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Hepatitis C serosorting among people who inject drugs in rural Puerto Rico

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ABSTRACT

Due to the high cost of treatment, preventative measures to limit Hepatitis C (HCV) transmission among people who inject drugs (PWID) are encouraged by many public health officials. A key one of these is serosorting, where PWID select risk partners based on concordant HCV status. Research on the general U.S. population by Smith et al. (2013) found that knowledge of one's own HCV status facilitated serosorting behaviors among PWID, such that respondents with knowledge of their own status were more likely to ask potential partners about their status prior to sharing risk. Our objective was to see if this held true in rural Puerto Rico. We replicate this study using a sample of PWID in rural Puerto Rico to draw comparisons. We used respondent driven sampling to survey 315 participants, and have a final analytic sample of 154. The survey was heavily modeled after the National HIV Behavioral Survey, which was the dataset used by the previous researchers. We found that among PWID in rural Puerto Rico, unlike in the general population, knowledge of one's own HCV status had no significant effect on the selection of one's most recent injection partner, based on his/her HCV status. We conclude that PWID in rural Puerto Rico differ from the general U.S. population when it comes to serosorting behaviors, and that these differences should be taken into account in future outreaches and intervention strategies.
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1. Introduction

Recent research on a national CDC data base of people who inject drugs (PWID) Smith et al. (2013) found that participants who knew their own Hepatic C (HCV) status were more likely to ask potential injection partners about their HCV status before sharing injection equipment than participants who didn't know their own HCV status. The goal of this inquiry is to find partners who are of concordant HCV status and share only with them, so uninfected PWID do not contract Hepatitis C. This is a process known as "serosorting," (Smith et al., 2013). While these national-level findings are significant, we seek to replicate one of the models in this study using data collected in rural Puerto Rico, in order to draw comparisons between rural Puerto Rican PWID and the general U.S. population of PWID in regards to their serosorting behaviors.

It is well known that the behavior and norms of PWID vary from community to community, and this is no different with serosorting. A 2007 study comparing PWID in five U.S. cities found that perceived peer norms condoning needle sharing were the biggest factor associated with serosorting and needle sharing behaviors (Golub et al., 2007). Such peer norms have been shown to apply to ethnic sub-populations within larger PWID communities. Puerto Rican PWID living in the U.S. are more likely to share needles with one another (Deren et al., 2001) and twice as likely to take part in indirect equipment sharing (Andía et al., 2008) as non-Puerto Rican PWID in these same areas. Additional research found that Puerto Rican PWID who recently immigrated to New York City reported more risky injection behavior than those who were not new immigrants (Deren et al., 2003). These differences have immediate consequences: one study comparing New York PWID who identified as Puerto Rican to PWID who lived in Puerto Rico found that the latter had over four times the annual mortality rate of their New York counterparts (Colon et al., 2006). In part, this is due to radical disparities in availability of care. Here we argue that underlying these disparities are large differences in behavior and disposition to risk.

Hepatitis C is a public health issue with the potential for serious consequences if left unattended. First discovered in 1989 (Choo et al., 1989), recent reports suggest that 2.7 million Americans are chronically HCV+ (Denniston et al., 2014), and worldwide between 130 and 170 million people, or 2 to 3% of the population, is infected with HCV (Averhoff et al., 2012). Of these, approximately 500,000 die each year as a result of HCV infection related diseases (Lozano et al., 2012). HCV is a blood borne virus, putting PWID at a particularly high risk of infection. Current research suggests that approximately one third of PWID under age 30 are infected with HCV, and prevalence among older and former PWID ranges from 70 to 90% (U.S. Centers of Disease Control and Prevention, 2015a). In recent years, deaths as a result of HCV have outpaced those from the human immunodeficiency virus (HIV) in the

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U.S. (Ly et al., 2012). Among PWID in particular, incidence and prevalence rates of HCV infection (Hahn et al., 2002; Roy et al., 2007) have far surpassed those of HIV (Mehta et al., 2006).

One reason for this is that the HCV virus is highly robust in comparison to HIV, capable of surviving for days without a host, particularly in some types of syringes (Paintsil et al., 2010) and injection works like cookers and cotton (Abadie et al., 2016). Additionally, a March 2014 CDC report states that 80% of PWID with HIV are co-infected with HCV as well (U.S. Centers of Disease Control and Prevention, 2015b), indicating that in many situations, potential HCV infections confront individuals with reduced immune function.

