ELSEVIER

Health & Place 13 (2007) 432–439

HEALTH & PLACE

www.elsevier.com/locate/healthplace

Neighborhood and HIV infection among IDU: Place of residence independently predicts HIV infection among a cohort of injection drug users

Benjamin Maas[a], Nadia Fairbairn[a], Thomas Kerr[a,b], Kathy Li[a], Julio S.G. Montaner[a,b], Evan Wood[a,b,*]

[a]*British Columbia Centre for Excellence in HIV/AIDS, St. Paul's Hospital, Canada*
[b]*Department of Medicine; University of British Columbia, Canada*

Received 6 September 2005; received in revised form 29 April 2006; accepted 1 May 2006

Abstract

This study was undertaken to investigate geographic residence in Vancouver's Downtown Eastside (DTES), Canada's poorest urban neighborhood, as an environmental risk factor for HIV infection among a cohort of injection drug users. HIV incidence rates were examined using Kaplan–Meier methods, and Cox proportional hazards regression was used to determine independent risk factors for HIV seroconversion. After intensive multivariate adjustment, DTES residence remained an independent predictor of HIV seroconversion (relative hazard = 2.0, 95% CI: 1.4–3.0, $p<0.001$). These findings indicate the need for a greater recognition among policy-makers of geographic location as a risk factor for HIV incidence in urban settings and the need for further research to determine why place contributes so greatly to HIV risk. The findings also mark a need for prevention interventions to be appropriately targeted towards high-risk neighborhoods.

Keywords: HIV; IDU; Risk environment; Neighborhood; Vancouver

Introduction

Vancouver's Downtown Eastside (DTES) is the poorest urban area in Canada, and the home to over 16,000 long-term residents and approximately 4700 of Vancouver's estimated 8000 injection drug users (IDU) (Wood et al., 2004a; Statistics Canada, 1996; Vancouver Coastal Health, 2003). Like disadvantaged urban neighborhoods in other cities, Vancouver's DTES is characterized by extreme poverty, high crime rates, homelessness, unsatisfactory housing, and high levels of alcohol and drug abuse (City of Vancouver, 2000; Wood et al., 2004b). As the largest and most open illicit drug market in the province, a significant number of other IDU regularly visit the DTES to obtain and use illicit drugs (Wood et al., 2004b). As such, it is possible that the DTES may act not only as an epicenter of drug distribution, but also potentially for the spread of infectious diseases.

The spread of Human Immunodeficiency Virus (HIV) among IDU remains a growing public health

*Corresponding author. Division of Clinical Activities, BC Centre for Excellence in HIV/AIDS, 608-1081 Burrard Street, Vancouver, BC, Canada V6Z 1Y6. Tel.: +1 403 701 8423; fax: +1 604 806 9044.
E-mail address: ewood@cfenet.ubc.ca (E. Wood).

1353-8292/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.healthplace.2006.05.005

emergency and this has been particularly true of Vancouver's DTES (Hamers and Downs, 2003; Kitayaporn et al., 1994; Des Jarlais et al., 1995). IDU studied in Vancouver experienced an 18% annual HIV incidence rate in 1997, and while rates of new infection have since decreased due to saturation in the local IDU community, an HIV prevalence rate of 35% persists among local IDU (Kuyper et al., 2004; Tyndall et al., 2001; Strathdee et al., 1997). Several studies have shown that neighborhood disadvantage and gentrification can increase HIV vulnerability in US inner-city districts, although the role of geographic neighborhoods and how they contribute to HIV risk remains an area in need of urgent further investigation (Rhodes et al., 2005; Fuller et al., 2005; Wallace, 1990; McCord and Freeman, 1990).

