YOUNG INJECTION DRUG USERS IN NEW YORK CITY: UNDERSTANDING DEMOGRAPHIC AND BEHAVIORS FOR HARM REDUCTION PROGRAMMING

A Thesis

Presented to the Faculty of the Weill Cornell Graduate School

of Medical Sciences

in Partial Fulfillment of the Requirements for the Degree of

Masters of Science

by

Benjamin J. Eckhardt

May 2016

ABSTRACT

Background: The injection of illicit drug and illicit drug related overdose deaths continues to rise across the United States. In many parts of the country safe injection facilities are being considered to address the epidemic and confront outdoor and public injection. To better understand injection drug users who injection in public or outdoor locations, we examined the demographic and behavior correlates associated with this practice. Hepatitis C virus (HCV) infection remains a significant public health problem in the United States, with people who inject drugs disproportionately afflicted. Over the last decade rates of heroin use have increased, with young persons (18-25 years) demonstrating the largest increase.

Methods: We conducted a cross-sectional study in young people who currently injected illicit drugs (age 18-35 or ≤ 5 years of illicit drug injection) in the Lower East Side of New York City from 2005 to 2012 to examine the risk factors associated with public and outdoor injection drug use as well as antibodies to HCV among young adults who began injecting during the era of syringe services programs.

Results: Among the 714 participants enrolled, 53.9% of participants injected predominately in public and outdoor spaces and the prevalence of antibodies to HCV was 48.0%. The majority of participants identified as homeless (68.8%), white (74.5%), and male (68.3%). Characteristics independently associated with public and outdoor injection included homelessness, methamphetamine use, recent incarceration, and less hygienic injection practices. Risk factors independently associated with HCV seropositivity

included older age, more years injection, higher injection frequency, injecting crack/cocaine, history of overdosed, lacking confidence in being able to avoid HCV infection, using more used syringes, and injecting primarily in public/outdoors spaces.

Conclusion: Our findings indicate a substantial percentage of young injection drug users in the Lower East Side of New York City are injecting predominately in outdoor and public locations. These findings suggest that currently debated harm reduction interventions such as safe injection facilitates may be able to impact the negative consequences of injection illicit drug use. Despite access to needle exchange program in New York City, the seroprevalence of hepatitis C in young and recent injectors remains high. Risk factors associated with more active substance use (more years injecting) are a strongly associated with HCV infection. Additionally this is the first study to demonstrate an association between public and outdoor injection and hepatitis C infection. In light of the growing acceptance of supervised injection facilities in many cities around the world, studying the potential impact of these facilities on public and outdoor injection and HCV transmission could provide added evidence to support their implementation.

BIOGRAPHICAL SKETCH

Benjamin J. Eckhardt is a third-year Infectious Diseases Fellow at Weill Cornell Medical Center and concurrently a Fellow in Clinical Epidemiology and Health Services Research at Weill Cornell Graduate School of Medical Sciences. Through medical school (with the *Cornell HIV Clinical Trials Unit*) and during residency (with the *New York University – AIDS Clinical Trials Unit*) he has been involved in HIV-related research projects primary focusing on the metabolic complications of HIV and antiretroviral therapy. After residency Dr. Eckhardt worked for Partners in Health and Brigham and Women's Hospital, spending the majority of his time in Rwanda where he focused his non-clinical time on quality improvement and implementation projects around improving access to outpatient HIV and chronic diseases services through a decentralization of care model. As a research fellow at Weill Cornell Medicine he continues to be interested to the development of strategies to engage disadvantaged patient populations in care for their chronic infections. The development of new, safer, more effective Hepatitis C treatment has allowed for a re-assessment of the traditional care delivery model. His current research focus evaluates models of care to facilitating access, engagement, and retention of HCV-infected patients who inject drugs, and determine the long-term impact of this treatment intervention on rates of hepatitis C re-infection and transmission, as well as changes in injection and harm reductive practices.

ACKNOWLEDGMENTS

This study was funded by the National Institute on Drug Abuse, grant numbers R01 DA016159 and R01 DA021550. Additional support was provided from the Agency for Healthcare Research and Quality, grant number T32HS000066. The content of this publication is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute on Drug Abuse or the Agency for Healthcare Research and Quality.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREBIATIONS

HIV – Human immunodeficiency virus

HBV – Hepatitis B virus

HCV – Hepatitis C virus

NSP – Needle syringe program

OR – Odds ratio

AOR – Adjusted odds ratio

GED – Graduate equivalency degree

PWID – People who inject drugs

Ab - Antibody

CHAPTER ONE

CHARACTERISTICS OF YOUNG PUBLIC INJECTION DRUG USERS IN NEW YORK CITY: AN OBSERVATIONAL STUDY

CHAPTER ONE

INTRODUCTION

Injection of illicit drugs is associated with a myriad of serious threats, including overdose, skin and soft tissue infection, and transmission of blood-borne infections (including HIV, HBV, and HCV). Despite growing public awareness of injection drug use, illicit injection drug use continues to increase within the United States with heroin use increasing 63% between 2002 and 2013, and an even higher increase noted in individuals aged 18-25[1]. In New York City, 2014 marked the fourth consecutive year where heroin overdose deaths have increased[2]. This increase in overdoses has occurred despite New York City's extensive initiatives to distribute the overdose antidote, naloxone[3]. Risk factors that have been associated with non-fatal overdose include binge drug use, requiring help injecting, homelessness, and outdoor and public injection[4]. With the goal of reducing overdose deaths by decreasing public/outdoor injection drug use, several advocacy groups, including The New York Academy of Medicine, have recently called for the establishment of supervised injection facilities[5].

Harm reduction strategies aim to mitigate the negative consequences of drug use. Needle and syringe programs (NSPs) are one harm reduction intervention developed to decrease the transmission of blood-borne infections such as HIV, hepatitis B, and hepatitis C and have been instituted in 33 states, operating within 196 cities within the United States[6]. Supervised injection facilities were first established over a decade ago to offer a safe and hygienic environment for people to inject drugs under medical supervision with the goal

of decreasing overdoses, injection related infections, and public injection drug use. There are currently close to 100 supervised injection facilities around the world within 10 countries (Australia, Canada, Denmark, Germany, Greece, Luxembourg, the Netherlands, Norway, Spain, and Switzerland), however none in the United States[7]. Data from these facilities has demonstrated reduced public injecting[8], safer injecting practices of participants (e.g. less rushed injecting, safer needle and syringe disposal)[9,10], increased access to drug treatment[11,12], and a significant reduction in injection drug related overdoses in surrounding areas[13,14]. Additionally modeling studies have suggested that these facilities could reduce the transmission of blood-borne pathogens, such as HIV and Hepatitis C, by decreasing the sharing of used needles, syringes, and other injecting equipment[15,16]. However unproven fears of increasing crime, community drug use, or initiation of drug user have prevented implementation of these facilities in the United States and New York City specifically.

In New York City, prior data suggests that roughly half of injection drug users have injected in public in the last month with injection in public bathrooms, parks, stairwells and abandoned buildings being the most common sites[17]. If interventions to address public and outdoor injection (such as supervised injection facilities) are to be pursued, better understanding of the demographics and injection practices of potential clientele are needed to maximize their impact. The current study examines the demographics and injection practices of young individuals who predominately inject drugs in public or outdoor locations in New York City.

METHODS

Between 2005 and 2012 young people who inject drug were recruited, consented, interviewed, and screened for potential inclusion into the Swan Project, a prospective cohort study looking at the risk factors for the acquisition of new hepatitis C infection[18]. The Swan study recruited young injection drug users from the Lower East Side of Manhattan through outreach programs, NSP, and word-of-mouth. Subjects were eligible for the study if they were between 18 to 35 years of age or had ≤5 years of injection drug use history, and had injected illicit drugs in the 30 days before enrollment.

At enrollment, all participants completed a standardized questionnaire and underwent testing for hepatitis C antibody. The questionnaire included demographic information, past substance use history, and recent substance use practices. Substance use history included questions related to past substances used, age of initiation of drug use, drugs injected, baseline HIV and HCV knowledge, drug treatment history, and information about with whom, and when the participants first drug injection took place. Recent substance use practices questions included injection frequency, size of current injection network, frequency of sharing of needles and drug preparation equipment, current injection practices to prevent infection (i.e. how drugs were split, how used needles were cleaned before re-use, where the injection events took place), setting of injection drug use, and engagement in substance abuse treatment. Written consent was obtained from all subjects and the protocol was approved by the Weill Cornell Medical College Institutional Review Board. The demographics and drug use patterns were compared for participants who primarily injected in public or outdoor locations

with those that primarily injected in a private residence (personal, partners, friends, or relatives). Chi-squared testing was used to explore demographic characteristics and potential risk factors associated with public or outdoor injection. Multiple logistic regression analysis was performed to determine which demographic and behavioral characteristics were independently associated with primarily injecting in public or outdoor locations. Collinearity of variables was assessed prior to model development and in cases where the Pearson correlation coefficient was >0.5, only one of the collinear variable was included in the multiple logistic regression model. A backwards stepwise elimination was performed with a threshold for removal of 0.10. Adjusted odds ratios (AOR) and p values were calculated. All analyses were performed using STATA software (v 13.1; StataCorp, College Station, TX).