Current common HCV treatment typically involves taking prophylactic medications, which have been found effective in 43 to 80% of patients, depending on the genotype of the infection (Manns et al., 2001). When these treatments do work, though, they come with problematic side effects (Alvarez et al., 2006). Additionally, a new HCV treatment drug, Sofosbuvir, has recently come on to the market. Though it has potential to treat HCV more effectively than current methods, it's high cost must be weighed against these benefits (Berden et al., 2014).

Because HCV is spread in much the same way as HIV, interventions to curb HCV transmissions are often patterned after HIV interventions. A common one is the "testing as intervention" method. Here, PWID are tested for the Hepatitis C virus and/or HIV and encouraged to serosort when selecting injection partners. However, the majority of serosorting research has been done on sexual partner selection, not injection partner selection (Cox et al., 2004; Fendrich et al., 2010; Zablotska et al., 2009). In regards to sexual transmission, there is indeed reason to believe that serosorting reduces the risk of HIV infection (Philip et al., 2010), and the practice is recommended for sexual risk by the CDC (Serosorting|HIV Risk Reduction Tool|CDC, 2016).

Concerning infection through co-injection, one study focusing specifically on HIV found that approximately 40% of PWID regularly serosorted (Mizuno et al., 2011). Earlier research on HCV serosorting among PWID found a similar proportion (Burt et al., 2009). Despite the similar percentage of serosorting, Hepatitis C is not considered a serious threat in some PWID communities, at least in comparison to HIV. One recent study found that 86% of Seattle PWID and 90% of those in Denver who knew they had an HCV infection failed to get treatment, despite outreach programs available in the community (Al-Tayyib et al., 2015). Other research suggests that many PWID see infection as an unavoidable consequence of injecting (Rhodes et al., 2004).

2. Methods

Interviews with 315 participants were completed between April 19th, 2015 and June 15, 2015 in rural areas approximately 30–40 miles from San Juan, Puerto Rico, drawing participants from several surrounding towns. We worked with El Punto en la Montaña, a syringe exchange program operating in these areas, to facilitation data collection. All information was collected in private research offices or a similar, confidential interview space. Eligible participants were alert, 18 years of age or older, and reported injecting drugs within the last 30 days. Visual inspections for injection signs, as well as questionnaires about drug injection knowledge, were used to confirm this. Upon completing the questionnaire, participants were compensated with $25. Recruitment into the sample was managed using respondent driven sampling (RDS) whereby participants who completed the survey were given three referral coupons they could pass out to other qualified individuals who had not previously participated in the project. For every referral that then completed the survey, the referee could earn an additional $10. This method of recruitment is often preferred for stigmatized populations (Heckathorn, 2002). The study received IRB approval through the University of Nebraska-Lincoln (IRB# 20131113844FB) and the University Of Puerto Rico School Of Medicine (IRB# A8480115). Additional details about the sampling procedure can be found in previous work using the data (Abadie et al., 2016).

The questionnaire itself was interviewer-administered and based on the CDC NHBS IDU Round 3 Questionnaire version 13. The instrument asked questions about injection behavior, prior HCV and HIV status and testing, and several other topics related to drug use and HIV/HCV risk. In addition to recording the participants' self-reported HCV and HIV status prior to participating in the study, the project provided rapid testing for both HIV and HCV - INSTI Rapid HIV antibody tests (Biolytical Laboratories) and OraQuick HCV Rapid antibody tests (OraSure Technologies). Participants were compensated an additional $5 for each test completed. Participants who tested positive for HCV or HIV were offered referral and transportation to a primary care doctor for confirmatory testing and link-to-care.

The current analysis replicates Model 2 from Smith et al., which examined if participants could have attempted to serosort on their last injection partner, or simply if they had knowledge of their last injection partner's HCV status (Smith et al., 2013). It does not examine how participants used this information: only if they sought it. The exact phrasing of this question is as follows: "*The last time you injected with this person* [last injection partner]*, did you know if they had been tested for Hepatitis C?*" The factors for asking your potential partner about their HCV status before co-injecting discussed by Smith et al. include 1) self-reported HCV status, 2) gender, 3) birth year (age), 4) education (high school graduate vs. not), 5) ever homeless, 6) employment status, 7) income, and 8) age at first injection. Multivariate logistic regressions were performed and adjusted odds ratios, where all variables are placed in the model at once to control for one another, were calculated to assess how each variable was associated with whether respondents had knowledge of their last injection partner's HCV status. Models 1 and 3 from the Smith et al. study are not replicated here due to our substantially smaller sample size.

