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A comparison of syringe disposal practices among injection drug users in a city with versus a city without needle and syringe programs

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ABSTRACT

Background: The United States (U.S.) approved use of federal funds for needle and syringe programs (NSPs) in December 2009. This study compares syringe disposal practices in a U.S. city with NSPs to a U.S. city without NSPs by examining the prevalence of improperly discarded syringes in public places and the self-reported syringe disposal practices of injection drug users (IDUs) in the two cities.

Methods: We conducted visual inspection walkthroughs in a random sample of the top-quartile of drug-affected neighborhoods in San Francisco, California (a city with NSPs) and Miami, Florida (a city without NSPs). We also conducted quantitative interviews with adult IDUs in San Francisco ($N = 602$) and Miami ($N = 448$).

Results: In the visual inspections, we found 44 syringes/1000 census blocks in San Francisco, and 371 syringes/1000 census blocks in Miami. Survey results showed that in San Francisco 13% of syringes IDUs reported using in the 30 days preceding the study interviews were disposed of improperly versus 95% of syringes by IDUs in Miami. In multivariable logistic regression analysis, IDUs in Miami had over 34 times the adjusted odds of public syringe disposal relative to IDUs in San Francisco (adjusted odds ratio = 34.2, 95% CI = 21.92, 53.47).

Conclusions: We found eight-fold more improperly disposed syringes on walkthroughs in the city without NSPs compared to the city with NSPs, which was corroborated by survey data. NSPs may help IDUs dispose of their syringes safely in cities with large numbers of IDUs.

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1. Introduction

In 2009, injection drug users (IDUs) accounted for 9% of the 48,100 new HIV infections in the U.S. (Prejean et al., 2011). In 2007, 15% of the 43,000 new Hepatitis B Virus infections and 44% of the 17,000 new Hepatitis C Virus infections in the U.S. were among persons who reported drug injection as a risk factor (Daniels et al., 2009). Many IDUs contract these viral infections through the sharing of contaminated syringes. Furthermore, although uncommon, the possibility of viral transmission to non-IDUs through accidental needle-sticks exists from unsafely disposed contaminated syringes in community settings (Alter, 1994; Hanrahan and Reutter, 1997; Jayanth et al., 2009). In response to these viral epidemics, needle and syringe programs (NSPs) have been implemented in many

countries including the U.S. (Mathers et al., 2010). These programs allow IDUs to dispose of contaminated syringes and receive sterile syringes, with the goal of reducing the likelihood of IDUs' sharing used syringes and community members being exposed to unsafely disposed contaminated syringes. Many studies have shown that NSPs help to reduce both the sharing of syringes and HIV infection among IDUs (Watters et al., 1994; Neaigus et al., 2008; Woodak and Cooney, 2006).

The first NSPs in the U.S. opened in the late 1980s in Boston, MA, and Tacoma, WA, followed shortly by a program in San Francisco, CA, which opened in November of 1988 (Hagan et al., 1991). The North American Syringe Exchange Network estimates that there are currently almost 200 NSPs operating in the U.S. (Guardino et al., 2010). In December of 2009, U.S. President Barack Obama signed a bill authorizing the use of federal dollars for NSPs. This signing marked the end of a 21-year long Congressional ban on NSPs instituted at the height of the AIDS epidemic (Kerlikowske and Crowley, 2010). One of the claims of NSP opponents had been that NSPs might increase, rather than decrease, the number of unsafely disposed

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contaminated syringes in neighborhoods, thereby exposing unsuspecting community members, including children, to viral infections through accidental needle-stick injuries (Golub et al., 2005; Lewis et al., 2002; Springer et al., 1999).

There are relatively few studies of syringe disposal among IDUs, especially as it pertains to NSPs (Coffin et al., 2007; Doherty et al., 1997, 2000; Guydish et al., 1991; Khoshnood et al., 2000). Bluthenthal et al. (2007) found that among 24 NSPs in California in 2003, IDUs reported no increased unsafe disposal in areas where NSPs were providing more syringe coverage. In 2008, members of our study team conducted a study in which we counted syringes on the streets and interviewed IDUs about disposal practices in San Francisco, which has four NSPs (Wenger et al., 2011). One important and unanswered question is whether disposal practices are different in cities with and without NSPs. No studies of which we are aware have compared the prevalence of unsafely disposed syringes in a city with NSPs to a city without NSPs. Furthermore, there have been very few studies that have empirically assessed the prevalence of unsafely discarded syringes (Wenger et al., 2011; Nyiri et al., 2004; de Montigny et al., 2010; Riley et al., 1998). Within this context, we compared syringe disposal practices in a U.S. city with NSPs (San Francisco) to a U.S. city without NSPs (Miami) by examining (1) the prevalence of improperly discarded syringes in public places and (2) the self-reported syringe disposal practices among IDUs in the two cities.

