous injection-related infection among injection drug users: a cohort study. BMC Public Health, 10, 327. doi:10.1186/1471-2458-10-327 [PubMed: 20534148]

Macalino GE, Celentano DD, Latkin C, Strathdee SA, & Vlahov D (2002). Risk behaviors by audio computer-assisted self-interviews among HIV-seropositive and HIV-seronegative injection drug users. AIDS Educ Prev, 14(5), 367–378. doi:10.1521/aeap.14.6.367.24075 [PubMed: 12413183]

Marks M, Pollock E, Armstrong M, Morris-Jones S, Kidd M, Gothard P, … Doherty JF (2013). Needles and the damage done: reasons for admission and financial costs associated with injecting drug use in a Central London Teaching Hospital. J Infect, 66(1), 95–102. doi:10.1016/j.jinf.2012.10.004 [PubMed: 23068454]

McCoy CB, Metsch LR, Chitwood DD, Shapshak P, & Comerford ST (1998). Parenteral transmission of HIV among injection drug users: assessing the frequency of multiperson use of needles, syringes, cookers, cotton, and water. J Acquir Immune Defic Syndr Hum Retrovirol, 18 Suppl 1, S25–29. doi:10.1097/00042560-199802001-00006 [PubMed: 9663620]

McLellan AT, Kushner H, Metzger D, Peters R, Smith I, Grissom G, … Argeriou M (1992). The Fifth Edition of the Addiction Severity Index. J Subst Abuse Treat, 9(3), 199–213. doi:10.1016/0740-5472(92)90062-s [PubMed: 1334156]

Metzger D (1993). Risk Assessment Battery (RAB)1993. Retrieved from http://adai.washington.edu/instruments/pdf/Risk_Assessment_Battery_208.pdf

Murphy EL, DeVita D, Liu H, Vittinghoff E, Leung P, Ciccarone DH, & Edlin BR (2001). Risk factors for skin and soft-tissue abscesses among injection drug users: a case-control study. Clin Infect Dis, 33(1), 35–40. doi:10.1086/320879 [PubMed: 11389492]

Palepu A, Tyndall MW, Leon H, Muller J, O'Shaughnessy MV, Schechter MT, & Anis AH (2001). Hospital utilization and costs in a cohort of injection drug users. CMAJ, 165(4), 415–420. [PubMed: 11531049]

Phillips K, Stewart C, Anderson BA, Liebschutz JM, Herman DS, & Stein MD (2020). A randomized controlled trial of a brief behavioral intervention to reduce skin and soft tissue infections among people who inject drugs. DAD. (Under review).

Phillips KT (2016). Barriers to practicing risk reduction strategies among people who inject drugs. Addict Res Theory, 24(1), 62–68. doi:10.3109/16066359.2015.1068301 [PubMed: 27499724]

Phillips KT, Altman JK, Corsi KF, & Stein MD (2013). Development of a risk reduction intervention to reduce bacterial and viral infections for injection drug users. Subst Use Misuse, 48(1-2), 54–64. doi:10.3109/10826084.2012.722159 [PubMed: 23017057]

Phillips KT, Anderson BJ, Herman DS, Liebschutz JM, & Stein MD (2017). Risk Factors Associated With Skin and Soft Tissue Infections Among Hospitalized People Who Inject Drugs. J Addict Med, 11(6), 461–467. doi:10.1097/ADM.0000000000000346 [PubMed: 28767536]

Phillips KT, & Stein MD (2010). Risk practices associated with bacterial infections among injection drug users in Denver, Colorado. Am J Drug Alcohol Abuse, 36(2), 92–97. doi:10.3109/00952991003592311 [PubMed: 20337504]

Phillips KT, Stein MD, Anderson BJ, & Corsi KF (2012). Skin and needle hygiene intervention for injection drug users: results from a randomized, controlled Stage I pilot trial. J Subst Abuse Treat, 43(3), 313–321. doi:10.1016/j.jsat.2012.01.003 [PubMed: 22341554]

Prevention, C. f. D. C. a. (2020). HIV Infection Risk, Prevention, and Testing Behaviors among Persons Who Inject Drugs—National HIV Behavioral Surveillance: Injection Drug Use, 23 U.S. Cities, 2018. HIV Surveillance Special Report24.