Our model mirrored the Smith et al. model, but with four distinguishable differences. First, race/ethnicity was included in the Smith et al. model, but this information was impractical for our rural Puerto Rican sample as all but a very small number of participants in the study identified as Puerto Rican. Second, Smith et al. measured homelessness by whether participants had ever been homeless. Our participants were asked only about homelessness during the 12 months prior to the interview. Third, due to differences in average income between Puerto Rico and the U.S. mainland, an annual income of $5000 was used as the threshold point between high-income and low-income, as opposed to the $15,000 marker used by Smith and colleagues. A threshold of $5000 was chosen to allow income percentiles to remain roughly proportional. U.S. Census data shows that the median 2012 income for the U.S. was $51,915 (U.S. Census Bureau, 2015a) and $19,518 for Puerto Rico (U.S. Census Bureau, 2015b). Keeping the same ratio, $15,000 on the mainland is comparable to $5638 on the island. Because our data on income was collected at the ordinal level, using a tipping point of $5000 is the best available option.

Finally, as our sample was substantially smaller, only one participant in the final sample was over the age of 65, this individual was binned down into the next younger age category and the highest age category was not used. Though data was collected from 315 participants, skip patterns in the questionnaire resulted in only 162 respondents on our dependent variable – if they had knowledge of their last injection partner's HCV status. Respondents who reported either a) never injecting with a partner, or b) injecting with multiple partners or in a shooting gallery on last injection were skipped on this question. List wise deletion for missing data across independent and control variables resulted in a loss of 8 additional cases, giving us a final sample-size of 154. *t*-Tests revealed significant differences between our analytic sample and our excluded sample in four areas: respondents in the analytic sample were more likely to be HCV positive ($p = 0.0446$), less likely to make $5000 a year or more ($p = 0.0184$), less likely to be unemployed ($p = 0.0175$) vs. employed, and more likely to have some other employment status (0.0269) than be employed, such as being a student or retired.

3. Results

Of the 154 individuals in the analytical sample, 55.8% reported HCV+ status, 24% reported HCV− status, and 20.1% were unsure of their HCV status. The vast majority of our sample was men, with women making up only 11.7%. Ages were grouped in categories for analysis, but the mean age was 42.21 years. The majority of our sample was unemployed (80.5%) and almost none made over $5000 a year (3.9%). Just over half the rural Puerto Rico sample had graduated high school. Around a third of our sample had been homeless in the past year. Age at first injection was distributed relatively evenly, with just under a 10% difference between the most and least common categories. Details of the sample can be found in Table 1 below.

When following the analysis of Model 2 using the rural Puerto Rico data, the main independent variable in Smith et al.'s analysis, HCV status, was found to *not* be a significant correlate of having knowledge of last injection partner's HCV status. Odds ratios were substantial – 1.46 for a positive status and 1.75 for a negative status (as comparted to an unknown status) – and trended in the same direction as in the national data. However, HCV status failed to reach significant p–values, or even approach them, as a factor. Furthermore, Table 2 shows that confidence intervals for these odds ratios are incredibly wide – with the upper limit being a full order of magnitude larger than the lower limit for positive status. Only one characteristic in the model was significantly associated with knowledge of last injection partner's HCV status: gender. Women were 5.295 times as likely to have knowledge of their last injection partner's HCV status as men, and this was significant with a p-value less than 0.01. In Smith et al., women were only 1.8 times as likely to have knowledge of their last injection partner's HCV status. All other factors that were statistically significant in the Smith et al. article, including known HCV status, income, education, homelessness, and employment status, were not significant in our data, and failed to even approach significance.

Due to our relatively small sample size, we ran an additional model using robust standard errors. We find almost no difference between the robust model and our initial model. The robust model is detailed in Table 3. Additionally, using a large number of controls violated common practice regarding logistic regression. Though some research suggests these rules can be relaxed (Vittinghoff and McCulloch, 2007), we ran an additional model using fewer controls.

Table 1
Frequency distribution of variables.

Variable	N	Percentage
Self-reported HCV status		
Positive	86	55.8
Negative	37	24.0
Unknown	31	20.1
Female	18	11.7
Age (years)		
18–34	40	26.0
35–44	45	29.2
45–54	52	33.8
55+	17	11.0
High school graduate or above	83	53.9
Homeless in past 12 months	55	35.7
Employment status		
Employed	12	7.8
Disabled	9	5.8
Other (student, retired, etc)	9	5.8
Unemployed	124	80.5
High income ($5000+/year)	39	3.9
Age at first injection		
Under 18	57	37.0
18–24	55	35.7
25+	42	27.3
Serochecked on last injection partner	47	30.5

Table 2
Adjusted odds ratios of awareness of last injection partner's HCV status.