Recently, there has been growing interest in environmental and ecological determinants in public health within illicit drug use research (Rhodes, 2002; Rhodes et al., 2003; Galea et al., 2003; Poundstone et al., 2004). While individual-level markers of risk that are prevalent among IDU are undoubtedly of significance, the ecological conditions that exacerbate risk behavior and adverse health outcomes among IDU have received relatively limited attention in the scientific literature. In particular, few studies have examined if place may be independently associated with HIV incidence among IDU. This is an important gap in current knowledge, since place of residence may act as a proxy for risk behaviors that are often not captured at the individual level in conventional epidemiologic studies. Specifically, place of residence may reflect the role of the social and physical environment on vulnerability and exposure to risk. Rhodes has recently elucidated the concept of the "risk environment" which has been defined to include social situations, structures, and places which contribute to risk, external to individual decision making (Rhodes et al., 2005; Rhodes, 2002; Singer, 1994). Thus, there is emerging evidence to suggest that place itself may affect health outcomes for IDU through physical features such as commercial injecting venues (e.g. "shooting galleries"), public drug markets, alleys commonly used for injection, and single room occupancy (SRO) hotels.

Apart from the specific role of place in the creation of risk, the identification of high-risk environments and neighborhoods can lead to the more effective distribution of resources, and appropriate local development initiatives that may help prevent the spread of disease locally and to other areas. The present study was, therefore, undertaken to evaluate the potential association between HIV incidence and geographic residence among a cohort of IDU in Vancouver, Canada.

Methods

The Vancouver Injection Drug Users Study (VIDUS) is an open prospective cohort of IDU that has been described previously (Tyndall et al., 2003; Wood et al., 2001; Strathdee et al., 1997). Briefly, at baseline and semi-annually, subjects provided blood samples for HIV serology and completed an interviewer-administered questionnaire. The VIDUS study is annually approved by the University of British Columbia's Research Ethics Board.

The present study was conducted to examine the relationship between residence in Vancouver's Downtown Eastside and the rate of HIV seroconversion. Participants were eligible if they were recruited between May 1996 and December 2004, have had at least one follow-up visit, and were HIV-negative at enrollment.

Factors associated with DTES residence

An a priori defined statistical protocol was developed based on previous findings from the VIDUS study (Strathdee et al., 1997; Tyndall et al., 2003). As a first step, the baseline characteristics of participants stratified by DTES residence versus non-DTES residence were examined in an effort to evaluate potential baseline differences between residents of the DTES and those who resided elsewhere. Variables considered included gender, age (>24 vs. <24), ethnicity (Aboriginal or other), residence in unstable housing, daily heroin injection, daily cocaine injection, binge drug use, syringe borrowing, requiring help injecting, use of methadone, having sought but been unable to access addiction treatment, injecting drugs in a shooting gallery, and sex trade involvement. All variable definitions were identical to earlier studies (Tyndall et al., 2003; Wood et al., 2001). All behavioral variables were in reference to the prior six months, with the exception of methadone use, which referred to current use, and shooting gallery use, which was only measured at baseline. Pearson's Chi-square test was used to compare categorical explanatory variables.

Kaplan-Meier analysis

Second, the cumulative HIV rate among baseline DTES residents versus baseline non-DTES residents was plotted using Kaplan–Meier methods and the cumulative HIV incidence rates of the two groups were compared using the log-rank test. As previously (Tyndall et al., 2003), the date of seroconversion was estimated using the midpoint between the last negative and the first positive antibody test result, and participants who remained persistently seronegative were censored at the time of their most recent HIV antibody test result prior to December 2004.

Cox proportional hazard analyses

Third, we also calculated the unadjusted and adjusted relative hazards of HIV seroconversion using Cox proportional hazard regression. Unless otherwise noted, all behavioral variables, including neighborhood residence, were treated as time-updated covariates based on semi-annual follow-up data. Finally, a fixed model was built that adjusted for all variables described above that were statistically associated with HIV seroconversion in unadjusted analyses at $p<0.05$. Analyses were conducted using SAS 8.0 (Cary, NC) and the threshold for statistical significance was set at $p<0.05$. All p-values were two sided.

Results

Between May 1996 and December 2004, 1587 individuals were enrolled into the VIDUS cohort. Of these, 321 (20.2%) were HIV positive at baseline. Of the 1266 baseline HIV negative participants, 231 (18.2%) did not return for at least one follow-up. The 231 HIV-negative participants with only a baseline visit were more likely not to reside in the DTES ($p<0.001$) and to be younger than 24 years ($p<0.05$), whereas gender, ethnicity, and daily cocaine injection was similar between these two groups ($p>0.05$).

