



Syringe disposal among people who inject drugs before and after the implementation of a syringe services program



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ABSTRACT

Introduction: Due to the increase in people who use opioids in the US, there has been a steady increase in injection drug use. Without access to safe syringe disposal locations, people who inject drugs (PWID) have few options other than improper disposal, including in public places. In 2016, Florida's first legal Syringe Services Program (SSP) was established in Miami. This study aims to compare syringe disposal practices among PWID before and after the implementation of an SSP.

Methods: Visual inspection walkthroughs of randomly selected census blocks in the neighborhoods in the top quartile of narcotics-related arrests were conducted to assess improperly discarded syringes. Syringe location was geocoded in ArcGIS. Adult PWID pre-SSP (n = 448) and post-SSP (n = 482) implementation were recruited for a survey using respondent-driven sampling in Miami. A Poisson regression model was used to determine the adjusted relative risk (aRR) of improper syringe disposal pre- and post-SSP.

Results: A total of 191 syringes/1000 blocks were found post-implementation versus 371/1000 blocks pre-implementation, representing a 49% decrease after SSP implementation. In the surveys, 70% reported any improper syringe disposal post-SSP implementation versus 97% pre-SSP implementation. PWID in the post-implementation survey had 39% lower adjusted relative risk (aRR = 0.613; 95% CI = 0.546, 0.689) of improper syringe disposal as compared to pre-implementation.

Conclusions: There was a significant decrease in the number of improperly discarded syringes in public in Miami after the implementation of an SSP. Providing PWID with proper disposal venues such as an SSP could decrease public disposal in other communities.

1. Introduction

In 2017, there were 38,739 people diagnosed with HIV in the United States (U.S.) (CDC, 2018). Over nine percent of those diagnoses were accounted for by people who inject drugs (PWID) (CDC, 2018). Furthermore, injection drug use is the most common route of hepatitis C virus (HCV) transmission in the U.S. (CDC, 2018). From 2004 to 2014, the increasing incidence of acute HCV correlated to the corresponding rise in injection drug use during this time-period (Zibbell et al., 2018). It is well-established that needle-sharing among PWID is a major risk factor for contracting both HIV and HCV (CDC, 2018, 2018). However, needle-sticks from improperly disposed needles in public spaces rarely

pose a viral transmission risk to community members. The annual incidence of community-acquired needle-stick injuries in the U.S. is estimated to be 2000 per year with an annual cost of \$9.8 million to the healthcare system (Jason et al., 2013; Papenburg et al., 2008; Slinger et al., 2000; Thompson et al., 2003) and unnecessary exposure of affected individuals to post-exposure prophylaxis. Despite this burden, there have been very few studies conducted detailing the role of various public health syringe disposal interventions in reducing the prevalence of improperly discarded syringes (Tookes et al., 2012; Wenger et al., 2011; Quinn et al., 2014).

Many public health interventions have been implemented in an effort to decrease the incidence of improper syringe disposal. These

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interventions include establishing Syringe Services Programs (SSPs) and overdose prevention sites, passing state legislation designating pharmacies as permissible sites for PWID to access and properly dispose of syringes, designating community syringe disposal sites (Riley et al., 1998), and providing PWID with sharps containers and education (Cleland et al., 2006; Gosden et al., 1975; Kinnard et al., 2014).

The current literature suggests SSPs are effective at reducing needle sharing among PWID and decreasing the risk of HIV and HCV infection (Abdul-Quader et al., 2013; Wodak and Cooney, 2006). Nationally, hospitalizations related to injection drug use have increased in recent years causing significant morbidity from life-threatening infectious diseases (e.g., endocarditis) and resulting in surging healthcare expenditures (Ronan and Herzig, 2016; Fleishauer et al., 2017). Skin and soft tissue infections are common among PWID, especially those without adequate access to harm reduction supplies and education, and have also been increasing with the nationwide epidemic (Dahlman et al., 2015; Ciccarone et al., 2016); Dahlman et al., 2017; Smith et al., 2015). High-risk injection practices are associated with increased risk of these preventable infections, emphasizing the need for programs that promote safe injection practices through education and provision of clean equipment (Dahlman et al., 2008; Phillips et al., 2017).