N = 154		
Participant characteristics	Adjusted odds ratio	95% confidence interval
Self-reported HCV status		
Positive	1.4940	(0.5069, 4.4032)
Negative	1.7536	(0.5469, 5.6222)
Unknown	Reference	
Gender		
Female	5.2954	(1.7221, 16.2831)
Male	Reference	
Age		
55+	1.6138	(0.3637, 7.1602)
45–55	1.5541	(0.5519, 4.3758)
35–45	1.1202	(0.3828, 3.2779)
18–34	Reference	
Education		
High school grad	1.2209	(0.5829, 2.557)
Less than HS	Reference	
Homeless in past 12 months		
Yes	0.6551	(0.2766, 1.5514)
No	Reference	
Employment status		
Unemployed	1.4911	(0.3477, 6.3935)
Disabled	1.4688	(0.1773, 12.1646)
Other	1.4626	(0.1615, 13.2433)
Employed	Reference	
Income		
$5000/yr+	1.5263	(0.6182, 3.7681)
Less than $15,000	Reference	
Age at 1st injection		
25+	0.6204	(0.2257, 1.7048)
18–24	1.1987	(0.5001, 2.8735)
Under 18	Reference	

This models also failed to find a significant relationship for our main independent variables. Details of this simplified model can be found in Table 4.

Table 3
Adjusted odds ratios of awareness of last injection partner's HCV status, with robust standard errors.

N = 154		
Participant characteristics	Adjusted odds ratio	95% confidence interval
Self-reported HCV status		
Negative	1.7536	(0.5469, 5.6222)
Positive	1.4940	(0.5069, 4.4032)
Unknown	Reference	
Gender		
Female	5.2954	(1.7221, 16.2831)
Male	Reference	
Age		
55+	1.6139	(0.3637, 7.1602)
45–55	1.5541	(0.5519, 4.3758)
35–45	1.1202	(0.3828, 3.2779)
18–34	Reference	
Education		
High school grad	1.2209	(0.5829, 2.5573)
Less than HS	Reference	
Homeless in past 12 months		
Yes	0.6551	(0.2766, 1.5514)
No	Reference	
Employment status		
Unemployed	1.4911	(0.3477, 6.3935)
Disabled	1.4688	(0.1773, 12.1646)
Other	1.4626	(0.1615, 13.2433)
Employed	Reference	
Income		
$5000/yr+	1.5263	(0.6182, 3.7681)
Less than $15,000	Reference	
Age at 1st injection		
25+	0.6204	(0.2257, 1.7048)
18–24	1.1987	(0.5001, 2.88735
Under 18	Reference	

4. Discussion

Our sample was similar to the larger, urban sample used by Smith and colleagues in many ways, but also unique in many ways as well. The two were comparable on age at first injection, age overall, education level (thought the rural sample was slightly less educated), and had similar distributions of HCV status. Our rural sample had fewer women, fewer homeless, and fewer low-income respondents.

The findings from our data are vastly different from those found in prior work on HCV serosorting. While Smith et al. found that self-reported HCV status (either positive or negative), income, education, homelessness, and employment status were all associated with having knowledge last injection partner's HCV status in the general U.S. population, none of these served as correlates in our sample of rural Puerto Ricans. Our results did mirror the finding from the general population that age is not strongly associated with attempted serosorting, however, in that it was unrelated to having knowledge of last injection partner's HCV status.

Whereas research on the U.S. mainland revealed that around 40% of PWID attempted to serosort on HCV (Burt et al., 2009) and Smith et al.'s study using similar questions found that 37.7% of PWID who shared equipment had knowledge of their last injection partner's HCV status, this was only true for 30.5% of respondents in rural Puerto Rico. Despite being the biggest factor in Smith et al.'s study of PWID across the U.S. mainland, knowing your own HCV status had no influence on attempting to serosort for PWID in rural Puerto Rico, via asking your last partner about their HCV status.

It is possible that our inability to obtain similar results is due to our drastically smaller sample size. However, we did run additional tests to examine this possibility, and still failed to obtain a significant relationship between HCV status and knowledge of last injection partner's HCV status.