Of the remaining 1035 participants considered in the present study, 582 (56.2%) reported DTES residence at baseline and 453 (43.7%) reported residence elsewhere in Vancouver. A number of the individuals followed reported changes of residence during follow-up: 470 (45.4%) participants reported at least one move to the DTES from elsewhere in Vancouver, and 739 total moves to the DTES were observed, whereas 487 (48.0%) individuals reported at least one move out of the DTES area with a total of 707 moves within the overall cohort. Non-DTES neighborhoods of reported residence included downtown south, Fraser area, Grandview, Mt. Pleasant/Fairview, Burnaby, New Westminster, Surrey, Richmond, and Coquitlam/Maple Ridge, but the majority of non-DTES residents lived low income neighborhoods proximal to the DTES.

Analysis of baseline characteristics

As indicated in Table 1, DTES residents were more likely to be 24 or older (odds ratio [OR] = 1.6; $p=0.004$), Aboriginal (OR = 1.6; $p=0.003$), reside in unstable housing (OR = 6.9; $p<0.001$), to be involved in the sex trade (OR = 1.3; $p<0.04$), to use cocaine daily (OR = 1.8; $p<0.001$), and to inject drugs at a shooting gallery (OR = 1.4; $p<0.03$). DTES residents were less likely to be currently receiving methadone (OR = 0.5; $p<0.001$). At baseline the DTES residents and non-DTES residents were statistically similar ($p>0.05$) with respect to all other variables including gender, heroin frequency, syringe borrowing, binge drug use, and requiring help injecting.

Kaplan– Meier analysis

As of December 2004, 133 of 1035 participants (12.8%) had become HIV-infected. As shown in Fig. 1, at 48 months after recruitment into the study the Kaplan–Meier cumulative HIV incidence rate was 16.1% among those who resided in the DTES at baseline, compared to 8.9% among those who resided in other areas of Vancouver (log-rank $p<0.001$).

Cox proportional hazard analyses

Table 2 shows the unadjusted relative hazards (RH) for risk factors for HIV seroconversion which included: female gender, age greater than 24, Aboriginal ethnicity, unstable housing, syringe borrowing, requiring help injecting, Methadone use, binge drug use, daily heroin injection, daily cocaine injection, injection in a shooting gallery, sex trade involvement, and residence in the Downtown Eastside.

After adjustment for those variables that were associated with HIV seroconversion at the $p<0.05$

Table 1
Baseline demographic characteristics of IDU stratified by residence

Characteristic	DTES residence $n = 82$	Non-DTES residence $n = 453$	Odds ratio (95% CI)	p-value
Gender				
Male	367 (63.1)	303 (66.9)		
Female	215 (36.9)	150 (33.1)	1.2 (0.9–1.5)	0.2
Ethnicity				
Non-Aboriginal	412 (70.8)	358 (79.0)		
Aboriginal	170 (29.2)	95 (21.0)	1.6 (1.2–2.1)	0.003
Unstable housing[*]				
No	121 (20.8)	292 (64.5)		
Yes	461 (79.2)	161 (35.5)	6.9 (5.2–9.1)	<0.001
On methadone[†]				
No	539 (92.6)	387 (85.4)		
Yes	43 (7.4)	66 (14.6)	0.5 (0.3–0.7)	<0.001
Sex trade involved[*]				
No	412 (70.8)	346 (76.4)		
Yes	170 (29.2)	107 (23.6)	1.3 (1.0– 1.8)	0.04
Heroin injection[*]				
Less than daily	359 (61.7)	289 (63.8)		
Daily use	223 (38.3)	164 (36.2)	1.1 (0.8–1.4)	0.5
Cocaine injection[*]				
Less than daily	364 (62.5)	339 (74.8)		
Daily use	218 (37.5)	114 (25.2)	1.8 (1.4–2.3)	<0.001
Require help injecting[*]				
No	325 (55.8)	280 (61.8)		
Yes	257 (44.2)	173 (38.2)	1.3 (1.0–1.6)	0.05
Syringe borrowing[*]				
No	370 (63.6)	287 (63.4)		
Yes	212 (36.4)	166 (36.6)	1.0 (0.8–1.3)	0.9
Binge drug use[*]				
No	306 (52.6)	230 (50.8)		
Yes	276 (47.4)	223 (49.2)	0.9 (0.7–1.2)	0.6
Shooting gallery use[*]				
No	397 (68.2)	337 (74.4)		
Yes	185 (31.8)	116 (25.6)	1.4 (1.0–1.8)	0.03

Note: IDU = injection drug user, NEP = needle exchange program, DTES = Downtown Eastside Residence, Denied treatment refers to having sought but been unable to access addiction treatment.