2. Methods

2.1. Two study cities

In order to compare syringe disposal practices among IDUs in San Francisco and Miami, we conducted visual inspection walkthroughs and interviewed IDUs in each city. This study was first conducted in San Francisco in 2008, the methods and results of which have been previously published (Wenger et al., 2011). To be able to compare data across cities, we replicated the methods of that study in Miami in 2009.

San Francisco and Miami metropolitan areas have sizable IDU populations with estimates in San Francisco of 24,582 IDUs and 10,529 IDUs in Miami (Friedman et al., 2004). San Francisco has a population of approximately 798,000 and the City of Miami has approximately 350,000 residents (U.S. Census Bureau, 2008). HIV prevalence estimates among IDUs are 11.7% in San Francisco and 22.8% in Miami (Tempalski et al., 2009). Furthermore, while there are four NSPs that provide an estimated 2.4 million sterile syringes annually in San Francisco, NSPs are expressly forbidden by law in Miami (Huriaux, 2010; The Florida Statutes, 2011). Two NSPs in San Francisco utilize a syringe access model called “one-for-one plus” and two NSPs utilize a “distribution” syringe access model. The policy of “one-for-one plus” NSPs is to give clients a few more syringes than were disposed, whereas “distribution” NSPs give clients the number of syringes they request, regardless of number of syringes that were disposed (Kral et al., 2004). California’s Disease Prevention Demonstration Project, enacted in 2005, authorizes pharmacies to provide up to 10 syringes to adults without a prescription (California Senate Bill 1159, 2005). In Miami, the Florida Statutes forbid the transfer of a syringe to a person known to inject illegal drugs (The Florida Statutes, 2011). There are no coordinated efforts in San Francisco or Miami for syringe cleanup in drug-affected areas. Current street sweeping and litter removal policies are similar in both cities (San Francisco Department of Public Works, 2011a,b; City of Miami Solid Waste Department, 2011a,b).

2.2. Visual inspection walkthroughs

We chose to conduct visual inspection walkthroughs in a quarter of neighborhoods in each city, representing those with the highest concentration of drug use. To assess which neighborhoods represented the top quartile of drug-affected areas, we used data furnished by each city to map arrests and drug treatment admissions by neighborhood using ArcGIS Software (version 9.3; Redlands, CA). In San Francisco, we selected 11 of 44 neighborhoods totaling 2114 census blocks. In Miami, we selected 59 of 258 neighborhoods totaling 1769 census blocks. (The Florida Department of Children and Families only releases drug treatment data by zip code. Miami drug-affected neighborhoods were determined by Miami Police Department narcotics-related arrest data.) We then used SPSS (version 17.0; Chicago, IL) to select a random sample of 1000 census blocks for inspection in San Francisco and 885 census blocks for inspection in Miami. A census block is an area of land bounded on all sides by streets or other visible features such as a highway, railroad track or water. In San Francisco, only one side of each census block was randomly selected for inspection. In Miami, all four sides of each census block were inspected. To mathematically adjust for having inspected all four sides of the census block in Miami and

only one side in San Francisco, we simply multiplied the number of found syringes in San Francisco by four. The random selection of census block sides in San Francisco included both long and short census block sides.

Each census block was visually inspected once for discarded syringes. All publicly accessible areas including sidewalks, gutters, grassy areas, alleys and parking lots were inspected. All inspection was visual and the environment was not altered. For each syringe encountered, the location was immediately recorded on a handheld device. With ArcGIS, the intersection closest to each found syringe was geocoded in both cities. This component of the study was exempt from human subjects research.