It should also be noted that our findings contrast those of Smith and colleagues' urban sample, in that we find a stronger effect for HCV− respondents than for those who are HCV+. This was the opposite in the urban study, which found that HCV+ respondents were 4.1 times and HCV− respondents were 2.5 times as likely as their peers with an unknown HCV status to have knowledge of their last injection partner's HCV status. We find that HCV+ respondents are 1.49 times as likely and HCV− respondents are 1.75 times as likely as their peers with an unknown HCV status to have knowledge of their last injection partner's HCV status.

In other words, PWID with HCV are more likely to know their last partner's HCV status than their peers without HCV in the urban sample. In our rural sample, we find the opposite: that PWID without HCV are more likely than their peers with the virus to know their last partner's HCV status. This suggests that the burden of preventing transmission may be on those without HCV in rural Puerto Rico. This may be unique to this community, as previous research suggests that PWID perceive the burden of preventing new infections to be on those already infected with HCV (Treloar et al., 2015).

Only one factor from Smith et al.'s study persisted: gender. Gender was found to be a much bigger factor in our PR data than in the general population: female PWID from rural Puerto Rico were over five times as likely to have knowledge of their last injection partner's HCV status as male PWID, compared to nearly twice as likely in the U.S. population as a whole. In our sample, women were less likely to self-report being HCV+ than men, and a comparatively smaller percentage of women who completed an HCV test with us had positive results as well. However, simple *t*-tests found that these differences were not significant. Furthermore, previous work found that women who inject drugs are actually 2–3 times more likely to acquire HCV than men (Lidman et al., 2009; Maher et al., 2007), suggesting that the benefits of attempting to serosort by knowing your injection partner's HCV status may be smaller than originally thought. However, women also share equipment more often than men (Frajzyngier et al., 2007) and are more likely to borrow needles (Evans et al., 2003) as well. It is possible that this is the cause for both their increased likelihood of infection, as well as their increased vigilance in serosorting behaviors. Not only do they have more opportunities for infection, but having more opportunities may also make the risk of infection more salient, leading to greater likelihood of asking their last partner about their HCV status.

The finding that Puerto Rican PWID behave in unique ways is not entirely a new one. Previous research found that Puerto Rican PWID are more likely to share needles and other equipment than their mainland counterparts, and Puerto Rican natives who immigrate to the U.S. mainland often make changes to their risk behaviors (Deren et al., 2003). These results point to another aspect of risk behavior in which rural Puerto Rican PWID represent unique challenges to programs aimed at lowering HCV infection and risk of infection, and likely HIV infection as well (Dombrowski et al., 2013a,b; Khan et al., 2013; Friedman et al., 1997).

Finally, our results supported the finding from Smith et al. that age at first injection is not a significant factor for knowing your last injection partner's HCV status. It is interesting, however, that both studies found that PWID who did not begin injecting until they were 25 years of age or older were less likely to have knowledge of their last injection partner's HCV status than their peers who began injecting earlier in life. Though neither study found this to be a significant factor at the 95% confidence level, it did approach significance in the Smith et al. study. The possibility exists that people who begin drug use later in life, when they are presumably wiser and more mature, are actually less likely to have this knowledge and may take part in riskier behavior. To the extent that this finding seems to defy conventional wisdom, future research could benefit from exploring this relationship further.

Table 4
Adjusted odds ratios of serochecking, robust standard errors, simplified model.

N = 154		
Participant characteristics	Adjusted odds ratio	95% confidence interval
Self-reported HCV status		
Negative	2.0792	(0.6815, 6.3437)
Positive	1.6257	(0.5999, 4.4053)
Unknown	Reference	
Gender		
Female	4.3938	(1.5546, 12.4183)
Male	Reference	

5. Limitations

The most important limitation in this study is the drastically smaller sample size in comparison to Smith et al.'s study. It should be noted that a substantial portion of our obtained sample was not included in our analytical sample, because they had injected with multiple partners on their last injection. This may skew our results and impact generalizability, as the riskiest respondents were not included in our analysis here. Furthermore, our rural sample does differ from the larger urban sample on some key demographics, such as gender and homelessness. Differences between the two samples may be due to these demographic characteristics, rather than something unique about the culture surrounding injection drug use in rural Puerto Rico.