[*]Indicates behavior during the six month period prior to the baseline interview.

[†]Indicates current use.

level, residence in the Downtown Eastside remained independently associated with HIV seroconversion. The relative hazard of HIV seroconversion for DTES versus non-DTES residents was 2.0 (95% CI: 1.4–3.0; $p < 0.001$). When the coefficients were tested for time dependence, we found that the assumptions of the Cox model were met. No statistically significant interactions were found.

Discussion

The findings of this study suggest that residence in Vancouver's DTES is an independent risk factor for HIV infection among a cohort of injection drug users. Its independent effect as a predictor of seroconversion, even after adjustment for all other reported risk behaviors emphasizes the importance of geography and location of residence in determining risk of infection. There were also a substantial number of moves to and from the DTES, which may have severe implications for HIV transmission beyond this community.

Like many impoverished urban neighborhoods, the standard of living in the DTES is very low and many residents live in unstable housing (City of Vancouver, 2000). Stress and depression caused by living in an impoverished urban environment may lead to increased drug use and HIV risk behavior as a coping mechanism (Latkin and Curry, 2003; Latkin et al., 2005; Sinha, 2001).

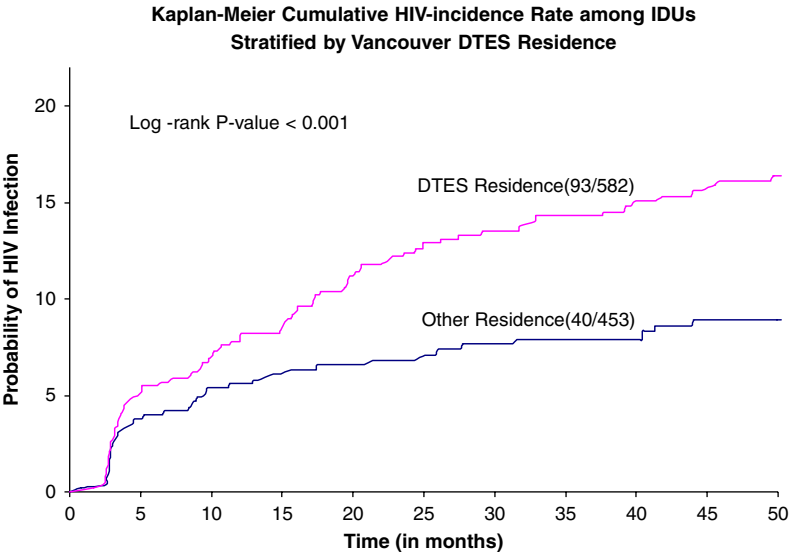

Fig. 1. The Kaplan-Meier cumulative HIV-incidence rate among injection drug users stratified by residence at baseline (Downtown Eastside versus Other).

Table 2
Univariate and multivariate Cox proportional hazard analyses of the time to HIV infection among 1035 injection drug users

	Unadjusted Relative hazard (RH)			Adjusted** Relative hazard (RH)		
Variable	RH	(95% CI)	*p*-value	RH	(95% CI)	*p*-value
*DTES residence**						
(Yes vs. No)	2.6	(1.8–3.7)	<0.001	2.0	(1.4–3.0)	<0.001
Gender						
(Female vs. Male)	1.5	(1.0–2.0)	0.03	1.1	(0.7–1.7)	0.6
Age						
(>24 yrs vs. <24 yrs)	0.9	(0.6–1.5)	0.9			
Ethnicity						
(Aboriginal vs. Other)	1.9	(1.4–2.7)	<0.001	1.8	(1.2–2.6)	0.003
*Unstable housing**						
(Yes vs. No)	1.6	(1.1–2.2)	0.01	1.1	(0.8–1.7)	0.5
Methadone use†						
(Yes vs. No)	0.8	(0.5–1.2)	0.3			
*Syringe borrowing**						
(Yes vs. No)	1.9	(1.3–2.8)	<0.001	1.5	(1.0–2.2)	0.04
*Require help injecting**						
(Yes vs. No)	2.3	(1.6–3.2)	<0.001	1.6	(1.1–2.3)	0.02
*Binge drug use**						
(Yes vs. No)	1.9	(1.4–2.8)	<0.001	1.4	(1.0–2.1)	0.05
*Cocaine injection**						
(Daily vs. not daily)	3.3	(2.3–4.7)	<0.001	2.3	(1.6–3.4)	<0.001
*Heroin injection**						
(Daily vs. not daily)	1.4	(0.9- 1.9)	0.07			
Shooting gallery use						
(Yes vs No)	1.6	(1.1–2.2)	0.02	1.4	(0.9–1.9)	0.1
*Sex trade involved**						
(Yes vs No)	1.5	(1.0–2.3)	0.04	0.8	(0.5–1.3)	0.4