RESULTS

A total of 714 active injection drug users were recruited, with 385 (53.9%) reporting that their primary location of injecting was a public and/or outdoor location. The average age of all subjects was 24.9 years, the majority of whom were male (68.3%) and self-identified as white (74.5%). Most of the participants were currently homeless (68.8%), unemployed (95.0%), and used a NSP as their primary source of needles (59.1%). On average participants had been injecting drugs for 6.0 years, with a median number of daily injections of 2 (mean 2.9).

Demographic characteristics that were associated with primarily injecting in public or outdoor locations included younger age, self-identifying as currently

homeless, being street homeless during the last 6 months, lacking a high school diploma, and being unemployed.

The duration of an individual's injecting career was not associated with public/outdoor injection, however participants who began injecting drugs at a younger age were more likely to be currently injecting in public or outdoors. Injection frequency (number of injections over the last month) was positively associated with public and outdoor injection. 95.9% of the studies participants had injected heroin within the last months, while injection of other illicit drugs was common with 51.3% having injected cocaine or crack during that time period. A history of injecting prescription opioids and active and past injection of methamphetamines was more common in individuals who injected in public and outdoor settings. Participants who primarily injected in outdoor or public spaces reported injecting with a used syringes that had been used by someone else more frequently, and were less likely to wash their hands prior to injecting.

A history of overdose was reported in 57.4% of study participants, and outdoor and public injectors more likely to have overdosed. Participants who injected in public or outdoor locations were more likely to be clients of a needle syringe program and conversely less likely to acquire needles from a pharmacy. Outdoor and public injectors were more likely to have spent the night in jail in the last 6 months, and more likely to have been arrested for possession of needles or syringes (without other charge).

Table 1.1 Demographic and behavioral characteristics associated with public and outdoor injection drug use, New York City, 2005-2012

Table 1.1

Variable	Overall (n=714)	inject in public (n=385)	OR	95% CI		p
Age, y						<0.001
18-19	99 (13.9)	66 (66.7)	1.00	-		
20-24	279 (39.1)	164 (58.8)	0.71	0.44	1.15	
25-29	207 (29.0)	102 (49.3)	0.49	0.30	0.80	
30-34	103 (14.4)	45 (43.7)	0.39	0.22	0.69	
≥35 [35-55]	26 (3.6)	8 (30.8)	0.22	0.09	0.56	
Gender						0.370
Male	488 (68.3)	268 (54.9)	1.00	-		
Female	226 (31.7)	117 (51.8)	0.97	0.72	1.31	
Race						0.033
White	532 (74.6)	293 (55.1)	1.00	-		
Black	25 (3.5)	16 (64.0)	1.45	0.63	3.34	
Latino	108 (15.2)	51 (47.2)	0.73	0.48	1.11	
Asian	7 (1.0)	2 (28.6)	0.33	0.06	1.70	
Mixed	31 (4.6)	13 (41.9)	0.59	0.28	1.23	
Other	10 (1.4)	9 (90.0)	7.34	0.92	58.36	
Homeless (self identified)	491 (68.8)	324 (66.0)	5.15	3.64	7.30	<0.001
Street homeless in last 6 months	538 (75.4)	354 (65.8)	9.00	5.87	13.79	<0.001
Homeless shelter in last 6 months	159 (22.3)	84 (52.8)	0.95	0.66	1.35	0.754
HS diploma or GED	517 (72.4)	265 (51.3)	0.68	0.48	0.94	0.021
Currently employed	36 (5.1)	11 (30.6)	0.36	0.17	0.74	0.004
Exchanged sex for money or drugs	202 (28.3)	112 (55.4)	1.09	0.79	1.51	
Year of injecting						0.679
<1 year	99 (13.9)	57 (57.6)	1.00	-		
1-4 years	213 (29.8)	118 (55.4)	0.92	0.57	1.48	
5-10 years	239 (33.5)	122 (51.0)	0.77	0.48	1.23	
>10 years	163 (22.8)	88 (54.0)	0.87	0.52	1.43	

Table 1.1 Continued

Age at first injection						<0.001
<15	73 (10.2)	47 (64.4)	1.00	-		
15-17	253 (35.4)	157 (62.1)	0.91	0.53	1.56	
18-19	161 (22.6)	88 (54.7)	0.67	0.38	1.18	
20-24	155 (21.7)	69 (44.5)	0.44	0.25	0.79	
>25	72 (10.1)	24 (33.3)	0.28	0.14	0.55	
Injection frequency (injections/month)						0.022
<30	213 (30.7)	114 (53.3)	1.00	-		
30-59	111 (15.6)	52 (46.8)	0.81	0.51	1.28	
60-89	110 (15.4)	51 (46.4)	0.80	0.50	1.26	
90-149	148 (20.7)	88 (59.5)	1.35	0.89	2.06	
150-299	96 (13.5)	64 (66.7)	1.84	1.12	3.04	
≥300	30 (4.2)	16 (53.3)	1.05	0.49	2.26	
Drugs ever injected						
Heroin	708 (99.2)	384 (54.2)	5.93	0.69	50.98	0.066
Cocaine or crack	571 (80.0)	309 (54.1)	1.04	0.72	1.50	0.835
Speedball	511 (71.6)	287 (56.2)	1.37	0.99	1.90	0.056
Methamphetamines	285 (39.9)	193 (67.7)	2.59	1.89	3.54	<0.001
Prescription opioids	374 (52.4)	220 (58.8)	1.52	1.13	2.04	0.006
Ketamine	204 (28.6)	116 (56.9)	1.18	0.85	1.64	0.319
Drug injected in last month						
Heroin	685 (95.9)	376 (54.9)	2.70	1.21	6.02	0.012
Cocaine or crack	365 (51.3)	205 (56.2)	1.19	0.89	1.60	0.251
Speedball	221 (31.0)	125 (56.6)	1.16	0.84	1.60	0.357
Methamphetamines	28 (3.9)	21 (75.0)	2.65	1.11	6.31	0.023
Prescription opioids	123 (17.3)	68 (55.3)	1.07	0.72	1.57	0.753
Ketamine	27 (3.8)	14 (51.9)	0.91	0.42	1.97	0.820
History of overdose	410 (57.4)	236 (57.6)	1.41	1.05	1.90	0.023
NSP Client	627 (87.8)	352 (56.1)	2.10	1.32	3.32	0.001
Spent night in jail in last 6 months	402 (56.3)	254 (63.2)	2.37	1.75	3.21	<0.001
Ever arrested for possessing needles or syringes	118 (16.5)	76 (64.4)	1.68	1.12	2.53	0.012

Table 1.1 Continued

Clean skin with alcohol before injecting						0.063
Never	241 (33.8)	135 (56.0)	1.00	-		
Occasionally (1-25%)	262 (36.7)	152 (58.0)	1.09	0.76	1.55	
About half the time (26-74%)	76 (10.6)	35 (46.1)	0.67	0.40	1.13	
Most of the time (75-99%)	62 (8.7)	33 (53.2)	0.89	0.51	1.56	
Always	73 (10.2)	30 (41.1)	0.55	0.32	0.93	
Wash hands before injecting						<0.001
Never	278 (38.9)	180 (64.7)	1.00	-		
Occasionally (1-25%)	213 (29.8)	113 (53.1)	0.62	0.43	0.89	
About half the time (26-74%)	97 (13.6)	45 (46.4)	0.47	0.30	0.75	
Most of the time (75-99%)	60 (8.4)	26 (43.3)	0.42	0.24	0.73	
Always	66 (9.2)	21 (31.8)	0.25	0.14	0.45	
Used needle or syringe used before you, last 6 months						0.017
None	325 (45.6)	167 (51.4)	1.00	-		
1-3 times	134 (18.8)	67 (50.0)	0.95	0.63	1.42	
4-9 times	80 (11.2)	49 (61.2)	1.50	0.91	2.47	
10-25 times	69 (9.7)	49 (71.0)	2.32	1.32	4.07	
More than 25 times	105 (14.7)	53 (50.5)	0.96	0.62	1.50	
Primary source of needles or syringes						<0.001
Needle Syringe Program (NSP)	422 (59.1)	249 (59.0)	1.00	-		
Another Person who got from NSP	94 (13.2)	56 (59.6)	1.02	0.65	1.61	
Pharmacy without prescription	177 (24.8)	72 (40.7)	0.48	0.33	0.68	
Pharmacy with prescription	1 (0.1)	1 (100.0)	-			
On the street	6 (0.8)	4 (66.7)	1.39	0.25	7.67	
Other	12 (1.7)	3 (25.0)	0.23	0.06	0.87	

On multiple logistic regression analysis, demographic and drug use characteristics that were independently associated with primarily injecting in public or outdoor locations included being currently homeless, having been street homeless in the last 6 months, a history of ever injecting crack or

cocaine, a history of ever injecting methamphetamines, having spent a night in jail in the last 6 months, less hand washing before injecting, and less use of used needles or syringes.