Whereas Smith and colleagues had a sample size of 4506 in their research, ours is limited to 154. However, Smith et al.'s main independent variable – HCV status – had p-values of less than 0.001 and large effect sizes, whereas HCV status in our data had smaller effect sizes and p-values ranging from 0.345 to 0.467. To put it another way, compared to unknown HCV status, HCV+ participants were 1.49 (CI: 0.51, 4.40) times as likely to have knowledge of their last injection partner's HCV status, with HCV− participants being 1.75 (CI: 0.55, 5.62) times as likely. Comparatively, Smith et al. found HCV+ participants to be 4.1 (CI: 3.4, 4.9) times as likely to have knowledge of their last injection partner's HCV status, with HCV− participants being 2.5 (CI: 2.0, 3.0)

times as likely, compared to those with an unknown HCV status. Given this, it is unlikely that the variation in findings are due only to sample sizes.

Furthermore, though both studies find that PWID who know their own HCV status are more likely to know their last partner's status, the trend is flipped for confirmed negatives and confirmed positives in our study. In other words, the strongest relationship in the large urban study by Smith and colleagues was for HCV+ respondents, whereas it was strongest for HCV− respondents in our rural sample. If knowing your own HCV status is indeed a significant factor in knowing your last injection partners HCV status in rural Puerto Rico, it is likely that this relationship is much weaker than on the U.S. mainland. Additionally, it is comparatively stronger for HCV− PWID than HCV+ PWID, the reverse of what we see on the mainland. Using sample sizes that are more comparable is suggested for future research.

6. Conclusion

This study provides evidence that PWID in rural Puerto Rico behave differently and may have different norms regarding HCV serosorting than PWID in urban communities on the U.S. mainland. Despite being the biggest factor on the mainland, knowing your own HCV status appears to have no recognizable influence on knowing the HCV status of your last injection partner in rural Puerto Rico. This is a substantial contrast between the two communities, and one that should be considered when designing preventative interventions and treatments.

While this may point to a situation of critical need (such as for education on the benefits of serosorting), future outreach programs can potentially see this lack of protective and preventative behaviors as an opening for immediate intervention. By a combined approach of both testing and education aimed at the long-term health risk of living with HCV, health professionals can potentially reduce the risk associated with ignoring status discordance altogether—to put it bluntly, there is nowhere to go but up. The extent to which the collective behaviors discussed here are limited to rural Puerto Rico, or rural areas more generally, remains is unknown. However, it seems likely that the combination of HCV saturation in PWID communities and the low levels of status reporting found in some other contexts (Miller et al., 2003) suggest that our results may carry over to other regions as well.

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References

Abadie, R., Welch-Lazoritz, M., Gelpi-Acosta, C., Reyes, J.C., Dombrowski, K., 2016. Understanding differences in HIV/HCV prevalence according to differentiated risk behaviors in a sample of PWID in rural Puerto Rico. Harm Reduct. J. 13, 10.

Al-Tayyib, A.A., Thiede, H., Burt, R.D., Koester, S., Feb 2015. Unmet health care needs and hepatitis C infection among persons who inject drugs in Denver and Seattle, 2009. Prev. Sci. Off J. Soc. Prev. Res. 16 (2), 330–340.

Alvarez, D., Dieterich, D.T., Brau, N., Moorehead, L., Ball, L., Sulkowski, M.S., Oct 2006. Zidovudine use but not weight-based ribavirin dosing impacts anaemia during HCV treatment in HIV-infected persons. J. Viral Hepat. 13 (10), 683–689.

Andía, J.F., Deren, S., Robles, R.R., Kang, Sung–Yeon, Colón, H.M., Jun 2008. Peer norms and sharing of injection paraphernalia among Puerto Rican injection drug users in New York and Puerto Rico. AIDS Educ. Prev. 20 (3), 249–257.

Averhoff, F.M., Glass, N., Holtzman, D., Jul 15 2012. Global burden of hepatitis C: considerations for healthcare providers in the United States. Clin. Infect. Dis. 55 (Suppl. 1), S10–S15.

Berden, F. a C., Kievit, W., Baak, L.C., et al., Oct 2014. Dutch guidance for the treatment of chronic hepatitis C virus infection in a new therapeutic era. Neth. J. Med. 72 (8), 388–400.

Burt, R.D., Thiede, H., Hagan, H., Dec 1 2009. Serosorting for hepatitis C status in the sharing of injection equipment among Seattle area injection drug users. Drug Alcohol Depend. 105 (3), 215–220.

Choo, Q.L., Kuo, G., Weiner, A.J., Overby, L.R., Bradley, D.W., Houghton, M., Apr 21 1989. Isolation of a cDNA clone derived from a blood-borne non-A, non-B viral hepatitis genome. Science 244 (4902), 359–362.