Note: DTES = Downtown Eastside Residence.
*Behaviors refer to activities in the last six months.
†Indicates current use.
**Model was fit adjusting for all variables significant in unadjusted analyses.

The present study demonstrates that place itself may contribute to the observed risk for HIV among IDU in the DTES. In previous studies, high-risk micro-environments such as shooting galleries, crack houses, and public injection sites, have been associated with higher levels of HIV infection (Patrick et al., 1997; Des Jarlais and Friedman, 1990; Carlson, 2000). These physical environments are more common in the DTES than other areas of Vancouver. For example, living in a SRO hotel has been associated with poor health status, including HIV infection, and 5150 (80%) of Vancouver's 6435 SRO units are located in the DTES (City of Vancouver, 2001; Statistics Canada, 2001; Shannon et al., 2006). Similarly, the use of shooting galleries and injecting drugs outdoors have been linked to higher risk of HIV infection, and these high-risk injecting locales are more common in poor urban neighborhoods including the DTES (Neaigus et al., 1994; Des Jarlais and Friedman, 1990; Buchanan et al., 2003). Nevertheless, in the present study we adjusted for shooting gallery use and unstable housing (primarily SRO vs. other) as well as a large number of other behavioral markers and yet the strong independent association between DTES residence and risk of HIV infection remained. While there may be some residual confounding due to imprecise measurement of injection locals that are unique to the DTES, consistent with Rhodes' ''risk environment'' concept, it is likely that unique micro-environments exist in this location that cannot be captured by conventional epidemiological surveying. Future study is needed to further elucidate the nature of these risk environments, and more importantly, to explore how HIV prevention efforts can be best targeted to address specific HIV risks that are mediated through the physical environment.

Moreover, place may act as a proxy for variables such as social networking and cultural interactions among IDU which we were unable to measure at the individual level. Individuals with similar lifestyles and activities are more likely to associate with one another, and risky behaviors such as sharing needles often occur among friends, acquaintances, and partners. Membership in a large sociometric risk-network has been identified in other cities as a predictor of serostatus and future risk for HIV infection (Friedman et al., 1997; Friedman et al., 2000; Rothenberg et al., 2000; Suh et al., 1997). Risk-networks in which IDU have both drug-injecting and sexual relationships with other members are a complex aspect of HIV risk that may be a more useful predictor than the sum amount of an individual's high-risk behavior. Because the DTES has a denser population of IDU than any other Vancouver neighborhood, individuals residing in the DTES likely have more contact with other IDU than those spread out in other parts of the city. The DTES IDU's high-risk behavior would be compounded by this increased exposure to other individuals at risk for HIV. These complex interactions and risk-networks could help explain the higher seroconversion risk among DTES residents even after adjustment for reported frequency of high-risk behavior.

The large number of moves observed within the group is another significant factor in the present analysis. The moves both into and out of the DTES could have been motivated by many factors. While many people cannot afford to leave the DTES area, other IDU may be drawn to the neighborhood and stay because of the availability of drugs, inexpensive housing, drug-scene and sex trade work, and social connections in the area.