By design, SSPs provide PWID access to clean syringes and proper syringe disposal. In one study, a city without an SSP (Miami, FL) was shown to have 8 times more improperly disposed needles than a city with multiple long-established SSPs (San Francisco, CA) (Tookes et al., 2012; Wenger et al., 2011). Furthermore, a recent study conducted in Los Angeles, CA, demonstrated that SSP utilization in the past 30 days was associated with decreased risk of improper syringe disposal, whereas access to syringes from a pharmacy in the past 6 months was correlated with increased risk of improper syringe disposal (Quinn et al., 2014). In New York, NY, implementation of pharmacy sales of syringes was not associated with an increased number of improperly discarded syringes in public (Fuller et al., 2002).

Miami-Dade County, Florida, continues to have the highest incidence of new HIV infections nationwide (2018). In response to reports of improperly discarded syringes in Miami, high healthcare expenditures related to injection drug use at the county safety-net hospital, increasing incidence of HIV, and surging number of opioid-caused deaths, the Florida Legislature passed the Infectious Disease Elimination Act, authorizing Florida's first legal SSP in July of 2016 (Tookes et al., 2015, 2012).

Prior to this investigation, to our knowledge, there have been few studies in a major U.S. city analyzing the changes in syringe disposal among PWID before and after the implementation of an SSP (Bluthenthal et al., 2007; Broadhead and Heckathorn, 1999; Doherty et al., 1997, 2000; Quinn et al., 2014). This study compares the prevalence of improperly disposed syringes in public spaces and self-reported syringe disposal among PWID in Miami before (2009) and after (2018) the implementation of an SSP.

2. Materials and methods

We conducted a serial cross-sectional study, replicating the methods from Tookes et al. (2012), to assess the differences between Miami in 2009 (pre-SSP) and Miami in 2018 (post-SSP). Visual inspection walkthroughs of Miami were conducted alongside structured interviews of PWID as part of the Center for Disease Control's National HIV Behavioral Surveillance (NHBS). Data were collected June to December of 2018 and compared to the previously published results of Miami in 2009¹⁴.

2.1. Visual inspection walkthroughs

Following the same methodological approach as Tookes et al. (2012), visual inspection walkthroughs were conducted among the census block groups with the highest quartile number of narcotics-

related arrests. Data provided by the Miami Police Department were mapped using ArcGIS Software (version 10.2; Redlands, CA). From the top quartile of census block groups, we randomly selected 775 census blocks for visual inspection walkthroughs. All four sides of each census block were inspected for improperly discarded syringes. Visual inspections were conducted in all publicly accessible areas, including sidewalks, alleys, parks and parking lots. All syringes that were found during the walkthroughs were photographed and geocoded via mobile phone in ArcGIS. Walkthroughs occurred from July to December of 2009 and August to December of 2018.

To examine the differences in syringe disposal practices among PWID, we conducted surveys of PWID in Miami at two time points pre- and post-SSP implementation (N = 448 in 2009 and N = 482 in 2018). As part of NHBS, respondent-driven sampling (RDS) was used to recruit participants. RDS has been shown to be an effective strategy for the recruitment of hidden populations involved in illegal behaviors (Lansky et al., 2007; Magnani et al., 2005; Malekinejad et al., 2008, 2011). Eligibility criteria included: (1) age 18 years or older; (2) injection of illicit drugs within the previous 12 months; and (3) informed consent. All data were collected via face-to-face interview and recorded electronically on a handheld assisted personal interviewing tablet computer. The interview application was developed using Questionnaire Development System software (QDS™ Version 2.6.1, NOVA Research Company, Bethesda, Maryland).

2.2. Ethics statement

The visual inspection walkthroughs were exempt from human subjects research. The quantitative surveys were approved by the Institutional Review Boards at the University of Miami (IRB#20,170,527) and the Florida Department of Health (IRB#2017-20-FDOH).

2.3. Measures

To compare results pre- and post- SSP implementation, we used the same syringe disposal measures that had been developed in Miami in 2009 (Tookes et al., 2012). This included asking how many syringes in the past 30 days had been disposed of (a) in a public place, (b) by selling or giving away, (c) in the trash, (d) at an SSP, (e) at a hospital/clinic, (f) at a pharmacy, (g) in a sharps container, or (h) other place. The main outcome variable was improper syringe disposal, which is defined as having disposed of a syringe in a public place, by selling them or giving them away, by putting them in the trash at home or another's home, in the sewer, or by flushing.

The outcome variable combined the counts of the improper methods of syringe disposal by summing them. Then that variable was dichotomized into no improper syringe disposal (no improper disposal methods) and improper disposal (≥ 1 improper disposal method reported).