Table 1.2 Multivariate analysis of factors associated with public and outdoor injection drug use, New York City, 2005-2012

Variable	AOR (95% CI)	p
Homeless (self-identified)	3.14 (2.09 - 4.72)	<0.001
Street homeless in last 6 months	3.73 (2.29 - 6.08)	<0.001
Year of injecting	0.95 (0.91 - 0.99)	0.014
Age at first injection	0.93 (0.89 - 0.97)	0.002
Drugs ever injected		
Cocaine or crack	0.56 (0.35 - 0.92)	0.020
Methamphetamines	2.00 (1.37 - 2.94)	<0.001
Drug injected in last month		
Heroin	2.38 (0.95 - 5.96)	0.064
Prescription opioids	0.67 (0.43 - 1.07)	0.093
NSP Client		
Injection frequency (log transformed)	1.17 (1.01 - 1.35)	0.039
Spent night in jail in last 6 months	1.74 (1.21 - 2.49)	0.003
Wash hands before injecting	0.81 (0.70 - 0.93)	0.004
Used needle or syringe used before you, last 6 months	0.87 (0.77 - 0.99)	0.036

DISCUSSION

Our study found that outdoor and public injection is common amongst young injection drug users recruited in the Lower East Side neighborhood of New York City. One of the strongest associations seen with public and outdoor injection was unstable housing. Not surprising current homelessness was strongly associated with predominant current outdoor or public injection. Interestingly, although current homelessness and homeless in the last six

months had some degree of collinearity, each was independently associated with public and outdoor injection on multiple logistic regression analysis.

Certain illicit drugs were associated with public and outdoor injection. Specifically a history injecting methamphetamine was positively associated with outdoor and public injection, while injection cocaine use was negatively associated. These unexpected findings may be a result of sampling bias, specifically the oversampling of a group unofficially called “urban nomads”[19]. These individuals who migrate around the United States, frequent the Lower East Side in the summers, and were anecdotally more likely to be homeless, and have a history of injection methamphetamine use. Unfortunately the questionnaire used in this study was unable to clearly capture what percentage of our total study population identified with this lifestyle.

Not surprisingly public and outdoor injection was associated with less sterile injection practices. Specifically individuals who injected in public and outdoors were less likely to wash their hands before administering an injection. Interestingly the use of alcohol to clean the injection site was not statistically different from public versus private injection potentially demonstrating high uptake of harm reduction practices and utilization of NSP.

One of the potential negative ramifications of public and outdoor injection is the increase in incarceration in this group of injection drug users. Individuals who inject in public and outdoor places are often rushed through their injection steps for fear of getting caught and arrested[9].

Safe injection facilities provide a means to address some of the issues raised in this study about outdoor and public injection. These SIF provide a site where an injection drug user has access to water, clean supplies, and can inject without feeling rushed or looking over his shoulder. These sites have been shown to decrease the density of publically discarded syringes and injection related litter[20], while also decreasing incarceration for minor drug offences.

This study has several limitations. The ability to generalize this study to all injection drug users is limited by the fact that recruitment for the study occurred in close association with a single NSP. Although we used multiple forms of recruitment to attract participants not currently seeking services at the NSP, the majority of participants still obtained their injection equipment from a SNP and the substance use practices of these individuals likely differs from the injecting drug using population as a whole. Additionally the geographic area of the Lower East Side of New York City where the study occurred and the most participants were recruited from is likely ethnically, socio-economically different from other neighborhoods with significant injection drug using populations. Historically the Lower East Side SNP has attracted a younger and whiter client population compared to other SNP in Manhattan or other Boroughs.

An additional limitation of the study was the cross sectional design of this study, which relied heavily on self-report demographic and behavioral patterns. The study design employed in this project creates the potential for recall bias, especially when attempting to remember several years in the past.

Additionally, several questions addressed sensitive topics related to drug use and sexual practices. These types of questions (related to drug use or sexual practices) are often associated with societal stigmas, and participants may not be entirely forthcoming or comfortable admitting to a known stigmatized behavior. Finally, despite there being several significant associations noted between demographics or behavior and outdoor and public injection, concluding a causative implication of these is not possible in a cross-sectional design.

Heroin use and heroin related overdose death have increased dramatically in the United States over the last decade. Evidence from Canada and Europe have clearly demonstrated that novel harm reductive interventions such as supervised injection facilities can significantly reduce many negative consequences of injection drug use including overdose deaths, especially in marginalized individuals who previously injected in public places. The time has come for State and local governments to overcome strongly held societal stigmas surrounding injection drug use, and to aggressively address the epidemic through implementation of evidence-based harm reduction intervention.

BIBLIOGRAPHY

1. Jones CM, Logan J, Gladden RM, Bohm MK, Author MPH. Vital Signs : Demographic and Substance Use Trends Among Heroin Users — United States , 2002 – 2013. MMWR Morb Mortal Wkly Rep. 2015;64(July 7).

2. New York City Department of Health and Mental Hygiene. Unintentional Drug Poisoning (Overdose) Deaths Involving Opioids in New York City, 2000–2014.; 2015.

3. Zucker H, Annucci AJ, Stancliff S, Catania H. Overdose prevention for prisoners in New York: a novel program and collaboration. Harm Reduct J. 2015;12(1):51.

4. Kerr T, Fairbairn N, Tyndall M, et al. Predictors of non-fatal overdose among a cohort of polysubstance-using injection drug users. Drug Alcohol Depend. 2007;87(1):39-45.

5. Alliance DP. Public Health Advocates Call for NYC to Authorize Supervised Injection Facilities to Fight Overdose Crisis. 2015. http://www.drugpolicy.org/news/2015/12/public-health-advocates-call-nyc-authorize-supervised-injection-facilities-fight-overdo. Accessed April 26, 2016.

6. AmfAR. Syringe Services Program Coverage in the United States - June 2014.; 2014. http://www.amfar.org/uploadedFiles/_amfarorg/Articles/On_The_Hill/2013/2013 SSP Map Final.pdf. Accessed April 26, 2016.

7. Drug Policy Alliance. Supervised Injection Facilities. 2016. http://www.drugpolicy.org/sites/default/files/DPA Fact Sheet_Supervised Injection Facilities %28Feb. 2016%29.pdf. Accessed April 26, 2016.

8. Wood E, Tyndall MW, Qui Z, Zhang R, Montaner JSG, Kerr T. Service uptake and characteristics of injection drug users utilizing North America's first medically supervised safer injecting facility. Am J Public Health. 2006;96(5):770-773.

9. Kinnard EN, Howe CJ, Kerr T, Skjødt Hass V, Marshall BDL. Self-reported changes in drug use behaviors and syringe disposal methods following the opening of a supervised injecting facility in Copenhagen, Denmark. Harm Reduct J. 2014;11(1):29.

10. Potier C, Laprévote V, Dubois-Arber F, Cottencin O, Rolland B. Supervised injection services: What has been demonstrated? A systematic literature review. Drug Alcohol Depend. 2014;145:48-68.

11. Tyndall MW, Kerr T, Zhang R, King E, Montaner JG, Wood E. Attendance, drug use patterns, and referrals made from North America's first supervised injection facility. Drug Alcohol Depend. 2006;83(3):193-198.

12. Debeck K, Kerr T, Bird L, et al. Injection drug use cessation and use of North America's first medically supervised safer injecting facility. Drug Alcohol Depend. 2010;113(2-3):172-176.