Colon, H.M., Deren, S., Robles, R.R., Kang, S.-Y., Cabassa, M., Sahai, H., Nov 2006. A comparative study of mortality among Puerto Rican injection drug users in East Harlem, New York, and Bayamon, Puerto Rico. J. Urban Health Bull. NY Acad. Med. 83 (6), 1114–1126.

Cox, J., Beauchemin, J., Allard, R., Dec 2004. HIV status of sexual partners is more important than antiretroviral treatment related perceptions for risk taking by HIV positive MSM in Montreal, Canada. Sex. Transm. Infect. 80 (6), 518–523.

Denniston, M.M., Jiles, R.B., Drobeniuc, J., et al., Mar 4 2014. Chronic hepatitis C virus infection in the United States, National Health and nutrition examination survey 2003 to 2010. Ann. Intern. Med. 160 (5), 293–300.

Deren, S., Robles, R., Andia, J., Colón, H.M., Kang, S.Y., Perlis, T., Feb 1 2001. Trends in HIV seroprevalence and needle sharing among Puerto Rican drug injectors in Puerto Rico and New York: 1992–1999. J. Acquir. Immune Defic. Syndr. 26 (2), 164–169.

Deren, S., Kang, S.-Y., Colón, H.M., et al., May 2003. Migration and HIV risk behaviors: Puerto Rican drug injectors in New York City and Puerto Rico. Am. J. Public Health 93 (5), 812–816.

Dombrowski, K., Curtis, R., Friedman, S., Khan, B., 2013a. Topological and historical considerations for infectious disease transmission among injecting drug users in Bushwick, Brooklyn (USA). World J. AIDS. 3 (1), 1–9 (Mar 1).

Dombrowski, K., Khan, B., McLean, K., et al., 2013b. A reexamination of connectivity trends via exponential random graph modeling in two IDU risk networks. Subst. Use Misuse 48 (14), 1485–1497 (Dec).

Evans, J.L., Hahn, J.A., Page-Shafer, K., et al., Mar 2003. Gender differences in sexual and injection risk behavior among active young injection drug users in San Francisco (the UFO study). J. Urban Health Bull. NY Acad. Med. 80 (1), 137–146.

Fendrich, M., Mackesy-Amiti, M.E., Johnson, T.P., Pollack, L.M., May 2010. Sexual risk behavior and drug use in two Chicago samples of men who have sex with men: 1997 vs. 2002. J. Urban Health 87 (3), 452–466.

Frajzyngier, V., Neaigus, A., Gyarmathy, V.A., Miller, M., Friedman, S.R., Jul 10 2007. Gender differences in injection risk behaviors at the first injection episode. Drug Alcohol Depend. 89 (2–3), 145–152.

Friedman, S.R., Neaigus, A., Jose, B., et al., Aug 1997. Sociometric risk networks and risk for HIV infection. Am. J. Public Health 87 (8), 1289–1296.

Golub, E.T., Strathdee, S.A., Bailey, S.L., et al., Nov 2007. Distributive syringe sharing among young adult injection drug users in five U.S. cities. Drug Alcohol Depend. 91 (Suppl. 1), S30–S38.

Hahn, J.A., Page-Shafer, K., Lum, P.J., et al., Dec 1 2002. Hepatitis C virus seroconversion among young injection drug users: relationships and risks. J. Infect. Dis. 186 (11), 1558–1564.

Heckathorn, D.D., Feb 2002. Respondent-driven sampling II: deriving valid population estimates from chain-referral samples of hidden populations. Soc. Probl. 49 (1), 11–34.

Khan, B., Dombrowski, K., Saad, M., et al., Jun 4 2013. Network firewall dynamics and the subsaturation stabilization of HIV. Discret. Dyn. Nat. Soc. 2013, e720818.

Lidman, C., Norden, L., Kåberg, M., et al., Sep 2009. Hepatitis C infection among injection drug users in Stockholm Sweden: prevalence and gender. Scand. J. Infect. Dis. 41 (9), 679–684.

Lozano, R., Naghavi, M., Foreman, K., et al., Dec 15 2012. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 380 (9859), 2095–2128.

Ly, K.N., Xing, J., Klevens, R.M., Jiles, R.B., Ward, J.W., Holmberg, S.D., Feb 21 2012. The increasing burden of mortality from viral hepatitis in the United States between 1999 and 2007. Ann. Intern. Med. 156 (4), 271–278.