2.4. Statistical analyses

2.4.1. Visual inspection walkthroughs

The number of syringes found in Miami in 2018 was standardized per 1000 census blocks in the sample. We also standardized the number of syringes per 1000 people living in the census blocks inspected.

2.4.2. Quantitative survey of PWID

We compared demographic and individual syringe disposal location variables by pre- and post-SSP implementation samples using chi-squared tests. Because the two samples were 9 years apart, it is not possible to use RDS-specific statistical methods (RDSAT). As such, the samples were not weighted to adjust for interdependence of study participants. A multivariable Poisson regression model with robust standard errors was used to assess the difference in self-reported

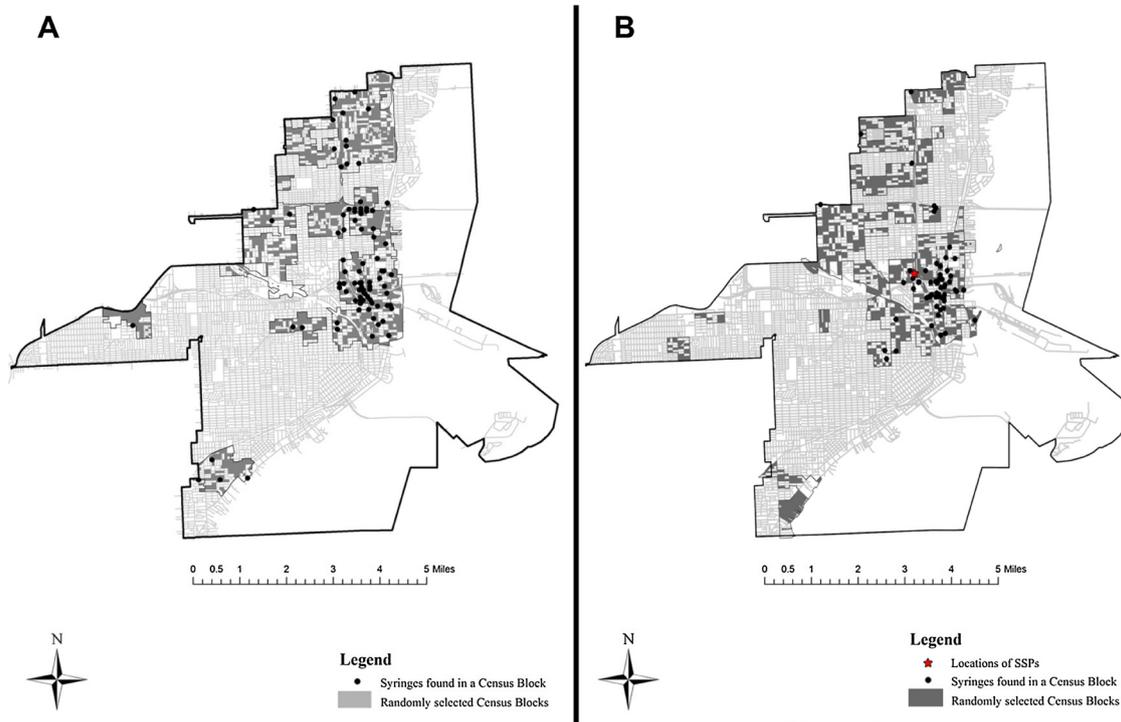


Fig. 1. Locations of publicly discarded syringes.
 A. Locations of found syringes in Miami, FL Pre-SSP (2009).
 B. Locations of found syringes in Miami, FL Post-SSP (2018).

improper disposal of syringes in 2009 and 2018, both unadjusted and adjusting for gender, race/ethnicity, ever HIV-positive, and current homelessness. Analyses were performed using SAS statistical software (Version 9.4; SAS Institute, Cary, NC). All tests were performed at a significance level of 0.05, and unadjusted (RR), adjusted relative risk ratios (aRR) and 95% confidence intervals (CI) were reported.

3. Results

3.1. Visual inspection walkthroughs and syringe density

There was a total of 149 syringes (191 per 1000 census blocks) found in Miami in 2018 compared to 328 syringes (371 per 1000 census blocks) found in Miami in 2009. This represents a 49% decrease in syringes found in public areas after the implementation of an SSP. The number of syringes found per 1000 people decreased from 4.9 in 2009 to 1.2 in 2018, representing a 75% decrease post-SSP. The locations of the syringes that were found in Miami in 2009 and 2018 are presented in Fig. 1. Each dot represents the location of an encountered syringe and can represent many syringes found within the census block.