13. Marshall BD, Milloy MJ, Wood E, Montaner JS, Kerr T. Reduction in overdose mortality after the opening of North America's first medically supervised safer injecting facility: A retrospective population-based study. Lancet. 2011;377(9775):1429-1437.

14. Salmon AM, Van Beek I, Amin J, Kaldor J, Maher L. The impact of a supervised injecting facility on ambulance call-outs in Sydney, Australia. Addiction. 2010;105(4):676-683.

15. Jozaghi E, Reid AA, Andresen MA. A cost-benefit / cost-effectiveness analysis of proposed supervised injection facilities in Montreal, Canada. Subst Abuse Treat Prev Policy. 2013;8(1):1.

16. Enns EA, Zaric GS, Strike CJ, Jairam JA, Kolla G, Bayoumi AM. Potential cost-effectiveness of supervised injection facilities in Toronto and Ottawa, Canada. Addiction. 2015:n/a - n/a.

17. SIF NYC. Research on Supervised Injection Facilities: A Review of Literature. 2015. http://sifnyc.injectingadvice.com/wp-content/uploads/2015/09/SIF-NYC-Research-Brief.pdf. Accessed April 26, 2016.

18. Edlin BR, Shu M a., Winkelstein E, et al. More Rare Birds, and the Occasional Swan. Gastroenterology. 2009;136(7):2412-2414.

19. Moynihan C. In East Village, Harbingers of Spring Are Missing. New York Times. http://www.nytimes.com/2011/06/15/nyregion/in-the-east-village-where-have-all-the-crusties-gone.html. Published June 14, 2011. Accessed April 26, 2016.

20. Wood E, Kerr T, Small W, et al. Changes in public order after the opening of a medically supervised safer injecting facility for illicit injection drug users. CMAJ. 2004;171(7):731-734.

CHAPTER TWO

RISK FACTORS ASSOCIATED WITH HEPATITIS C VIRUS AMONG YOUNG INJECTION DRUG USERS IN NEW YORK CITY

CHAPTER TWO

INTRODUCTION

Hepatitis C virus (HCV) is the most common blood-borne pathogen in the United States, with chronic infection being a leading cause of cirrhosis and liver cancer[1], with death associated with HCV infection surpassing all other 60 notifiable infectious diseases combined[2]. Although hepatitis C incidence estimates in the general population declined from 1992 to 2009[3], between 2009 and 2013 rates of acute infection have more than doubled[4] with rates in people who inject drugs (PWID) remain alarmingly high. Efficiently transmitted via contaminated needles and syringes, HCV is endemic in PWID.

Injection drug users who share needles, syringes, or other injection equipment are at the highest risk for contracting HCV [1,5]. The prevalence of HCV infection in injection drug using populations varies widely around the world with an estimated 70-90% of IDUs in the US are infected with HCV[6–11], although the prevalence among those who have been injecting < 5 years has fallen considerably since the implementation of education, outreach, and clean needle programs[7,9,12–16]. Needle and syringe programs were developed to reduce the transmission of blood-borne infections such as HIV, hepatitis B, and hepatitis C and have been instituted in 33 states, operating within 196 cities within the United States[17]. Data suggests that needle syringe programs have made a significant impact on the incidence and prevalence of HCV transmission and infection in PWID[5,18,19], although both remain alarmingly high in the United States[20–22].

The United States is experiencing a dramatic opioid epidemic over the last several years, especially affecting young people, and has spurred an alarming increase in HCV transmission as opioid-dependent people turn to injection. This has widely affected communities with little or no access to HIV prevention interventions resulting in rapid spread of HCV[23], and even putting them at risk for HIV transmission, such as demonstrated recently in Indiana[24]. Between 2002 and 2013 heroin use in the United States has increased by 63%, with the highest increase in young persons age 18-25[25]. This rise in heroin use in young people has been accompanied by increases in HCV infection in young PWID[26–30].

Despite the impact of HIV prevention interventions, and increased availability of sterile injection equipment on reducing the incidence of HCV over the last 20 years, transmission remains alarmingly high and is now rising with a new wave of HCV transmission occurring on the heels of the injection opioid epidemic. Certain demographic characteristics and risk behaviors have consistently been associated with HCV infection. These risk factors include older age, more years injecting drugs, greater frequency of injection drug use, and injection of cocaine[21,31–34]. However more information is needed about why HCV continues to spread among people who use drugs where they do have access to existing interventions. This information will be particularly important as efforts are made to arrest the spread of HCV among the many communities newly affected by the opioid epidemic.

This study examines data from the Swan Project to explore mechanisms of HCV spread and potentially modifiable risk factors for transmission in a group of young active injection drug users in New York City.

METHODS

Between 2005 and 2012, the Swan Project recruited young people who inject drugs (PWID) on the Lower East Side of Manhattan through outreach, community-based agencies, and word-of-mouth. Eligible participants were between 18 to 35 years of age or had injected drugs for ≤5 years, and had injected illicit drugs in the 30 days before enrollment. Participants were interviewed, tested for hepatitis C, and screened for a prospective cohort study on the acquisition of new hepatitis C infection [35]. This study reports baseline data on all eligible participants with HCV antibody data available.

At enrollment, all participants underwent a face-to-face interview using a standardized questionnaire and were tested for hepatitis C antibody. The questionnaire included questions about demographic characteristics past and current substance use and other experiences. Questions about past substance use queried substances used, age of initiation of drug use, drugs injected, baseline HIV and HCV knowledge, and information about with whom, when, and where the participant's first drug injection took place. Questions about recent substance use addressed injection frequency, injection network, frequency of sharing of needles and drug preparation equipment, current injection practices to prevent infection (i.e. how drugs were split, how used needles were cleaned before re-use), setting of injection drug use, and engagement in treatment for substance use. Blood was collected from each

participant and tested for HCV antibodies by second (HCV EIA 2.0, Abbott Laboratories, Abbott Park, IL) or third (HCV 3.0 ELISA and RIBA HCV 3.0, Ortho Clinical Diagnostics, Raritan, NJ) generation tests. Written consent was obtained from all subjects and the protocol was approved by the Institutional Review Boards of Weill Cornell Medical College, Beth Israel Medical Center, and SUNY Downstate College of Medicine.

The demographics and drug use patterns were compared for participants who were HCV antibody positive and HCV antibody negative. Chi-square testing was used to explore risk factors associated with HCV antibody (Ab) positivity. Logistic regression models were used to calculate odds ratios (OR) and confidence intervals. Multiple logistic regression analysis was performed to determine which demographic and behavioral characteristics were associated with HCV seropositivity independently of specific injection practices postulated to result in HCV transmission. Collinearity of variables was assessed prior to model development and in cases where the Pearson correlation coefficient was >0.5, only one of the collinear variable was included in the multiple logistic regression model. Continuous variables with skewed distribution were log transformed prior to analysis (e.g., injections per month). This improved the fit of the multivariate models. A hierarchical multiple logistic model was created where factors hypothesized to represent potential mechanisms of transmission were first assessed, and then controlled for when subsequent social, behavioral and contextual factors were added to the model. Adjusted odds ratios (AOR) and p values were calculated. All analyses were performed using STATA software (v 13.1; StataCorp, College Station, TX).

RESULTS

The Swan Project recruited 714 eligible participants who met the eligibility criteria. Their median age was 24 years (mean 24.9). Three-quarters of the participants identified as white, and nearly three-quarters had a high school education or the equivalent (Table 2.1). Two-thirds reported being homeless. The median duration of injecting drugs was 5 years (mean 6.0 years). The median number of injections during the prior 30 days was 60 (mean 87.8).