2.3. Quantitative survey of IDUs

To examine syringe disposal practices among IDUs, we conducted quantitative interviews with IDUs in the two study cities ($N=602$ in San Francisco in 2008 and $N=448$ in Miami in 2009). IDUs in both cities were recruited from neighborhoods known to have high levels of injection drug use using targeted sampling (TS) in San Francisco and respondent-driven sampling (RDS) in Miami (Bluthenthal and Watters, 1995; Watters and Biernacki, 1989; Magnani et al., 2005). RDS and TS have been shown to yield samples similar in demographics (age, race, sex, and drug of choice) and similar to Census and HIV surveillance data across multiple cities (Kral et al., 2010; Robinson et al., 2006). IDUs in San Francisco were not recruited from NSPs, though many IDUs reported having used an NSP. Eligibility criteria for participation in the quantitative interviews were (1) recent injection of illicit drugs as verified by checking for signs of recent venipuncture or assessing knowledge of injection practices; (2) age 18 years or older; and (3) ability to provide informed consent. Trained interviewers conducted computer-assisted personal interviewing in confidential settings. The survey questionnaire included items on demographic characteristics as well as syringe disposal practices. This component of the study was approved by the Institutional Review Boards at RTI International, the University of Miami, and the Florida Department of Health.

2.4. Measures

We assessed syringe disposal practices of IDUs in two ways. First we asked participants “In the last 30 days, have you gotten rid of or disposed of used syringes. . . (a) in a public place (alleys; parks; bushes; bridges; canals; railroad tracks; parking lot; street, public trash); (b) by selling them or giving them away; (c) by putting them in the trash at home or another person’s home or hotel room; (d) at a needle exchange program; (e) at a hospital clinic; (f) at a pharmacy; (g) using a sharps container; (h) at some other place (specify).” The interviewers gave no instructions so the responses may not have been mutually exclusive. For each affirmative answer, we asked the follow-up question “in the last 30 days, how many syringes did you dispose of using each of the methods “a” through “h.” The responses to these questions indicating the number of syringes disposed by an individual were summed by each method for all participants. We defined improper disposal as any disposal of syringes in a public place, by selling them or giving them away, by putting them in the trash at home or another person’s home or hotel room, in the sewer, or by flushing. We defined safe disposal as syringe disposal at an NSP, hospital, clinic or pharmacy, and using a sharps container or public disposal box. We ascertained the proportion of improperly disposed syringes by dividing the number of syringes disposed of improperly by the total number of disposed syringes.

2.5. Statistical analyses

2.5.1. Visual inspection walkthroughs. The number of syringes was normalized to syringe density and syringe prevalence to facilitate comparison between the two cities. We defined syringe prevalence as the number of syringes per 1000 population living in inspected census blocks. We defined syringe density as the number of syringes per 1000 census blocks in the sample.

2.5.2. Quantitative survey of IDUs. The demographic differences and difference in the percentages of participants disposing in a particular location were tested for site differences using a Chi-squared test. In order to determine site differences in the rate of public disposal, a multivariable logistic regression model was developed; independent variables included site and demographic variables. The adjusted odds ratios (AOR), 95% confidence intervals (CI) and p -value for the site differences and each demographic group were calculated using SAS release 9.13 Service Pack 4 (SAS Institute Inc., Cary, NC).

3. Results

3.1. Prevalence of improperly discarded syringes from visual inspection walkthroughs

The locations of improperly discarded syringes in San Francisco and Miami are presented in Fig. 1A and B. We found 11 syringes in our inspections in San Francisco and 328 in our inspections in



Fig. 1. (A) Locations of found syringes, San Francisco, CA. (B) Locations of found syringes, Miami, FL.

Miami. The number of syringes found in San Francisco was multiplied by 4 to extrapolate to the entire census block and facilitate comparison between the 2 cities. In San Francisco, the syringe density was 44/1000 census blocks and the syringe prevalence was 0.3/1000 people in the census blocks inspected. In contrast, in Miami the syringe density was 371/1000 census blocks and the syringe prevalence was 4.9/1000 people in the census blocks inspected.

3.2. Syringe disposal practices reported by IDUs in quantitative survey

Demographic characteristics are presented in Table 1. The majority of respondents in San Francisco and Miami were male and over 40 years of age. Respondents in San Francisco were less likely to be Hispanic (10% vs. 40%, $p < 0.001$) and more likely to be homeless (69% vs. 50%, $p < 0.001$) than respondents in Miami. Fifteen percent of IDUs in San Francisco and 10% of IDUs in Miami self-reported being HIV positive ($p < 0.05$).