Maher, L., Li, J., Jalaludin, B., Chant, K.G., Kaldor, J.M., Feb 2007. High hepatitis C incidence in new injecting drug users: a policy failure? Aust. N. Z. J. Public Health 31 (1), 30–35.

Manns, M.P., McHutchison, J.G., Gordon, S.C., et al., Sep 22 2001. Peginterferon alfa-2b plus ribavirin compared with interferon alfa-2b plus ribavirin for initial treatment of chronic hepatitis C: a randomised trial. Lancet 358 (9286), 958–965.

Mehta, S.D., Ghanem, K.G., Rompalo, A.M., Erbelding, E.J., May 2006. HIV seroconversion among public sexually transmitted disease clinic patients: analysis of risks to facilitate early identification. J. Acquir. Immune Defic. Syndr. 1999 42 (1), 116–122.

Miller, M., Mella, I., Moi, H., Eskild, A., Jul 1 2003. HIV and hepatitis C virus risk in new and longer-term injecting drug users in Oslo, Norway. J. Acquir. Immune Defic. Syndr. 1999 33 (3), 373–379.

Mizuno, Y., Purcell, D., Metsch, L., Gomez, C., Knowlton, A., Latka, M., Dec 2011. Is injection serosorting occurring among HIV-positive injection drug users? Comparison by injection partner's HIV status. J. Urban Health 88 (6), 1031–1043.

Paintsil, E., He, H., Peters, C., Lindenbach, B.D., Heimer, R., Oct 1 2010. Survival of hepatitis C virus in syringes: implication for transmission among injection drug users. J. Infect. Dis. 202 (7), 984–990.

Philip, S.S., Yu, X., Donnell, D., Vittinghoff, E., Buchbinder, S., Sep 9 2010. Serosorting is associated with a decreased risk of HIV seroconversion in the explore study cohort. PLoS One 5 (9), e12662.

Rhodes, T., Davis, M., Judd, A., May 2004. Hepatitis C and its risk management among drug injectors in London: renewing harm reduction in the context of uncertainty. Addiction 99 (5), 621–633.

Roy, E., Alary, M., Morissette, C., et al., Jan 2007. High hepatitis C virus prevalence and incidence among Canadian intravenous drug users. Int. J. STD AIDS 18 (1), 23–27.

Serosorting|HIV Risk Reduction Tool|CDC [Internet]. [cited Dec 8 2016]. Available from: https://wwwn.cdc.gov/hivrisk/decreased_risk/communication/same_status.html

Smith, B.D., Jewett, A., Burt, R.D., Zibbell, J.E., Yartel, A.K., DiNenno, E., Dec 15 2013. "To Share or Not to Share?" serosorting by hepatitis C status in the sharing of drug injection equipment among NHBS-IDU2 participants. J. Infect. Dis. 208 (12), 1934–1942.

Treloar, C., McCredie, L., Lloyd, A.R., May 2015. Acquiring hepatitis C in prison: the social organisation of injecting risk. Harm Reduct. J. 12 (1), 1–7.

U.S. Census Bureau, 2015a. Household Income: 2013 - acsbr13-02.pdf [Internet]. (Aug 4). (Available from:). https://www.census.gov/content/dam/Census/library/publications/2014/acs/acsbr13-02.pdf.

U.S. Census Bureau, 2015b. Income in Puerto Rico Holds Steady After Recession [Internet]. (Aug 4). (Available from:). http://www.census.gov/newsroom/press-releases/2014/cb14-17.html.

U.S. Centers of Disease Control and Prevention, 2015a. HCV FAQs for Health Professionals|Division of Viral Hepatitis|CDC [Internet]. (Jul 27). (Available from:). http://www.cdc.gov/hepatitis/HCV/HCVfaq.htm.

U.S. Centers of Disease Control and Prevention. HIV and Viral Hepatitis. - library_factsheets_HIV_and_viral_Hepatitis.pdf [Internet]. www.cdc.gov. (Aug 4) 2015b. (Available from:) http://www.cdc.gov/hiv/pdf/library_factsheets_HIV_and_viral_Hepatitis.pdf

Vittinghoff, E., McCulloch, C.E., Mar 15 2007. Relaxing the rule of ten events per variable in logistic and cox regression. Am. J. Epidemiol. 165 (6), 710–718.

Zablotska, I.B., Imrie, J., Prestage, G., et al., Apr 2009. Gay men's current practice of HIV seroconcordant unprotected anal intercourse: serosorting or seroguessing? AIDS Care 21 (4), 501–510.