Table 2.1 HCV seroprevalence by demographics characteristics, young people who inject drugs, New York City 2005-2012

Table 2.1

Variable	Overall	HCV Ab (+)	OR	95% CI		p
TOTAL	714 (100%)	343 (48.0%)				
Age, y						<0.001*
18-19	99 (13.9%)	21 (21.2%)	1.00	REF		
20-24	279 (39.1%)	116 (41.6%)	2.64	1.54	4.52	
25-29	207 (29.0%)	125 (60.4%)	5.66	3.24	9.88	
30-34	103 (14.4%)	66 (64.1%)	6.63	3.54	12.41	
≥35 [35-55]	26 (3.6%)	15 (57.7%)	5.06	2.03	12.65	
Gender						0.209
Male	486 (68.1%)	241 (49.6%)	1.00	REF		
Female	222 (31.1%)	99 (44.6%)	0.82	0.59	1.13	
Ethnicity						0.137
White	532 (74.6%)	265 (49.8%)	1.00	REF		
Black	25 (3.5%)	7 (28.0%)	0.39	0.16	0.95	
Latino	108 (15.2%)	108 (48.2%)	0.94	0.62	1.42	
Asian	7 (1.0%)	1 (14.3%)	0.17	0.02	1.4	
Mixed	31 (4.4%)	13 (41.9%)	0.73	0.35	1.52	
Other	10 (1.4%)	5 (50.0%)	1.01	0.29	3.52	
Currently homeless						0.006
No	223 (31.2%)	90 (40.3%)	1.00	REF		
Yes	491 (68.8%)	253 (51.5%)	1.57	1.14	2.17	
High School Diploma or GED						0.148
No	197 (29.6%)	86 (43.7%)	1.00	REF		
Yes	517 (72.4%)	257 (49.7%)	1.28	0.92	1.77	
Currently employed						0.031
No	677 (95.0%)	332 (49.0%)	1.00	REF		
Yes	36 (5.0%)	11 (30.6%)	0.46	0.22	0.94	

***** Mantel-Haenszel chi-square test for tren

Of the 714 participants, 343 (48.0%) had a positive HCV antibody test at enrollment, indicating either past or present HCV infection (Table 2.1). Of the 466 participants in the study who reported being tested previously for hepatitis C, only 180 reported a prior positive test. Thus, 47.5% of those found with positive HCV antibody during our study were new diagnoses. Several demographic characteristics were associated with HCV seropositivity (Table 2.1). The risk of being HCV antibody-positive increased markedly with increasing age (Table 2.1). Although most of the people in the study were men, gender did not impact the likelihood of being infected with HCV. Social factors that were significantly associated with being infected with HCV included being homeless and being unemployed.

Study Participants had been injecting drugs for a median of 5 years (mean 6.0) and those who had injected longer were at dramatically increased risk for having HCV antibodies (Table 2.2). Of participants who had injected for 10 years or more, 68.1% had HCV antibodies. Most (80.4%) participants had been given their first injection by another person. The older the age of that person, the more likely the participant was to have been infected. Only 67.5% of participants knew that hepatitis C could be transmitted by sharing needles when they began injecting, and those that lacked this understanding were at increased risk for becoming infected. In contrast, 92.0% of subjects were aware of HIV transmission through contaminated needles, and this understanding was not a significant risk or protective factor for HCV acquisition. Participants were at least somewhat aware of the magnitude of their own risk. Excluding those who reported a prior positive HCV test,

participants' lack of confidence in their ability to avoid infection was associated with a positive HCV antibody test.

Table 2.2 HCV seroprevalence by injection drug use characteristics, young people who inject drugs, New York City 2005-2012

Table 2.2

Variable	Overall	HCV Ab (+)	OR	95% CI		p
TOTAL	714 (100%)	343 (48.0%)				
Duration of injection drug use						<0.001*
<1	99 (13.9%)	20 (20.2%)	1.00	REF		
1-4	213 (29.8%)	72 (33.8%)	2.02	1.14	3.56	
5-9	239 (33.5%)	140 (58.6%)	5.59	3.21	9.72	
≥10	163 (22.8%)	111 (68.1%)	8.43	4.67	15.22	
Who administered first injection						0.58
Self	140 (19.6%)	65 (46.4%)	1.00	REF		
Primary sex partner	96 (13.4%)	48 (50.0%)	1.15	0.69	1.94	
Other sex partner	14 (2.0)	7 (50.0%)	1.15	0.38	3.46	
A relative or close friend	327 (45.8%)	150 (43.7%)	0.98	0.66	1.45	
Dealer, gallery operator, hit doctor	15 (2.1%)	8 (53.3%)	1.32	0.45	3.83	
Acquaintance	116 (16.2%)	60 (51.7%)	1.24	0.76	2.02	
Other	6 (0.8%)	5 (83.3%)	5.77	0.66	50.66	
Age of person who administered your first injection						0.039*†
Self	140 (19.6%)	65 (46.4%)	-	-		
<20	194 (27.2%)	87 (44.9%)	1.00	REF		
20-24	174 (24.4%)	78 (44.8%)	1.00	0.66	1.51	
25-29	101 (14.1%)	50 (49.5%)	1.21	0.74	1.95	
≥30	96 (13.4%)	58 (60.4%)	1.88	1.14	3.09	
Before first injection knew HIV could be transmitted by sharing needles						0.2
No	57 (8.0%)	32 (56.1%)	1.00	REF		
Yes	657 (92.0%)	311 (47.3%)	0.70	0.41	1.21	
Before first injection knew hepatitis could be transmitted by sharing needles						<0.001
No	232 (32.5%)	140 (60.3%)	1.00	REF		
Yes	482 (67.5%)	203 (42.1%)	0.48	0.35	0.66	
Before first injection knew hepatitis could be transmitted by sharing cottons, cookers, or rinse water						0.1
No	458 (64.3%)	230 (50.2%)	1.00	REF		
Yes	254 (35.7%)	111 (43.7%)	0.77	0.57	1.05	
Confident in avoiding getting hepatitis C virus						<0.001‡
Extremely confident	180 (32.4%)	45 (25.0%)	1.00	REF		
Somewhat confident	230 (41.4%)	70 (30.4%)	1.31	0.85	2.04	
A little confident	72 (13.0%)	29 (40.3%)	2.02	1.13	3.61	
Not confident at all	74 (13.3%)	49 (66.2%)	5.88	3.27	10.59	
Self-reported HCV-positive	180	165 (91.7%)	-	-	-	

*****Mantel-Haenszel chi-square test for trend; †Excludes those who self-injected; ‡Excluded self-reported positive

Heroin was injected by 99.2% of our participants, and many injected other substances as well (Table 2.3). Injection of several of these additional illicit agents (cocaine, prescription pain killers, crystal meth, and ketamine) was associated with being at increased risk for hepatitis C infection. 57.4% of our participants reported having overdosed in the past, and these individuals were more likely to have a positive HCV antibody test than those who had never overdosed. Additional risk factors associated with HCV seropositivity included having exchanged sex for money or drugs and having been arrested solely for drug residue or possession of needle or syringe.

Table 2.3 HCV seroprevalence by injection and other experiences, young people who inject drugs, New York City, 2005-2015

Variable	Overall	HCV Ab (+)	OR	95% CI		p
TOTAL	714 (100%)	343 (48.0%)				
Ever injected heroin						0.5
No	6 (0.8%)	2 (33.3%)	1.00	-		
Yes	708 (99.2%)	341 (48.2%)	1.85	0.34	10.21	
Ever injected crack/cocaine						<0.001
No	143 (20.0%)	34 (23.8%)	1.00	-		
Yes	571 (80.0%)	309 (54.1%)	3.78	2.49	5.75	
Ever injected pharmaceutical pain killers						0.009
No	616 (86.3%)	284 (46.1%)	1.00	-		
Yes	98 (13.7%)	59 (60.2%)	1.77	1.15	2.73	
Ever injected crystal meth						0.001
No	429 (60.1%)	185 (43.1%)	1.00	-		
Yes	285 (39.9%)	158 (55.4%)	1.64	1.21	2.22	
Ever injected ketamine						0.047
No	510 (71.4%)	233 (45.7%)	1.00	-		
Yes	204 (28.6%)	110 (53.9%)	1.39	1	1.93	
Ever overdosed						<0.001
No	304 (42.6%)	104 (34.2%)	1.00	-		
Yes	410 (57.4%)	239 (58.3%)	2.69	1.98	3.66	
Ever been given money or drugs in exchange for sex?						0.02
No	512 (71.7%)	232 (45.3%)	1.00	-		
Yes	202 (28.3%)	111 (55.0%)	1.47	1.06	2.04	
Ever arrested solely for drug residue or possession of syringe or needle						<0.001
No	579 (81.1%)	239 (41.3%)	1.00	-		
Yes	135 (18.9%)	104 (77.0%)	4.77	3.09	7.36	

Recent injection practices that were associated with increased HCV antibody positivity included higher injection frequency, more frequent use of syringes previously used by another person, use of syringes previously used by more people, and less frequent cleaning of skin with alcohol (Table 2.4). 53.9% of our study participants most frequently injected most often in public or outdoor

locations, and this practice was associated with HCV antibody positivity. Splitting drug within a cooker in the last 6 months was not associated with HCV seroposivity, while splitting drug with a used syringe was.