Eleven percent of IDUs in San Francisco reported having disposed of syringes in the past 30 days in a public place compared to 69% of IDUs in Miami ($p < 0.001$) (Table 1). Sixty-five percent of IDUs in San Francisco reported any improper disposal in the past 30 days versus 97% of IDUs in Miami ($p < 0.001$). Overall, in San Francisco, 13% (8474 of 64,259) of syringes disposed by IDUs in the past 30 days were disposed of improperly (Table 2). In Miami, 95% (9845 of 10,379) of syringes disposed by IDUs in the past 30 days were disposed of improperly. In San Francisco, 1% (718) of syringes were disposed of in a public place, whereas in Miami 45% (4689) of syringes were disposed of in a public place. In San Francisco, 80% (53,143) of all syringes were disposed at NSPs. No syringes in Miami were disposed at an NSP. In the multivariable logistic regression analysis, after adjusting for age, gender, homelessness, and self-reported HIV seropositivity, IDUs in Miami had over 34 times

Table 1
 Demographic characteristics of injection drug users in San Francisco (2008) and Miami (2009) and self-reported syringe disposal locations.

	San Francisco (N = 602) (%)	Miami (N = 448) (%)	p Value
Biological sex			
Male	73	79	0.045
Female	26	21	
Intersex	<1	0	
Race/ethnicity			
White (Non-Hispanic)	44	23	<0.001
Black (Non-Hispanic)	37	36	
Hispanic	10	40	
Native American	4	1	
Asian or Pacific Islander	<1	1	
Multiple Races/Other	5	0	
Age (years)			
18–29	6	8	0.009
30–39	18	20	
40–49	41	31	
50+	35	41	
Currently homeless	69	50	<0.001
HIV-positive (self report)	15	10	0.014
Syringe disposal locations			
Public place	11.0	68.7	<0.001
Selling/giving away	12.7	12.6	0.979
Trash	52.5	66.2	<0.001
NSP	61.5	0	–
Hospital or clinic	11.5	1.6	<0.001
Pharmacy	1.2	0	–
Sharps container	2.3	3.8	<0.077
Flush down the toilet	15.0	2.0	<0.001
Public disposal box	7.0	0	–
Sewer/manhole	3.7	4.5	0.496
Any improper disposal	64.8	96.6	<0.001

Table 2
Number of syringes disposed in the past 30 days as reported by injection drug users in San Francisco (2008) and Miami (2009).

	San Francisco (%)	Miami (%)
Public place	718 (1.1)	4689 (45.2)
Selling/giving away	680 (1.1)	675 (6.5)
Trash	5865 (9.1)	4004 (38.6)
NSP	53,143 (82.7)	0 (0.0)
Hospital or clinic	1049 (1.6)	200 (1.9)
Pharmacy	220 (0.3)	0 (0.0)
Sharps container	238 (0.4)	334 (3.2)
Public disposal box	1135 (1.8)	0(0.0)
Sewer/manhole	136 (0.2)	234(2.2)
Flush down the toilet	1026 (1.6)	163(1.6)
Other	49 (0.1)	80 (0.8)
Total syringes improperly disposed	8474 (13.2)	9845 (94.9)
Total syringes disposed	64,259	10,379

Table 3
Self-reported disposal of syringes in a public place: adjusted odds ratios and 95% confidence intervals.

	Adjusted odds ratio	95% CI
Miami versus San Francisco	34.234	(21.920, 53.467)
Female (vs. Male)	0.599	(0.395, 0.907)
Age (years)	0.973	(0.955, 0.992)
Homeless	4.958	(3.296, 7.457)
HIV positive	1.391	(0.845, 2.289)
Race/Ethnicity		
Black	1.000	
White	1.640	(1.048, 2.567)
Other	1.298	(0.563, 2.991)
Hispanic	1.764	(1.090, 2.856)

Note: n = 1036.

the adjusted odds of public syringe disposal relative to IDUs in San Francisco (adjusted odds ratio (AOR) = 34.2, 95% CI = 21.92, 53.47) (Table 3). Those homeless had almost 5 times the adjusted odds of public disposal (AOR = 5.0, 95% CI = 3.30–7.46).