These findings point to a need for neighborhood-specific public health initiatives to mitigate the observed higher risk. Structural interventions such as needle exchange programs and safer injecting facilities may help modify the broader risk environment of IDU and thereby reduce the spread of blood borne diseases (Kerr et al., 2005; Des Jarlais, 2000; Vlahov and Junge, 1998), and it is noteworthy that these data were derived before the opening of North American's first supervised injecting facility in the DTES (Wood et al., 2004c). While many interventions focus on changing an individual's risk behavior, the environmental pressures which lead to and exacerbate risk behavior should also be targeted and broader neighborhood development initiatives that increase the standard of living and ensure stable housing in the DTES may also serve to address the health crisis.

This study has several limitations, first of which is the self-reporting nature of the survey method. It has been demonstrated in previous studies that participants in IDU cohort studies likely under-report high-risk behaviors such as syringe-borrowing and unprotected sex due to socially desirable responding (Des Jarlais et al., 1999; Macalino et al., 2002; Wood et al., 2005). With respect to this concern, we know of no reason why risk factors would be differentially reported based on geographic residence. Second, while drug scene roles,

networking characteristics, and physical features are known to mediate health risks, these were not directly evaluated in the present study, and the present study would be informed by qualitative analyses examining why, risk behaviors may be elevated in certain places, such as the DTES neighborhood. Finally, the VIDUS cohort is not a random sample, although previous studies have indicated that the group is highly representative of Vancouver IDU (Wood et al., 2000).

In sum, residence in Canada's poorest urban neighborhood was independently associated with time to HIV seroconversion among IDU. Because of the numerous moves observed in and out of the DTES, initiatives to lower the high rate of HIV transmission in the DTES may reduce the spread of HIV in other parts of the city as well. These findings indicate the need for increased emphasis on the role of geographic location as a determinant of HIV risk behavior and subsequent HIV seroconversion and for the implementation of neighborhood-specific public health and development initiatives, such as the supervised injecting facility which has recently been opened in this neighborhood.

Acknowledgments

We would particularly like to thank the VIDUS participants for their willingness to participate in the study. We also thank Bonnie Devlin, John Charette, Caitlin Johnston, Robin Brooks, Steve Kain, Kathy Churchill, Dave Isham, Will Small, Peter Vann, Sue Currie and Nancy Laliberte for their research and administrative assistance. The study was supported by the US National Institutes of Health (Grant no. RO1 DA11591) and the Canadian Institutes of Health Research (122258).

References

Buchanan, D., Shaw, S., Teng, W., Hiser, P., Singer, M., 2003. Neighborhood differences in patterns of syringe access, use, and discard among injection drug users: implications for HIV outreach and prevention education. Journal of Urban Health 80 (3), 438–454.

Carlson, R.G., 2000. Shooting galleries, dope houses and injection doctors: examining the social ecology of HIV risk behaviors among drug injectors in Dayton, Ohio. Human Organization 59, 325–333.

City of Vancouver, 2000. Downtown Eastside Community Monitoring Report, fifth ed. Vancouver Planning Department, Vancouver.

City of Vancouver, 2001. Downtown Eastside Community Monitoring Report, sixth ed. Vancouver Planning Department, Vancouver.

Des Jarlais, D.C., 2000. Structural interventions to reduce HIV transmission among injecting drug users. AIDS 14 (Suppl 1), S41–S46.

Des Jarlais, D.C., Friedman, S.R., 1990. Shooting galleries and AIDS: infection probabilities and 'tough' policies. American Journal of Public Health 80 (2), 142–144.

Des Jarlais, D.C., Hagan, H., Friedman, S.R., Friedman, P., Goldberg, D., Frischer, M., Green, S., Tunving, K., Ljungberg, B., Wodak, A., 1995. Maintaining low HIV seroprevalence in populations of injecting drug users. Journal of American Medical Association 274 (15), 1226–1231.

Des Jarlais, D.C., Paone, D., Milliken, J., Turner, C.F., Miller, H., Gribble, J., Shi, Q., Hagan, H., Friedman, S.R., 1999. Audio-computer interviewing to measure risk behavior for HIV among injecting drug users: a quasi-randomized trial. Lancet 353, 1657–1661.

Friedman, S.R., Neaigus, A., Jose, B., Curtis, R., Goldstein, M., Ildefonso, G., Rothenberg, R.B., Des Jarlais, D.C., 1997. Sociometric risk networks and risk for HIV infection. American Journal of Public Health 87 (8), 1289–1296.