Table 2.4 HCV seroprevalence by recent injection practices, young people who inject drugs, New York City, 2005-2012

Table 2.4

Variable	Overall	HCV Ab (+)	OR	95% CI		p
TOTAL	714 (100%)	343 (48.0%)				
Injection frequency (injections/month)						<0.001
<30	219 (30.7%)	86 (39.3%)	1.00	-		
30-59	111 (15.6%)	43 (38.7%)	0.98	0.61	1.56	
60-89	110 (15.4%)	56 (50.9%)	1.60	1.01	2.55	
90-149	148 (20.7%)	85 (57.4%)	2.09	1.37	3.19	
150-299	96 (13.5%)	52 (54.2%)	1.83	1.13	2.97	
≥300	30 (4.2%)	21 (70.0%)	3.61	1.58	8.28	
Location where injected drugs most (last 6 months)						0.008
Your or primary partner's home	187 (26.2%)	72 (38.5%)	1.00			
Home of a friend or relative	79 (11.1%)	32 (40.5%)	1.09	0.64	1.86	
Public or outdoor space	358 (53.9%)	206 (53.5%)	1.84	1.29	2.62	
Other indoor space	37 (5.2%)	19 (51.4%)	1.68	0.83	3.42	
Other	26 (3.6%)	14 (53.9%)	1.86	0.82	4.25	
No. times splitting drug solution with a previously used syringe (past 6 months)						<0.001
Never	325 (45.6%)	131 (40.3%)	1.00	-		
1-3 times	134 (18.8%)	59 (44.0%)	1.16	0.78	1.75	
4-9 times	80 (11.2%)	41 (51.3%)	1.56	0.95	2.54	
10-25 times	69 (9.7%)	47 (68.1%)	3.16	1.82	5.5	
>25 times	105 (14.7%)	65 (61.9%)	2.41	1.53	3.78	
No. people who used a syringe before participant (past 6 months)						<0.001
None	333 (48.2%)	136 (40.8%)	1.00	-		
1 person	168 (24.3%)	85 (50.6%)	1.48	1.02	2.15	
2 people	59 (8.5%)	26 (44.1%)	1.14	0.65	1.99	
3 people	43 (6.2%)	28 (65.1%)	2.70	1.39	5.25	
4-9 people	65 (9.4%)	41 (63.1%)	2.47	1.43	4.29	
10-25 people	18 (2.6%)	14 (77.8%)	5.07	1.63	15.73	
>25 people	5 (0.7%)	4 (80.0%)	5.79	0.64	52.41	
No. times drawing drugs from cooker used previously by someone else (last 6 months)						<0.001
Never	317 (45.4%)	144 (45.4%)	1.00	-		
1-3 times	90 (12.9%)	28 (31.1%)	0.54	0.33	0.89	
4-9 times	53 (7.6%)	24 (45.3%)	0.99	0.55	1.78	
10-25 times	65 (9.3%)	32 (49.2%)	1.16	0.68	1.99	
>25 times	174 (24.9%)	105 (60.3%)	1.83	1.26	2.66	

Table 2.4 Continued

No. times drawing drugs from cotton previously accessed by someone else (past 6 months)						0.001
Never	323 (45.2%)	139 (43.0%)	1.00	-		
1-3 times	107 (15.0%)	42 (39.3%)	0.86	0.55	1.34	
4-9 times	81 (11.3%)	43 (53.1%)	1.50	0.92	2.44	
10-25 times	77 (10.8%)	40 (52.0%)	1.43	0.87	2.36	
>25 times	126 (62.7%)	79 (62.7%)	2.23	1.46	3.40	
No. times using rinse water previously accessed by someone else (past 6 months)						0.022
Never	346 (48.5%)	154 (44.5%0	1.00	-		
1-3 times	109 (15.3%)	46 (42.2%)	0.91	0.59	1.41	
4-9 times	68 (9.5%)	32 (47.1%)	1.11	0.66	1.87	
10-25 times	57 (8.0%)	31 (54.4%)	1.49	0.85	2.61	
>25 times	134 (18.8%)	80 (59.7%)	1.84	1.23	2.77	
Frequency of cleaning skin with alcohol before injecting (last 6 months)						<0.001
never	241 (33.8%)	134 (55.6%)	1.00	-		
occasionally (1-25%)	262 (36.7%)	134 (51.1%)	0.84	0.59	1.19	
about half the time (26-74%)	76 (10.6%)	27 (35.5%)	0.44	0.26	0.75	
most of the time (75-99%)	62 (8.7%)	28 (45.2%)	0.66	0.38	1.15	
always	73 (10.2%)	20 (27.4%)	0.30	0.17	0.53	
Frequency of cleaning your skin with soap and water before injecting (past 6 months)						0.161
never	437 (61.2%)	220 (50.3%)	1.00	-		
occasionally (1-25%)	172 (24.1%)	81 (47.1%)	0.88	0.62	1.15	
about half the time (26-74%)	42 (5.9%)	14 (33.3%)	0.49	0.25	0.96	
most of the time (75-99%)	34 (4.8%)	13 (38.2%)	0.61	0.3	1.25	
always	29 (4.1)	15 (51.7%)	1.06	0.5	2.24	
Frequency of cleaning your hands with soap and water before injecting (last 6 months)						0.017
never	278 (38.9%)	141 (50.7%)	1.00	-		
occasionally (1-25%)	213 (29.8%)	109 (31.8%)	1.02	0.71	1.46	
about half the time (26-74%)	97 (13.6%)	47 (48.5%)	0.91	0.58	1.45	
most of the time (75-99%)	60 (8.4%)	19 (31.7%)	0.45	0.25	0.81	
always	66 (9.2%)	27 (40.9%)	0.67	0.39	1.16	

Analysis of variables that potentially were mechanisms of HCV transmission resulted in a hierarchical model with five control variables; age, years injecting drugs, splitting of drug solution with a previously used syringe, drawing drugs from cooker used previously by someone else, and using a used syringe from a large number of people (Table 2.5). In multiple regression modeling, when adjusting for the control variables, social and behavioral characteristics that remained significantly associated with HCV seroprevalence included having been arrested for drug residue or paraphernalia, lacking confidence in being able to avoid HCV infection, and injecting primarily in public/outdoors spaces (Table 2.5).

Table 2.5 Factors associated with HCV antibody in multivariate analysis*

Table 2.5

Variable*	AOR (95% CI)	p
Control variables		
Age †	2.50 (1.72-3.62)	<0.001
Years injecting drugs †	1.65 (1.29-2.10)	<0.001
No. times splitting drug solution with a previously used syringe (past 6 months)	1.34 (1.11-1.63)	0.003
No. times drawing drugs from cooker used previously by someone else (last 6 months) †	1.14 (0.99-1.31)	0.063
No. people who used a syringe before participant (past 6 months)	1.25 (1.05-1.50)	0.013
Demographic variables		
Gender (male)	1.21 (0.76-1.94)	0.425
High School Diploma or GED	1.10 (0.63-1.92)	0.739
Currently employed	0.70 (0.22-2.22)	0.541
Currently homeless	1.31 (0.73-2.33)	0.363
Variables related to first illicit drug injection		
Administered own first injection	0.88 (0.45-1.72)	0.699
Age of person who administered first injection † ‡	1.96 (0.66-5.84)	0.225
Before first injection knew HIV could be transmitted by sharing needles	1.02 (0.38-2.72)	0.970
Before first injection knew hepatitis could be transmitted by sharing needles	0.98 (0.57-1.68)	0.940
Before first injection knew hepatitis could be transmitted by sharing cottons, cookers, or rinse water	0.96 (0.57-1.63)	0.878
Variables associated with past injection practices		
Ever injected crack/cocaine	1.67 (0.84-3.33)	0.144
Ever injected pharmaceutical pain killers	1.08 (0.55-2.12)	0.812
Ever injected crystal meth	0.99 (0.60-1.66)	0.984
Ever injected ketamine	1.57 (0.90-2.72)	0.113
Ever overdosed	1.81 (1.09-3.00)	0.210
Ever arrested solely for drug residue or possession of syringe or needle	3.62 (1.83-7.15)	<0.001
Ever been given money or drugs in exchange for sex?	0.99 (0.58-1.70)	0.978
Variables associated with current injection practices		
Injection frequency (past 6 months) †	1.09 (0.87-1.35)	0.455
Injected most commonly in public/outdoors (past 6 months)	2.42 (1.44-4.06)	0.001
Frequency of cleaning skin with alcohol before injecting (last 6 months)	0.75 (0.60-0.95)	0.015
Frequency of cleaning your skin with soap and water before injecting (past 6 months)	0.90 (0.69-1.17)	0.436
Frequency of cleaning your hands with soap and water before injecting (past 6 months)	0.77 (0.62-0.97)	0.026
No. times injecting drugs using a previously used syringe (past 6 months)	1.12 (0.90-1.40)	0.323
No. times drawing drugs from cotton previously accesssed by someone else (past 6 months)	1.05 (0.87-1.26)	0.625
No. times using rinse water previously accessed by someone else (past 6 months)	1.01 (0.84-1.21)	0.928
Perceived risk variables		
Self-reported HCV-positive	22.88 (8.46-61.92)	<0.001
Confident that you can avoid getting hepatitis C virus? (4-point Likert scale) §	1.79 (1.30-2.48)	<0.001