4. Discussion

This study is the first of which we are aware to compare the prevalence of improperly discarded syringes in a city with NSPs and a city without NSPs. We found eight times the number of syringes on walkthroughs in Miami as compared to San Francisco. Our survey of IDUs in both cities corroborated the walkthrough data, showing that IDUs in Miami are much more likely to dispose of syringes in public places than IDUs in San Francisco. The relative abundance of free syringes in San Francisco compared to Miami might suggest that IDUs in San Francisco possess and therefore dispose of more syringes over a given period of time. However, IDUs in San Francisco disposed of the majority of used syringes at NSPs. These results suggest that NSPs are a significant means of collecting used syringes and do not increase the amount of publically discarded used syringes. Coupled with results from prior studies showing that NSPs help reduce the risk of viral transmission among IDUs, this study suggests that NSPs may also help reduce the risk of transmission to community members at large.

The survey of IDUs in both cities showed that in Miami, IDUs have few alternatives for disposal other than in public areas or the trash—these methods accounted for 83.8% of disposed syringes in the quantitative survey. Any syringe thrown in the trash is both a public health risk to sanitation workers and the general public. Importantly, there were locations in which syringes had accumulated in large quantities in Miami. There were four locations in which there were greater than 10 syringes encountered. Proper disposal venues such as NSPs are needed along with education and social marketing of those venues to IDUs in Miami.

This study has several limitations. First, both the walkthroughs and the survey were conducted in two U.S. cities in two different years. While we control for key demographic characteristics, we may not have captured all important variation. Since both cities have similar street cleaning and litter removal policies and walkthroughs were conducted at random times, it is unlikely there was systematic under- or over-estimation of the syringe density as a result of cleanup. Secondly, visual inspection was not conducted of all blocks in these two cities, but rather a random sample of the areas of the cities that were likely most affected. Thirdly, the quantitative survey relied on self-reported data by study participants which has the potential of being biased by recall and social desirability. However, there is no reason to believe that this bias was differential in these two cities. Fourthly, while our survey field sites were located in neighborhoods with high numbers of IDUs in both cities, we cannot infer that the results generalize to other areas of the cities where syringe disposal behaviors may differ. Finally, while we utilized different sampling techniques, targeted sampling and respondent driven sampling, these two recruitment strategies are the most widely utilized methods for reaching community-based IDUs and have been shown to yield similar distribution of demographic and risk characteristics in four major U.S. cities including one of the study cities, San Francisco (Kral et al., 2010; Robinson et al., 2006). To address limitations of the individual study designs, we used a triangulation approach with a quantitative survey to corroborate the visual inspections.

Despite these limitations, this study provides important comparative data that demonstrates the potential value of NSPs in terms of providing a venue for safe syringe disposal. These findings add to the vast literature that shows the benefits of NSPs (Shalala, 1997) and demonstrate that cities such as Miami may benefit from implementation of NSPs to reduce the transmission of blood-borne diseases to IDUs and other community members.

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Contributors

Authors Tookes, Kral, Wenger, Martinez, Sherman, Forrest and Metsch designed the study. Author Tookes managed the literature review and summaries of previous related work. Authors Martinez and Sherman undertook the ArcGIS mapping. Author Tookes conducted the study in Miami. Authors Cardenas and Pereyra undertook the statistical analysis, and author Tookes wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