3.2. Quantitative surveys

The demographic and syringe disposal practices in 2009 and 2018 are presented in Table 1. The sample in 2018 was significantly more likely to be non-Hispanic White (29% vs. 23%, $p = 0.004$), younger (49% younger than 40 vs. 28%, $p < 0.001$), and to report current homelessness (84% vs. 50%, $p < 0.001$).

In bivariate analysis, PWID in 2018 were significantly less likely to report disposal of syringes in a public place (49.1% vs. 68.7%, $p < 0.001$) and in the trash (31.3% vs. 66.2%, $p < 0.001$) compared to PWID in 2009. After the establishment of the SSP, 38.6% of PWID surveyed in 2018 reported syringe disposal at the SSP. Additionally, in 2018, PWID were significantly more likely to dispose of syringes in a sharps container (15.4% vs. 3.8%, $p < 0.001$) and sell/give away

Table 1

Demographic characteristics of people who inject drugs in Miami 2009 and 2018 and self-reported syringe disposal locations in the Past 30 days.

Variable	Miami 2009 (n = 448)	Miami 2018 (n = 482)	p-value
Biological Sex			0.766
Male	79%	77%	
Female	21%	23%	
Intersex	0%	0%	
Race/ethnicity			0.004
White (Non-Hispanic)	23%	29%	
Black (Non-Hispanic)	36%	29%	
Hispanic	40%	39%	
Native American	1%	2%	
Asian or Pacific Islander	1%	1%	
Multiple Races/Other	0%	1%	
Age (years)			< 0.001
18–29	8%	17%	
30–39	20%	32%	
40–49	31%	25%	
50+	41%	26%	
Currently homeless	50%	84%	< 0.001
HIV-positive (self-report)	10%	11%	0.788
Syringe Disposal Locations			
Public place	68.7%	49.1%	< 0.001
Selling/giving away	12.6%	23.3%	< 0.001
Trash	66.2%	31.3%	< 0.001
SSP	0%	38.6%	< 0.001
Hospital or clinic	1.6%	1.9%	0.802
Pharmacy	0%	0%	–
Sharps container	3.8%	15.4%	< 0.001
Other Location	6.5%	8.3%	0.293
Any improper disposal	96.6%	69.5%	< 0.001

syringes (23.3% vs. 12.6%, $p < 0.001$) than in 2009. Overall, PWID in 2018 were significantly less likely to report any improper disposal of syringes (69.5% vs. 96.6%, $p < 0.001$) than in 2009.

Of the total reported syringes disposed in the past 30 days, in 2018,

Table 2
Number of syringes disposed in the past 30 days as reported by people who inject drugs in Miami pre (2008) and post (2018) implementation of SSP.

Disposal Location	Pre-SSP (%)	Post-SSP (%)
Public Place	4,689 (45.2)	4095 (13.0)
Selling/giving away	675 (6.5)	1301 (4.1)
Trash	4,004 (38.6)	2356 (7.5)
Syringe Service Program	0 (0.0)	17,914 (57.0)
Hospital or clinic	200 (1.9)	128 (0.4)
Pharmacy	0 (0.0)	8 (0.03)
Sharps container	334 (3.2)	5029 (16.0)
Sewer/manhole	234 (2.2)	0 (0)
Flush down the toilet	163 (1.6)	208 (0.7)
Other	80 (0.8)	373 (1.2)
Total syringes improperly disposed	9845 (94.9)	7960 (25.3)
Total syringes disposed	10,379	31,412

Table 3
Self-reported improper disposal of syringes by people who inject drugs in Miami (n = 930).

Variable	RR	95% CI	aRR	95% CI
Miami Pre vs Post-SSP	0.705*	(0.66 – 0.755)	0.61*	(0.545 – 0.69)
Male (vs Female)	1.03	(0.95 – 1.11)	1.15	(0.985 – 1.34)
Age (years)	1.00	(1.00 – 1.01)	0.995	(0.99 – 1.00)
Race/Ethnicity				
White (vs Black)	0.88*	(0.81 – 0.96)	0.89	(0.76 – 1.05)
Other (vs Black)	0.78	(0.60 – 1.01)	0.83	(0.55 – 1.25)
Hispanic (vs Black)	0.95	(0.89 – 1.02)	1.03	(0.90 – 1.17)
Homeless	1.04	(0.975 – 1.11)	1.59*	(1.40–1.80)
HIV Positive	0.91	(0.815 – 1.02)	0.935	(0.78 – 1.125)

* significant at $p < 0.05$.