*All values are adjusted for the first 5 variables in the table (Control variables)

† log-transformed

‡ Adjusted for individuals who 'Administered own first injection'

§ Adjusted for self-reported positive

DISCUSSION

We found a high seroprevalence of HCV in in young active injection drug users of 48%. The observed seroprevalence is not substantially different from the estimated 51% seroprevalence in New York City injection drug users of all ages[36]. These numbers may suggests that although increasing age is a risk for HCV seropositivity, much of the acquisition of infection is occurring within the first few years of an individual commencing injecting drugs which has been seen in prior studies[37]. Specifically, we found a disconcerting seroprevalence of HCV infection in individuals who have injected drugs for less than one year (20.2%). This rate appears higher than the prevalence rates found in similar cohorts in other cities around the United States [33,36]. These new injection drug users are seldom linked to harm reduction services and needle syringe exchanges programs at the time they initiate their injection career. This, coupled with the fact that only two-thirds of patients in our study were aware that hepatitis could be transmitted through sharing of needles and syringes, highlights the need for HCV prevention strategies specifically identifying and targeting youth before they initiate injecting drugs. Additionally, these early infections are important to consider when discussing the potential for HCV eradication. These new injection drug users likely have poor linkage to harm reduction services and limited understanding of HCV transmission and prevention. As a result they will be one of the most difficult groups of people to engage in treatment, and thus represent a potential persistent reservoir of infection and transmission.

Several demographic characteristics and risk behaviors that were significantly associated with HCV seropositivity were consistent with prior published studies in injection drug using populations. These included older age and more years injecting drugs. Interestingly, injection frequency was not independently associated with HCV seropositivity deviating from many prior studies. Instead, we were able to identify more specific sharing behaviors and practices within the injection pathway that, when occurring at higher frequency, were independent risk factors for HCV infection. An associations with HCV infection was seen with the number of people who used a syringe before participant and the number of times drawing drug from a used cooker. Additionally, a never reported variable of times splitting drug solution with a previously used syringe was independently associated with HCV infection, were as number of times injecting drugs using a previously used syringe was not independently associated on multiple logistic models.

Although HIV remains a major issue for PWID, the seroprevalence of HIV in this population remains significantly less than the seroprevalence of HCV. 612 of our 714 participants reported having prior HIV testing, with only 6 individuals self-reporting being infected; in comparison only 466 participants had previously been tested for HCV. These data suggest that the message about HIV transmission through drug use is permeating, while the message surrounding HCV transmission within this same population is lagging.

However, two recent developments may provide the impetus to address and re-prioritize HCV services in the near future. First, within the last few years the nationwide age-adjusted mortality from HCV, both hepatic and extra-hepatic, rose above HIV for the first time[38]. Second, the advent of new direct acting antiviral agents may provide a new opportunity to cure active injection drug users of their infection, with the added potential to substantially decrease transmission, and subsequently decrease prevalence of HCV in PWID through a treatment as prevention model[39–41]. The high prevalence of HCV infection, high relative mortality associated with HCV infection, and recent advances in HCV treatment provide the basis for advocates and policy makers to argue that public health investment is needed to address issues of HCV prevention and treatment.

What remains a challenge in the prevention of blood-borne pathogen transmission in PWID is ensuring a consistent supply of clean injection equipment. Over half of our study participants reported the use of used syringes over the last six months. More encouraging is that most of our participants kept a small injection network, with 82% of participants sharing used needles with two or fewer individuals. If each member of a small network can be aviremic either through prevention or cure of their HCV, further transmission from or within this nidus can be terminated[42].

Over half of our study participants injected most frequently in public or outdoor locations, with this factor being independently associated with HCV antibody positivity. To our knowledge this is the first study to demonstrate the finding that public and outdoor injection is associated with HCV antibody positivity, although some prior studies have demonstrated the association of shooting galleries use and HCV acquisition[43,44]. Public and outdoor injection drug use is often more rushed than home-based injection due to the potential/fear of getting caught, and the rushed nature of this practice may make the implementation of safe injection practices more difficult. Over the last several years there has been growing support for supervised injection facilities. Studies have demonstrated that these facilities significantly reduce overdose associated mortality in the area surrounding the site[45,46]. Our study, showing the association between public/outdoor injection and HCV, suggests that moving PWID indoors into supervised injection facilities may have the added benefit of reducing HCV transmission. Further studies looking at this association may provide additional motivation to institute supervised injection facilities in regions with high outdoor/public injection drug use.

This study has several limitations. First, the ability to generalize this study to all injection drug users is limited by the fact that recruitment for the study occurred in close association with a needle syringe program. Although we used multiple forms of recruitment to attract participants not currently seeking services at the needle syringe program, the potential oversampling of PWID

who are more engaged in harm reduction services is a potential source of bias. Whether the injection practices of drug users seeking out harm reduction services is significantly different from those not engaged with these services was not captured in this study.

Second, the cross sectional design of this study relied on self-report of potential exposures or risk behaviors. This study design could have led to recall bias, especially where participants were asked about events which may have occurred 5 or even 10 years prior. Additionally it is possible that participants were not entirely forthcoming about their risk behavior especially in situations where a societal stigma is associated with the behavior, such as sharing of syringes and needles and exchange of sex for money or drugs. Additionally, despite there being several significant associations noted between demographics or behavior and HCV seropositivity, concluding a causal effect is not possible.

Third, this study took place in New York City where for over two decades there have existed independent, community-based, needle syringe programs. As a result it is difficult to extend these findings to many areas of the country, especially non-urban settings, where injection drug use is becoming an increasing issue and access to clean injection equipment and harm reductive services is limited.

In this study, we noted relatively high rates of HCV infection in young active injection drug users, with a significant proportion being infected within one year of their first injection. These early seroconversions highlight the need to re-evaluate the current harm reduction model when attempting to impact the transmission of HCV in the injection drug using populations. There remains a need to identify high risk individuals before they initiate injecting drugs, and convey to them harm reduction messages with the goal of impacting future injection practices and potentially HCV incidence. Finally, our study suggests a possible role for supervised injection facilities to reduce public and outdoor injection and subsequently decrease the transmission of HCV.

BIBLIOGRAPHY

1. Klevens RM, Hu DJ, Jiles R, Holmberg SD. Evolving epidemiology of hepatitis C virus in the United States. Clin Infect Dis. 2012;55 Suppl 1:S3-S9.

2. Ly KN, Hughes EM, Jiles RB, Holmberg SD. Rising Mortality Associated With Hepatitis C Virus in the United States, 2003-2013. Clin Infect Dis. March 2016.

3. Division of Viral Hepatitis, National Center for HIV/AIDS, Viral Hepatitis, STD & TP. Viral Hepatitis Surveillance, United States, 2009. http://www.cdc.gov/hepatitis/Statistics/ 2009Surveillance/index.htm.

4. Division of Viral Hepatitis C. Viral Hepatitis Surveillance: United States, 2013.; 2013. http://www.cdc.gov/hepatitis/statistics/2013surveillance/pdfs/2013hepsurveillancerpt.pdf. Accessed April 26, 2016.

5. Tseng F-C, O'Brien TR, Zhang M, et al. Seroprevalence of hepatitis C virus and hepatitis B virus among San Francisco injection drug users, 1998 to 2000. Hepatology. 2007;46(3):666-671.

6. Garfein RS, Vlahov D, Galai N, Doherty MC, Nelson KE. Viral infections in short-term injection drug users: the prevalence of the hepatitis C, hepatitis B, human immunodeficiency, and human T-lymphotropic viruses. Am J Public Health. 1996;86(5):655-661.

7. Lorvick J, Kral AH, Seal K, Gee L, Edlin BR. Prevalence and duration of hepatitis C among injection drug users in San Francisco, Calif. Am J Public Health. 2001;91(1):46-47.

8. Thomas DL, Vlahov D, Solomon L, et al. Correlates of hepatitis C virus infections among injection drug users. Medicine (Baltimore). 1995;74(4):212-220.

9. Tseng F-C, O'Brien TR, Zhang M, et al. Seroprevalence of hepatitis C virus and hepatitis B virus among San Francisco injection drug users, 1998 to 2000. Hepatology. 2007;46(3):666-671.