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References

- Alter, M.J., 1994. Occupational exposure to hepatitis C virus: a dilemma. *Infect. Control Hosp. Epidemiol.* 15, 742–744.
- Bluthenthal, R.N., Anderson, R., Flynn, N.M., Kral, A.H., 2007. Higher syringe coverage is associated with lower odds of HIV risk and does not increase unsafe disposal among syringe exchange program clients. *Drug Alcohol Depend.* 89, 214–222.
- Bluthenthal, R.N., Watters, J.K., 1995. Multimethod research from targeted sampling to HIV risk environments. *NIDA Res. Monogr.* 157, 212–230.
- California Senate Bill 1159, 2004. Disease Prevention Demonstration Project, Vascancellos, Statutes of 2004.
- City and County of San Francisco Department of Public Works, 2011a. Mechanical Street Sweeping Program. <http://sfdpw.org/index.aspx?page=322> (accessed 09.07.11).
- City and County of San Francisco Department of Public Works, 2011b. Community One-Stop: Litter. <http://sfdpw.org/index.aspx?page=1111> (accessed 09.07.11).
- City of Miami Solid Waste Department, 2011a. Street Sweeping. http://www.miamigov.com/solidwaste/pages/solidwaste_services/sweeping.asp (accessed 09.07.11).
- City of Miami Solid Waste Department, 2011b. Mayor's Clean Up Program. <http://www.miamigov.com/SolidWaste/pages/cleanup/default.asp> (accessed 09.07.11).
- Coffin, P.O., Latka, M.H., Latkin, C., Wu, Y., Purcell, D.W., Metsch, L., Gomez, C., Gourevitch, M.N., Inspire Study Group, 2007. Safe syringe disposal is related to safe syringe access among HIV-positive injection drug users. *AIDS Behav.* 11, 652–662.
- Daniels, D., Grytdal, S., Wasley, A., Centers for Disease Control and Prevention, 2009. Surveillance for acute viral hepatitis—United States, 2007. *MMWR Surveill. Summ.* 58, 1–27.
- de Montigny, L., Vernez Moudon, A., Leigh, B., Kim, S.Y., 2010. Assessing a drop box programme: a spatial analysis of discarded needles. *Int. J. Drug Policy* 21, 208–214.
- Doherty, M.C., Garfein, R.S., Vlahov, D., Junge, B., Rathouz, P.J., Galai, N., Anthony, J.C., Bellenson, P., 1997. Discarded needles do not increase soon after the opening of a needle exchange program. *Am. J. Epidemiol.* 145, 730–737.
- Doherty, M.C., Junge, B., Rathouz, P., Garfein, R.S., Riley, E., Vlahov, D., 2000. The effect of a needle exchange program on numbers of discarded needles: a 2-year follow-up. *Am. J. Public Health* 90, 936–939.
- Florida Statutes, 2011. Sections 893.145, 893.146, 893.147 (Chapter 893).
- Friedman, S.R., Tempalski, B., Cooper, H., Perlis, T., Keem, M., Friedman, R., Flom, P.L., 2004. Estimating numbers of injecting drug users in metropolitan areas for structural analyses. *J. Urban Health* 81, 377–400.
- Golub, E.T., Baretta, J.C., Mehta, S.H., McCall, L.D., Vlahov, D., Strathdee, S.A., 2005. Correlates of unsafe syringe acquisition and disposal among injection drug users in Baltimore, Maryland. *Subst. Use Misuse* 40, 1751–1764.
- Guardino, V., Des Jarlais, D.C., Arasteh, K., Johnston, R., Purchase, D., Solberg, A., Lansky, A., Lentine, D., 2010. Syringe exchange programs—United States, 2008. *MMWR* 59, 1488–1491.
- Guydish, J.R., Clark, G., Garcia, D., Downing, M., Case, P., Sorenson, J.L., 1991. Evaluating needle exchange: do distributed needles come back? *Am. J. Public Health* 81, 617–619.
- Hagan, H., Des Jarlais, D.C., Purchase, D., Reid, T., Friedman, S.R., 1991. The Tacoma syringe exchange. *J. Addict. Dis.* 10, 81–88.
- Hanrahan, A., Reutter, L., 1997. A critical review of the literature on sharps injuries: epidemiology, management of exposures and prevention. *J. Adv. Nurs.* 25, 144–154.
- Huriaux, E., 2010. Personal Communication from the Health Program Coordinator, HIV Prevention Section and Community Behavioral Health Services. Department of Public Health, San Francisco.
- Jayanth, S.T., Kirupakaran, H., Brahmadathan, K.N., Gnanaraj, L., Kang, G., 2009. Needle stick injuries in a tertiary care hospital. *Indian J. Med. Microbiol.* 27, 44–47.
- Kerlikowske, G., Crowley, J.S., 2010. Expanding Access to Evidence-Based Services for Injection Drug Users. whitehouse.gov. (accessed 07.26.10).
