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Title: Patterns of cocaine and opioid co-use and polyroutes of administration among street-based cocaine users in Montréal, Canada

Background: Effective public health programs aimed at problematic cocaine users are challenged by the fact that they can have complex patterns of drug use with respect to polysubstance use and routes of drug administration. This study was carried out to explore the presence of subgroups of cocaine users on the basis of their concurrent use of opioids and their routes of cocaine and opioid administration, and to determine if subgroups could be differentiated in terms of sociodemographic factors and risk behaviours.

Methods: Regular cocaine users (≥ 1 per week) were recruited in low-threshold services located in the Montréal downtown area. The following variables were examined: demographic characteristics, types of drug used, routes of drug administration, and condom use with occasional or commercial sexual partners. Latent class analysis and multinomial logistic regression modeling were carried out.

Results: 886 cocaine users were recruited (83.5% male; mean age 35.38 years). A 5-class model was identified: 1) “Cocaine Smokers” (CSs) ($n = 161$; membership probability (MP) = 0.183); 2) “Cocaine Smokers/Sniffers” (CSSs) ($n = 201$; MP = 0.218); “Cocaine Injectors” (CIs) ($n = 207$; MP = 0.231); 4) “Cocaine-Opioid Injectors” (COIs) ($n = 277$; MP = 0.291); and 5) “Cocaine-Opioid Polyroute users” (COPs) ($n = 40$; MP = 0.077). Compared with COIs, other subtypes were significantly different in terms of either age, duration of cocaine use, ethnic background, homelessness, polydrug use or condom use.

Conclusion: The heterogeneity of consumption patterns supports the importance of offering an array of interventions aimed at problematic cocaine users. These should include the provision of clean injecting and smoking material, the promotion of safe sexual behaviours and the prevention of initiation to drug injection. In the absence of specific treatment, cocaine users should have access to primary health care services and addiction treatment based on innovative behavioral and pharmacological approaches.

Key words: cocaine users; cocaine and opioid co-use; street-involved; latent class analysis.

INTRODUCTION

Problematic cocaine use (used by injection or involving dependence) (UNODC, 2011a) is a major public health concern in several countries of the world, especially in North America (UNODC, 2001b) where it plays a major role in the HIV and HCV epidemics (Edlin et al., 1994; Nelson et al., 2002; Patrick et al., 2001; Tyndall et al., 2003; Bruneau, Roy, Arruda, Zang & Jutras-Aswad, 2012; Roy et al., 2012). The development of public health programs aimed at problematic cocaine users is challenged by the fact that they can have complex patterns of drug use, particularly with respect to polysubstance use and routes of drug administration (Fischer et al., 2010; Guindalini, Vallada, Breen, & Laranjeira, 2006; Latkin, Knowlton, & Sherman, 2001; Prinzleve et al., 2004; Roy, Arruda, Vaillancourt, et al., 2012; Shaw, Shah, Jolly, & Wylie, 2008).

Cocaine and heroin co-use is noticeably associated with the use of multiple routes of drug administration including drug injection (Latkin, et al., 2001; Monga et al., 2007; Kuramoto, Bonhert, & Latkin, 2011; Roy, Arruda, Vaillancourt, et al. 2012). Cocaine injection with or without opioid co-use, is demonstrated to be associated with erratic drug use practices and increase risk of HIV and HCV transmission (Bourgois & Bruneau, 2000; Patrick et al., 2001; Tyndall et al., 2003). Recent evidence suggests a synergistic effect of cocaine and heroin injection on HCV risk (Bruneau et al., 2012). Crack smoking has also been found to increase risks of HIV and HCV infections, mainly via increased unsafe sexual behaviours and multiperson use of crack-smoking implements (Booth, Watter, & Chitwood, 1993; Booth, Kwiatkowski, & Chitwood, 2000; Harzke, Williams, & Bowen, 2009; Inciardi, 1995; Jones et al., 1998; Schönnesson et al., 2008; Tortu, McMahon, Pouget, & Hamid, 2004).