Raff AB, & Kroshinsky D (2016). Cellulitis: A Review. JAMA, 316(3), 325–337. doi:10.1001/jama.2016.8825 [PubMed: 27434444]

Rivera AV, DeCuir J, Crawford ND, Amesty S, & Lewis CF (2014). Internalized stigma and sterile syringe use among people who inject drugs in New York City, 2010-2012. Drug Alcohol Depend, 144, 259–264. doi:10.1016/j.drugalcdep.2014.09.778 [PubMed: 25307745]

Roy E, Arruda N, Bertrand K, Dufour M, Laverdiere E, Jutras-Aswad D, … Bruneau J (2016). Prevalence and correlates of prescription opioid residue injection. Drug Alcohol Depend, 166, 69–74. doi:10.1016/j.drugalcdep.2016.06.025 [PubMed: 27397582]

Roy E, Arruda N, Leclerc P, Haley N, Bruneau J, & Boivin JF (2012). Injection of drug residue as a potential risk factor for HCV acquisition among Montreal young injection drug users. Drug Alcohol Depend, 126(1-2), 246–250. doi:10.1016/j.drugalcdep.2012.05.018 [PubMed: 22699096]

Salmon AM, Dwyer R, Jauncey M, van Beek I, Topp L, & Maher L (2009). Injecting-related injury and disease among clients of a supervised injecting facility. Drug Alcohol Depend, 101(1-2), 132–136. doi:10.1016/j.drugalcdep.2008.12.002 [PubMed: 19167171]

Shah M, Wong R, Ball L, Puka K, Tan C, Shojaei E, … Silverman M (2020). Risk factors of infective endocarditis in persons who inject drugs. Harm Reduct J, 17(1), 35. doi:10.1186/s12954-020-00378-z [PubMed: 32503573]

Shah SM, Shapshak P, Rivers JE, Stewart RV, Weatherby NL, Xin KQ, … McCoy CB (1996). Detection of HIV-1 DNA in needle/syringes, paraphernalia, and washes from shooting galleries in Miami: a preliminary laboratory report. J Acquir Immune Defic Syndr Hum Retrovirol, 11(3), 301–306. doi:10.1097/00042560-199603010-00010 [PubMed: 8603266]

Sharma M, Lamba W, Cauderella A, Guimond TH, & Bayoumi AM (2017). Harm reduction in hospitals. Harm Reduct J, 14(1), 32. doi:10.1186/s12954-017-0163-0 [PubMed: 28583121]

Simpson D (1997). The Texas Christian University HIV/AIDS Risk Assessment. Retrieved from https://www.emcdda.europa.eu/html.cfm/index4513EN.html

Smith ME, Robinowitz N, Chaulk P, & Johnson KE (2015). High rates of abscesses and chronic wounds in community-recruited injection drug users and associated risk factors. J Addict Med, 9(2), 87–93. doi:10.1097/ADM.0000000000000093 [PubMed: 25469653]

Stein MD, Phillips KT, Herman DS, Keosaian J, Stewart C, Anderson BJ, … Liebschutz J (2020). Skin-cleaning among hospitalized people who inject drugs: a randomized controlled trial. Addiction. doi:10.1111/add.15236

Thakarar K, Nenninger K, & Agmas W (2020). Harm Reduction Services to Prevent and Treat Infectious Diseases in People Who Use Drugs. Infect Dis Clin North Am, 34(3), 605–620. doi:10.1016/j.idc.2020.06.013 [PubMed: 32782104]

Tran LT, Peacock A, Colledge S, Memedovic S, Grebely J, Leung J, … Degenhardt L (2020). Injecting risk behaviours amongst people who inject drugs: A global multistage systematic review and meta-analysis. Int J Drug Policy, 84, 102866. doi:10.1016/j.drugpo.2020.102866 [PubMed: 32712484]

Van Handel MM, Rose CE, Hallisey EJ, Kolling JL, Zibbell JE, Lewis B, … Brooks JT (2016). County-Level Vulnerability Assessment for Rapid Dissemination of HIV or HCV Infections Among Persons Who Inject Drugs, United States. J Acquir Immune Defic Syndr, 73(3), 323–331. doi:10.1097/QAI.0000000000001098 [PubMed: 27763996]

Whiteman A, Burnett J, Handanagic S, Wejnert C, Broz D, & Group NS (2020). Distance matters: The association of proximity to syringe services programs with sharing of syringes and injecting equipment - 17 U.S. cities, 2015. Int J Drug Policy, 85, 102923. doi:10.1016/j.drugpo.2020.102923 [PubMed: 32920424]