Friedman, S.R., Kottiri, B.J., Neaigus, A., Curtis, R., Vermund, S.H., Des Jarlais, D.C., 2000. Network-related mechanisms may help explain long-term HIV-1 seroprevalence levels that remain high but do not approach population-group saturation. American Journal of Epidemiology 152 (10), 913–922.

Fuller, C.M., Morrell, L., Latkin, C., Galea, S., Ompad, D., Strathdee, S., Vlahov, D., 2005. Effects of race, neighborhood, and social network on age at initiation of injection drug use. American Journal of Public Health 95 (4), 689–695.

Galea, S., Ahern, J., Vlahov, D., 2003. Contextual determinants of drug use risk behavior: a theoretic framework. Journal of Urban Health 80 (4 Suppl 3), iii50–iii58.

Hamers, F.F., Downs, A.M., 2003. HIV in central and eastern Europe. Lancet 361 (9362), 1035–1044.

Kerr, T., Tyndall, M., Li, K., Montaner, J., Wood, E., 2005. Safer injection facility use and syringe sharing in injection drug users. Lancet 366 (9482), 316–318.

Kitayaporn, D., Uneklabh, C., Weniger, B.G., Lohsomboon, P., Kaewkungwal, J., Morgan, W.M., Uneklabh, T., 1994. HIV-1 incidence determined retrospectively among drug users in Bangkok, Thailand. AIDS 8 (10), 1443–1450.

Kuyper, L.M., Hogg, R.S., Montaner, J.S., Schechter, M.I., Wood, E., 2004. The cost of inaction on HIV transmission among injection drug users and the potential for effective interventions. Journal of Urban Health 81 (4), 655–660.

Latkin, C.A., Curry, A., 2003. Stressful neighborhoods and depression: a prospective study of the impact of neighborhood disorder. Journal of Health Social Behavior 44 (1), 34–44.

Latkin, .A., Williams, C.T., Wang, J., Curry, A.D., 2005. Neighborhood social disorder as a determinant of drug injection behaviors: a structural equation modeling approach. Health Psychology 24 (1), 96–100.

Macalino, G.E., Celentano, D.D., Latkin, C., Strathdee, S.A., Vlahov, D., 2002. Risk behaviors by audio computer-assisted self-interviews among HIV seropositive and HIV-seronegative injection drug users. AIDS Education and Prevention 14, 367–378.

McCord, C., Freeman, H.P., 1990. Excess mortality in Harlem. New England Journal of Medicine 322 (3), 173–177.

Neaigus, A., Friedman, S.R., Curtis, R., Des Jarlais, D.C., Furst, R.T., Jose, B., Mota, P., Stepherson, B., Sufian, M., Ward, T., et al., 1994. The relevance of drug injectors' social and risk networks for understanding and preventing HIV infection. Social Science Medicine 38 (1), 67–78.

Patrick, D.M., Strathdee, S.A., Archibald, C.P., Ofner, M., Craib, K.J., Cornelisse, P.G., Schechter, M.T., Rekart, M.L., O'Shaughnessy, M.V., 1997. Determinants of HIV seroconversion in injection drug users during a period of rising prevalence in Vancouver. International Journal of STD & AIDS 8 (7), 437–445.

Poundstone, K.E., Strathdee, S.A., Celentano, D.D., 2004. The social epidemiology of human immunodeficiency virus/acquired immunodeficiency syndrome. Epidemiologic Reviews 26, 22–35.

Rhodes, T., 2002. The 'risk environment': a framework for understanding and reducing drug-related harm. International Journal of Drug Policy 13 (2), 85–94.

Rhodes, T., Mikhailova, L., Sarang, A., Lowndes, C.M., Rylkov, A., Khutorskoy, M., Renton, A., 2003. Situational factors influencing drug injecting, risk reduction and syringe exchange in Togliatti City, Russian Federation: a qualitative study of micro risk environment. Social Science & Medicine 57 (1), 39–54.

Rhodes, T., Singer, M., Bourgois, P., Friedman, S.R., Strathdee, S.A., 2005. The social structural production of HIV risk among injecting drug users. Social Science & Medicine 61 (5), 1026–1044.