The consumption of more than one substance on a short period of time or concurrently (polysubstance use), especially the combined use of opioids and cocaine, is also an important issue when it comes to addiction and health services for drug users (Fischer et al., 2006; Léri, Stewart, Tremblay, & Bruneau, 2004; Léri et al., 2005; Roy, Arruda, Vaillancourt, et al., 2012). For instance, co-use of stimulants and opioids significantly contributes to fatal and non-fatal overdoses, resulting in high morbidity and mortality rates among polydrug users (Coffin et al., 2003; Davidson et al., 2003; Ochoa, Hahn, Seal, & Moss, 2001). Moreover, effective treatment programs, with positive long-term effects are not yet available for problematic cocaine users (de Lima, de Oliveira Soares, Perreira Reisser, & Farrell, 2002). While substitution therapy programs, high- and low-threshold, have shown very positive outcomes for opioid users (Farré, Mas, Torrens, Moreno, & Cami, 2002; Fareed, Vayalapalli, Casarella, Amar, & Drexler, 2010; Marsch, 1998) an analogous option for problematic cocaine users has yet to emerge. Opioid substitution treatment (OST) has no

direct effect on cocaine use, which in turn has a deleterious effect on treatment outcome for opioid dependence (Sullivan et al., 2010; Williamson, Darke, Ross, & Teeson, 2006).

Little is known about specific combinations of substances and routes of administration in populations of problematic cocaine users. Latent class analysis (LCA) (McCutcheon, 1987) has been recently used in a few studies to examine subtypes of problematic drug users given their specific patterns of drug use and routes of drug administration (Kuramoto et al., 2011; Patra, Fischer, Maksimowska, & Rehm, 2009). One study carried out in USA found five patterns in a sample of inner-city users of heroin and cocaine, with three subgroups of IDUs (heroin injecting, polydrug and polyroute, and heroin and cocaine injecting) and two with low proportions of IDUs (heroin snorting and crack smoking) (Kuramoto et al., 2011). In a Canadian study carried out among regular street-based opioid users, the analysis resulted in a typology of eight types of users characterized both by the distinct relative prevalence of different substances, mostly stimulants and opioids, and the presence or absence of injection as the primary route of administration (Patra et al., 2009).

Although studies demonstrated high rates of opioid use and injection among problematic cocaine users (Roy, Arruda, Vaillancourt, et al., 2012; Prinzleve et al., 2004), no study so far has specifically examined drug use sub-types in relation to opioid co-use among problematic cocaine users. Understanding differences between patterns of use among problematic cocaine users is of paramount importance to better control HIV and HCV transmission. We carried out this study with the aim of improving intervention programs designed for problematic cocaine users. The main objective of this analysis was to explore the presence of subgroups of cocaine users on the basis of their concurrent use of opioids, including heroin and POs, and their routes of cocaine and opioid administration. A secondary objective was to determine if subgroups could be differentiated in terms of sociodemographic factors and drug use and sexual behaviours.

METHODS

Study design and participants

The study used a cross-sectional design. Regular cocaine users were recruited by trained interviewers in community-based low-threshold programs located in downtown Montréal. These programs offer services such as provision of clean drug injection and smoking paraphernalia, and various primary health care and social services. Eligibility criteria were 1) being aged 14 or older, 2) speaking French or English, and 3) having used cocaine on a

regular basis, that is, once a week or more in the past month. After signing a consent form, eligible cocaine users completed an interviewer-administered questionnaire lasting approximately 60 minutes. They received a monetary stipend of CAN\$20 for their participation. Ethical approval was provided by Le comité d'éthique de la recherche en santé chez l'humain du CHUS et de l'Université de Sherbrooke.

Study variables and measures

To examine subgroups of problematic cocaine users, types of drugs used and routes of administration were assessed. Participants were asked if they had used cocaine, heroin, cannabis, amphetamines, speedball, phencyclidine (PCP) or other substances. The non-medical use of hydromorphone (either Dilaudid® or Hydromorph Contin®) was also specifically assessed since this type of PO is the one most frequently used by street-based drug users in East-Central Canada (Parent et al., 2009). Participants who reported using other POs (included in the 'other drug' category) were also classified as using POs. These POs were Empracet®, Fentanyl®, methadone, morphine, Oxycontin®, Statex®, and Supeudol®. Routes of administration—including injected, smoked, snorted, eaten and/or drank—were examined for each drug.