- Khoshnood, K., Blankenship, K.M., Pollack, H.A., Roan, C.T., Altice, F.L., 2000. Syringe source, use, and discard among injection-drug users in New Haven, Connecticut. *AIDS Public Policy J.* 15, 88–94.
- Kral, A.H., Anderson, R., Flynn, N.M., Bluthenthal, R.N., 2004. Injection risk behaviors among clients of syringe exchange programs with different syringe dispensation policies. *J. Acquir. Immune Defic. Syndr.* 37, 1307–1312.
- Kral, A.H., Malekinejad, M., Vaudrey, J., Martinez, A.N., Lovrick, J., McFarland, W., Raymond, H.F., 2010. Comparing respondent-driven sampling and targeted sampling methods of recruiting injection drug users in San Francisco. *J. Urban Health* 87, 839–850.
- Lewis, B.A., Koester, S.K., Bush, T.W., 2002. Pharmacists' attitudes and concerns regarding syringe sales to injection drug users in Denver, Colorado. *J. Am. Pharm. Assoc. (Wash.)* 42, S46–S51.
- Magnani, R., Sabin, K., Sidel, T., Heckathorn, D., 2005. Review of sampling hard-to-reach and hidden populations for HIV surveillance. *AIDS* 19, S67–S72.
- Mathers, B.M., Degenhardt, L., Ali, H., Wiessing, L., Hickman, M., Matick, R.P., Myers, B., Ambekar, A., Strathdee, S.A., 2010. HIV prevention, treatment and care services for people who inject drugs: a systematic review of global, regional and national coverage. *Lancet* 375, 1014–1028.
- Neaigus, A., Zhao, M., Gyarmathy, V.A., Cisek, L., Friedman, S.R., Baxter, R.C., 2008. Greater drug injecting risk for HIV, HBV and HCV infection in a city where syringe exchange and pharmacy syringe distribution are illegal. *J. Urban Health* 85, 309–322.
- Nyiri, P., Leung, T., Zuckerman, M.A., 2004. Sharps discarded in inner city parks and playgrounds—risk of bloodborne virus exposure. *Commun. Dis. Public Health* 7, 287–288.
- Prejean, J., Song, R., Hernandez, A., Ziebell, R., Green, T., Walker, F., Lin, L.S., An, Q., Mermin, J., Lansky, A., Hall, H.L., HIV Incidence Surveillance Group, 2011. Estimation of HIV incidence in the United States. *PLoS ONE* 6, e17502.
- Riley, E., Beilenson, P., Vlahov, D., Smith, L., Koenig, M., Jones, T.S., Doherty, M., 1998. Operation Red Box. A pilot project of needle and syringe drop boxes for injection drug users in East Baltimore. *J. Acquir. Immune Defic. Syndr. Hum. Retrovirol.* 18, S120–S125.
- Robinson, W.T., Risser, J., McHoy, S., Becker, A.B., Rehman, H., Jefferson, M., Griffin, V., Wolverson, M., Tortu, S., 2006. Recruiting injection drug users: a three-site comparison of results and experiences with respondent-driven and targeted sampling procedures. *J. Urban Health* 83, i29–i38.
- Shalala, D.E., 1997. Needle Exchange Programs in America: Review of Published Studies and Ongoing Research. Report to the Committee on Appropriations for the Departments of Labor, Health and Human Services, Education and Related Agencies, February 18, 1997.
- Springer, K.W., Sterk, C.E., Jones, T.S., Friedman, L., 1999. Syringe disposal options for injection drug users: a community-based perspective. *Subst. Use Misuse* 34, 1917–1934.
- Tempalski, B., Lieb, S., Cleland, C.M., Cooper, H., Brady, J.E., Friedman, S.R., 2009. HIV prevalence rates among injection drug users in 96 large US metropolitan areas, 1992–2002. *J. Urban Health* 86, 132–154.
- U.S. Census Bureau, 2006–2008. American Community Survey, 3-year estimates. Census.gov (accessed 07.26.10).
- Watters, J.K., Biernacki, P., 1989. Targeted sampling: options for the study of hidden populations. *Soc. Prob.* 36, 416–430.
- Watters, J.K., Estilo, M.J., Cark, G.L., Lorrwick, J., 1994. Syringe and needle exchange as HIV/AIDS prevention for injection drug users. *JAMA* 271, 115–120.
- Wenger, L., Martinez, A.N., Carpenter, L., Geckeler, D., Colfax, G., Kral, A.H., 2011. Syringe disposal among injection drug users in San Francisco. *Am. J. Public Health* 101, 484–486.
- Woodak, A., Cooney, A., 2006. Do needle syringe programs reduce HIV infection among injecting drug users: a comprehensive review of the international evidence. *Subst. Use Misuse* 41, 777–813.