Wright T, Hope V, Ciccarone D, Lewer D, Scott J, & Harris M (2020). Prevalence and severity of abscesses and cellulitis, and their associations with other health outcomes, in a community-based study of people who inject drugs in London, UK. PLoS One, 15(7), e0235350. doi:10.1371/journal.pone.0235350 [PubMed: 32663203]

Zibbell JE, Hart-Malloy R, Barry J, Fan L, & Flanigan C (2014). Risk factors for HCV infection among young adults in rural New York who inject prescription opioid analgesics. Am J Public Health, 104(11), 2226–2232. doi:10.2105/AJPH.2014.302142 [PubMed: 25211717]

Zibbell JE, Iqbal K, Patel RC, Suryaprasad A, Sanders KJ, Moore-Moravian L, … Prevention. (2015). Increases in hepatitis C virus infection related to injection drug use among persons aged </=30 years - Kentucky, Tennessee, Virginia, and West Virginia, 2006-2012. MMWR Morb Mortal Wkly Rep, 64(17), 453–458. [PubMed: 25950251]

Highlights

- Shared Injection drug preparation equipment (IDPE) is common in people who inject drugs
- Shared IDPE alone has a 2.2 fold higher incidence rate for skin infections
- Shared needles with or without IDPE has a 3.3 fold higher incident rate for skin infections
- Using a new needle and IDPE with each injection episode will reduce risk of skin infections

Table 1.

Baseline Characteristics of Hospitalized active PWID (n = 252)

	n (%)	Mean	SD
Age in Years		37.9	10.7
Gender (Male)	147 (58%)		
Race			
White	150 (60%)		
Black	52 (20%)		
Other	50 (20%)		
LatinX ethnicity	40 (16%)		
Years of Education	11.6		2.4
Homelessness *	157 (62%)		
Primary drug injected *			
Opiates	227 (90%)		
Cocaine	20 (8%)		
Methamphetamine	1 (0.4%)		
Other	4 (1%)		
Ever serious bacterial infection **	89 (35%)		
Number of SSTI *		1.58	2.35
Number of injections *		357.7	414.0
Randomized to SKIN Treatment Arm	128 (51%)		
Sharing Behavior *			
No Sharing	72 (29%)		
Needles Only	21 (8%)		
IDPE Only	33 (13%)		
Needles with or without IDPE	147 (58%)		

Abbreviations: IDPE, Injection drug preparation equipment; ; PWID, people who inject drugs; SSTI, skin and soft tissue infections; SKIN, Skin and Needle Hygiene Intervention.

* 90 days prior to baseline.

** Composite of lifetime history of sepsis, endocarditis, osteomyelitis, septic arthritis.

Table 2.

Mixed Effects Negative Binomial Regression Model Estimating the Adjusted Effects of Baseline Sharing Behaviors on Incidence Rate Ratio of SSTI During Follow-Up Months 1, 3, 6, 9, 12 (n = 213 Persons Observed on 669 Occasions)

		95% CI			
	IRR	**LCL**	**UCL**	**t**	**p =**
Month 1	1.37	0.55	3.41	0.68	0.498
Month 3	1.67	0.82	3.40	1.42	0.155
Month 6	1.67	0.82	3.38	1.42	0.155
Month 9	1.73	0.97	3.08	1.87	0.061
Month 12 [Reference]	1.00				
Randomized to SKIN Treatment Arm	0.67	0.36	1.22	−1.31	0.189
Number of SSTI at Baseline *	1.20	1.09	1.32	3.64	< 0.001
Number of injections at Baseline *	1.08	0.80	1.46	0.49	0.623
Years Age	1.02	0.98	1.05	0.80	0.422
Sex (Male)	0.80	0.39	1.66	−0.59	0.553
Race (White)	1.50	0.69	3.27	1.01	0.311
LatinX ethnicity (Yes)	1.24	0.55	2.80	0.52	0.603
Shared IDPE Only	2.21	1.27	3.85	2.79	0.005
Shared Needles with or without IDPE	3.31	2.04	5.37	4.85	< 0.001

Abbreviations: CI, confidence interval; IDPE, injection drug preparation equipment; IRR, incidence rate ratio; LCL, lower control limit; SKIN, Skin and Needle Hygiene Intervention; SSTI, skin and soft tissue infections; UCL, upper control limit.

Tests of significance and confidence interval estimates were based on the robust Huber-White variance estimator. The model adjusted for co-variables month of assessment, randomization of SKIN intervention, number of SSTI at baseline, and demographic characteristics of age, gender, race and ethnicity.

* 90 days prior to baseline.