Rothenberg, R.B., Long, D., Sterk, C.E., Pach, A., Potterat, J.J., Muth, S., Baldwin, J.A., Trotter, R.T., 2000. The Atlanta Urban Networks Study: a blueprint for endemic transmission. AIDS 14 (14), 2191–2200.

Shannon, K., Ishida, T., Lai, C., Tyndall, M., 2006. The impact of unregulated single room occupancy hotels on the health status of illicit drug users in Vancouver. International Journal of Drug Policy 17, 107–114.

Singer, M., 1994. AIDS and the health crisis of the US urban poor: the perspective of critical medical anthropology. Social Science & Medicine 39, 931–948.

Sinha, R., 2001. How does stress increase risk of drug abuse and relapse? Psychopharmacology (Berl) 158 (4), 343–359.

Statistics Canada. 1996. Population Census of Canada, Government of Canada.

Statistics Canada, 2001. Health Indicators. Canadian Institute for Health Information, Ottawa.

Strathdee, S.A., Patrick, D.M., Currie, S.L., Cornelisse, P.G., Rekart, M.L., Montaner, J.S., Schechter, M.T., O'Shaughnessy, M.V., 1997. Needle exchange is not enough: lessons from the Vancouver injecting drug use study. AIDS 11 (8), F59–F65.

Suh, T., Mandell, W., Latkin, C., Kim, J., 1997. Social network characteristics and injecting HIV-risk behaviors among street injection drug users. Drug and Alcohol Dependence 47 (2), 137–143.

Tyndall, M.W., Craig, K.J., Currie, S., Li, K., O'Shaughnessy, M.V., Schechter, M.T., 2001. Impact of HIV infection on mortality in a cohort of injection drug users. Journal of Acquired Immune Deficiency Syndromes 28 (4), 351–357.

Tyndall, M.W., Currie, S., Spittal, P., Li, K., Wood, E., O'Shaughnessy, M.V., Schechter, M.T., 2003. Intensive injection cocaine use as the primary risk factor in the Vancouver HIV-1 epidemic. AIDS 17 (6), 887–893.

Vancouver Coastal Health News Release, September 15, 2003. Injection Drug Use in the DTES.

Vlahov, D., Junge, B., 1998. The role of needle exchange programs in HIV prevention. Public Health Report 113 (Suppl 1), 75–80.

Wallace, R., 1990. Urban desertification, public health and public order: 'planned shrinkage', violent death, substance abuse and AIDS in the Bronx. Social Science & Medicine 31 (7), 801–813.

Wood, E., Schechter, M.T., Tyndall, M.W., Montaner, J.S., O'Shaughnessy, M.V., Hogg, R.S., 2000. Antiretroviral medication use among injection drug users: two potential futures. AIDS 14 (9), 1229–1235.

Wood, E., Tyndall, M.W., Spittal, P.M., Li, K., Kerr, T., Hogg, R.S., Montaner, J.S., O'Shaughnessy, M.V., Schechter, M.T., 2001. Unsafe injection practices in a cohort of injection drug users in Vancouver: could safer injecting rooms help? CMAJ 165, 405–410.

Wood, E., Kerr, T., Small, W., Li, K., Marsh, D.C., Montaner, J.S., Tyndall, M.W., 2004a. Changes in public order after the opening of a medically supervised safer injecting facility for illicit injection drug users. CMAJ 171 (7), 731–734.

Wood, E., Patricia, M., Spittal, M., Small, W., Kerr, T., Li, K., Hogg, R.S., Tyndall, M.W., Montaner, J.S., Schechter, M.T., 2004b. Displacement of Canada's largest public illicit drug market in response to a police crackdown. CMAJ 170 (10), 1551–1556.

Wood, E., Kerr, T., Lloyd-Smith, E., Buchner, C., Marsh, D.C., Montaner, J.S., Tyndall, M.W., 2004c. Methodology for evaluating Insite: Canada's first medically supervised safer injection facility for injection drug users. Harm Reduction Journal 1 (1), 9.

Wood, E., Li, K., Miller, C.L., Hogg, R.S., Montaner, J.S., Schechter, M.T., Kerr, T., 2005. Baseline self-perceived risk of HIV infection independently predicts the rate of HIV seroconversion in a prospective cohort of injection drug users. International Journal of Epidemiology 34 (1), 152–158.