25.3% (7960 of 31,412) were improperly disposed of compared to 94.9% (9845 of 10,379) in 2009. In 2018, 17,914 (57%) and 5029 (16%) syringes were disposed of in an SSP or sharps container, respectively, compared to 0 (0%) and 334 (3.2%) in 2009 (Table 2).

In the multivariable Poisson regression (Table 3), after adjusting for gender, age, race/ethnicity, homelessness, and HIV-positive status, PWID in the post-implementation survey had 29.5% lower non-adjusted (RR = 0.705; 95% confidence interval [CI] = 0.659, 0.755) and 39% lower adjusted (aRR = 0.613; 95% CI = 0.546, 0.689) relative risk of improper syringe disposal compared to PWID in the pre-implementation survey. The regression model also revealed that those reporting current homelessness had increased adjusted relative risk of improper syringe disposal (aRR = 1.589, 95% CI: 1.400, 1.803).

4. Discussion

This study provides comparative data assessing syringe disposal in a city before and after the implementation of an SSP both through visual inspection walkthroughs and a quantitative survey. There were almost half of the number of syringes found discarded publicly in Miami after SSP implementation, at a time when there is a national Public Health Emergency due to the opioid overdose crisis. Importantly, the quantitative survey corroborated these findings, with PWID in 2018 significantly less likely to report that they improperly disposed of syringes. Public awareness of the nationwide opioid overdose crisis and acceptance of opioid use disorder as a disease could have contributed to better syringe disposal practices, but the decrease in improperly discarded syringes in public despite increased opioid use suggests the importance of the SSP in providing a venue for proper syringe disposal.

While only 38.6% of respondents in 2018 reported having used the SSP, 57% of syringes disposed by all respondents in the prior 30 days were disposed at the SSP. This suggests that the SSP provides safe disposal for not just the PWID who use the program. PWID who go to SSPs often exchange syringes for PWID who do not go to SSPs, thus

broadening the reach of SSPs (Lorvick et al., 2006). Additionally, the increase in syringe disposal in sharps containers is likely the result of widespread distribution of sharps containers at the SSP, suggesting that up to 73% of syringes were properly disposed in 2018 as a result of the SSP. Increasing the reach of the SSP through concerted mobile outreach in the areas identified with publicly discarded syringes should be prioritized in order to increase the number of syringes in circulation and simultaneously provide a venue for proper disposal (Iyengar et al., 2019; Kaplan and Heimer, 1994). This increased access to syringes has been shown to decrease syringe sharing and HIV infection among PWID (Bluthenthal et al., 2007). Importantly, visual inspection of blocks in Miami showed that there were 49% fewer improperly disposed syringes in public post-SSP implementation, despite the SSP's distribution of 149,989 syringes in 2018. These results support the findings of Tookes et al. (2012) that SSPs are a significant means of collecting of used syringes and do not increase the number of publicly discarded syringes.

Several potential limitations should be noted when interpreting the results of this study. First, the visual inspection study may have undercounted the number of publicly discarded syringes in 2018 because there may have been an increase in public works cleanup due to gentrification of parts of Miami. However, the visual inspection walkthroughs were not conducted in the same blocks during 2009 and 2018 but in the areas most affected by drug use at each point in time as reflected in Miami Police Department data. Furthermore, the survey data of PWID corroborated our visual inspection findings. Second, these findings may not generalize to all areas of the city or to other cities. Third, the results of the quantitative survey may have been impacted by social desirability or recall bias. However, it is important to note that these surveys were conducted as part of a Florida Department of Health and Centers for Disease Control surveillance, independent of the SSP or its staff. We conducted both quantitative surveys and walkthrough inspections in order to address the limitations of each individual study design.

5. Conclusion

There was a significant decrease in the number of improperly discarded syringes encountered through visual inspection of in Miami after the implementation of the SSP, a finding that was corroborated by quantitative surveys of PWID. Providing PWID proper disposal venues such as an SSP could decrease public syringe disposal in other communities where they are implemented while also reducing syringe sharing and its attendant risks for HIV and viral hepatitis transmission.

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Contributors

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All authors have contributed to and approved of the final article.

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