10. Hagan H, McGough JP, Thiede H, Weiss NS, Hopkins S, Alexander ER. Syringe exchange and risk of infection with hepatitis B and C viruses. Am J Epidemiol. 1999;149(3):203-213.

11. Bell J, Batey RG, Farrell GC, Crewe EB, Cunningham AL, Byth K. Hepatitis C virus in intravenous drug users. Med J Aust. 1990;153(5):274-276.

12. Garfein RS, Doherty MC, Monterroso ER, Thomas DL, Nelson KE, Vlahov D. Prevalence and incidence of hepatitis C virus infection among young adult injection drug users. J Acquir Immune Defic Syndr Hum Retrovirol. 1998;18 Suppl 1:S11-S19.

13. Thorpe LE, Ouellet LJ, Levy JR, Williams IT, Monterroso ER. Hepatitis C virus infection: prevalence, risk factors, and prevention opportunities among young injection drug users in Chicago, 1997-1999. J Infect Dis. 2000;182(6):1588-1594.

14. Diaz T, Des Jarlais DC, Vlahov D, et al. Factors associated with prevalent hepatitis C: differences among young adult injection drug users in lower and upper Manhattan, New York City. Am J Public Health. 2001;91(1):23-30.

15. Hahn JA, Page-Shafer K, Lum PJ, Ochoa K, Moss AR. Hepatitis C virus infection and needle exchange use among young injection drug users in San Francisco. Hepatology. 2001;34(1):180-187.

16. Des Jarlais DC, Perlis T, Arasteh K, et al. Reductions in hepatitis C virus and HIV infections among injecting drug users in New York City, 1990-2001. AIDS. 2005;19 Suppl 3:S20-S25.

17. AmfAR. Syringe Services Program Coverage in the United States - June 2014.; 2014. http://www.amfar.org/uploadedFiles/_amfarorg/Articles/On_The_Hill/2013/2013 SSP Map Final.pdf.

18. Kwon J a., Anderson J, Kerr CC, et al. Estimating the cost-effectiveness of needle-syringe programs in Australia. Aids. 2012;26(17):2201-2210. doi:10.1097/QAD.0b013e3283578b5d.

19. Edlin BR. Perspective: test and treat this silent killer. Nature. 2011;474(7350):S18-S19.

20. van Beek I, Dwyer R, Dore GJ, Luo K, Kaldor JM. Infection with HIV and hepatitis C virus among injecting drug users in a prevention setting: retrospective cohort study. BMJ. 1998;317(7156):433-437.

21. Hagan H, Pouget ER, Des Jarlais DC. A systematic review and meta-analysis of interventions to prevent hepatitis C virus infection in people who inject drugs. J Infect Dis. 2011;204(1):74-83. doi:10.1093/infdis/jir196.

22. Turner KME, Hutchinson S, Vickerman P, et al. The impact of needle and syringe provision and opiate substitution therapy on the incidence of hepatitis C virus in injecting drug users: pooling of UK evidence. Addiction. 2011;106(11):1978-1988. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=medc&NEWS=N&AN=21615585. Accessed April 26, 2016.

23. Zibbell JE, Iqbal K, Patel RC, et al. 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. 2015;64(17):453-459.

24. Conrad C, Bradley HM, Broz D, et al. Community Outbreak of HIV Infection Linked to Injection Drug Use of Oxymorphone — Indiana, 2015. Mmwr. 2015;64(16):443-444.

25. Jones CM, Logan J, Gladden RM, Bohm MK, Author MPH. Vital Signs : Demographic and Substance Use Trends Among Heroin Users — United States , 2002 – 2013. MMWR Morb Mortal Wkly Rep. 2015;64(July 7).

26. Center of Disease Control and Prevention. Use of enhanced surveillance for hepatitis C virus infection to detect a cluster among

young injection-drug users--new York, November 2004-April 2007. MMWR Morb Mortal Wkly Rep. 2008;57(19):517-521.

27. Center of Disease Control and Prevention. Hepatitis C Virus Infection Among Adolescents and Young Adults — Massachusetts , 2002 – 2009. MMWR Morb Mortal Wkly Rep. 2011;60(17):537-541.

28. Center of Disease Control and Prevention. Hepatitis C Virus Infection Among Young Adults - Rural Wisconsin, 2010. MMWR Morb Mortal Wkly Rep. 2012;61(19):358.

29. Center of Disease Control and Prevention. Risk Factors for Hepatitis C Virus Infections Among Young Adults - Massachusetts, 2010. MMWR Morb Mortal Wkly Rep. 2011;60(42):1457-1458.

30. Valdiserri R, Khalsa J, Dan C, et al. Confronting the emerging epidemic of hcv infection among young injection drug users. Am J Public Health. 2014;104(5):816-821.

31. Schulte M, Hser Y, Saxon a., et al. Risk Factors Associated with HCV Among Opioid-Dependent Patients in a Multisite Study. J Community Health. 2015.

32. Villano S a, Vlahov D, Nelson KE, Lyles CM, Cohn S, Thomas DL. Incidence and risk factors for hepatitis C among injection drug users in Baltimore, Maryland. J Clin Microbiol. 1997;35(12):3274-3277.

33. Hahn J a., Page-Shafer K, Lum PJ, Ochoa K, Moss a. R. Hepatitis C virus infection and needle exchange use among young injection drug users in San Francisco. Hepatology. 2001;34(1):180-187.

34. Diaz T, Des Jarlais DC, Vlahov D, et al. Factors associated with prevalent hepatitis C: Differences among young adult injection drug users in lower and upper Manhattan, New York City. Am J Public Health. 2001;91(1):23-30.

35. Edlin BR, Shu M a., Winkelstein E, et al. More Rare Birds, and the Occasional Swan. Gastroenterology. 2009;136(7):2412-2414.

36. Amon JJ, Garfein RS, Ahdieh-Grant L, et al. Prevalence of hepatitis C virus infection among injection drug users in the United States, 1994-2004. Clin Infect Dis. 2008;46(12):1852-1858.

37. Hagan H, Pouget ER, Des Jarlais DC, Lelutiu-Weinberger C. Meta-regression of hepatitis C virus infection in relation to time since onset of illicit drug injection: the influence of time and place. Am J Epidemiol. 2008;168(10):1099-1109.

38. Ly KN, Xing J, Monina Klevens R, Jiles RB, Ward JW, Holmberg SD. The increasing burden of mortality from viral hepatitis in the United States between 1999 and 2007. Ann Intern Med. 2012;156(4):271-278.

39. Martin NK, Hickman M, Hutchinson SJ, Goldberg DJ, Vickerman P. Combination Interventions to Prevent HCV Transmission Among People Who Inject Drugs: Modeling the Impact of Antiviral Treatment, Needle and Syringe Programs, and Opiate Substitution Therapy. Clin Infect Dis. 2013;57(suppl 2):S39-S45.

40. Martin NK, Vickerman P, Grebely J, et al. Hepatitis C virus treatment for prevention among people who inject drugs: Modeling treatment scale-up in the age of direct-acting antivirals. Hepatology. 2013;58(5):1598-1609.

41. Grebely J, Matthews G, Lloyd A, Dore G. Elimination of Hepatitis C Virus Infection Among People Who Inject Drugs Through Treatment as Prevention: Feasibility and Future Requirements. Clin infect dis. 2013;57(7):1014-1020.

42. Hellard M, Rolls DA, Sacks-Davis R, et al. The impact of injecting networks on hepatitis C transmission and treatment in people who inject drugs. Hepatology. 2014;60(6):1861-1870.

43. Morano JP, Gibson BA, Altice FL. The Burgeoning HIV/HCV Syndemic in the Urban Northeast: HCV, HIV, and HIV/HCV Coinfection in an Urban Setting. PLoS One. 2013;8(5):1-12.

44. Thorpe LE, Ouellet LJ, Levy JR, Williams IT. Hepatitis C Virus Infection : Prevalence , Risk Factors , and Prevention Opportunities among Young Injection Drug Users in Chicago , 1997 – 1999. 1999:1997-1999.

45. Marshall BD, Milloy MJ, Wood E, Montaner JS, Kerr T. Reduction in overdose mortality after the opening of North America's first medically supervised safer injecting facility: A retrospective population-based study. Lancet. 2011;377(9775):1429-1437.

46. Potier C, Laprévote V, Dubois-Arber F, Cottencin O, Rolland B. Supervised injection services: What has been demonstrated? A systematic literature review. Drug Alcohol Depend. 2014;145:48-68.