To determine if subgroups could be differentiated in terms of sociodemographic factors and risk behaviours, a second set of analyses was carried out on the whole sample, including all participants whether they injected drugs or not. The following variables were considered: age, sex, ethnic background (based on the country of birth of at least one parent (Canada or other), residential status, polydrug use, duration of cocaine use and condom use. Participants who resided most of the time in a hotel/motel room, a shelter or on the street were considered homeless. Polydrug use was defined as using three or more drugs, excluding heroin and POs, which allowed exploration of associations between polydrug use and subgroups of cocaine users beyond cocaine and opioid co-use. Participants were considered as having risky sexual practices if they reported never or only sometimes using a condom for oral, anal or vaginal sex with occasional or commercial sexual partners. All questions regarding behaviours focused on the month preceding the interview.

Analyses strategy

Latent class analysis (LCA) (McCutcheon, 1987) has been used previously to examine subtypes of drug users given their specific patterns of drug use and routes of drug administration (Kuramoto et al., 2011, Monga et al., 2007;

Patra, et al., 2009). For this study, LCA was used to identify subgroups of street-based cocaine users with similar past-month patterns of cocaine and opioid (PO and heroin) consumption, and routes of administration. The analysis was applied to seven dichotomous variables (past-month injected cocaine, smoked cocaine, snorted cocaine, injected heroin [including speedball], non-injected heroin, injected POs and non-injected POs) to determine the more limited number of emerging subgroups of cocaine users. The best number of latent classes was determined using the bootstrap likelihood ratio test (BLRT), as suggested by Nylund, Asparouhov, and Muthén (2007). This test compares the overall fit between a model with $k-1$ class and a model with k class. If the p -value is smaller than 0.05 then using a k class model rather than a $k-1$ class model significantly improves the fit. The model selection was also based on the Adjusted Bayesian Information Criterion (ABIC), where a lower value indicates a better fit. The maximum likelihood method was carried out to estimate models, and different starting values were used to avoid local maxima. The assumption of local independence was verified using bivariate residuals (Magidson & Vermunt, 2007). Participants were assigned to classes based on the posterior probabilities of class membership given drug use behaviours. LCA was performed using MPlus version 6.1 (Muthén & Muthén, 2010). Emerging subgroups were compared based on sociodemographics, drug use patterns and risky sexual practices by means of Chi-square tests for categorical variables.

A multinomial logistic regression analysis was carried out to explore the correlates of subgroups emerging from the LCA. Class membership was the dependent variable. The following independent variables were entered into the model: age (≤ 24 vs. > 24), ethnic background (both parents born in Canada vs. at least one parent born outside Canada), homelessness (yes/no), duration of cocaine consumption (continuous value), polydrug use (≥ 3 excluding heroin and PO), and risky sexual practices (yes/no). All variables associated with class membership at a p -value of 0.20 in bivariate analyses were considered in the full model. The purposeful selection method (Hosmer & Lemeshow, 2000) was used to select variables. After verification of potential confounders, variables were retained in the final model using a significance threshold of less than 0.05. Analyses were performed with PASW 18.

RESULTS

A total of 886 cocaine users were recruited between June 2008 and October 2010 (Table 1). Men comprised 83.5% of the sample and mean age of participants was 35.4 years old. On average, participants had been using cocaine

for 18.17 years. Only 15.1% of participants had one parent born outside Canada and 40.4% of participants had experienced homelessness in the preceding month.

More than 50% of participants reported cocaine as the drug most frequently used (52%), followed by cannabis (26.1%), POs (11.9%), heroin (7.1%), and amphetamines (2.4%). Polydrug use, beyond cocaine and opioid co-use, was also frequent (41.5%). Regarding past-month routes of cocaine administration, 86.5% reported smoking the drug, 61.2% injecting it, and 37% snorting it. More than half of participants reported past-month opioid use, while 40.3% had used POs, 36.3% heroin, and 11.5% speedball (a mixture of heroin and cocaine).

INSERT TABLE 1

Class membership

Based on the BLRT, the 5-class model was selected over the 4-class ($p < 0.001$) and the 6-class (BLRT; $p=0.42$) models. Furthermore, the 5-class model had the lowest ABIC (5880.43) and highest entropy (0.89), and met the local independence assumption since none of its bivariate residuals were significant. Table 2 presents the 5-class solution as well as each class membership probability, and probabilities of substance use and route of drug administration, given class membership. Results showed that the probability of smoking cocaine was high for each class. Emerging cocaine user subgroups were named according to their specific pattern of drug use and routes of drug administration. Classes 1 and 2 were characterized by minimal cocaine and opioid co-use and low proportion of IDUs. The Cocaine Smokers (CSs) (class 1; membership probability = 0.183) was characterised by a 100% probability (or 1) of smoking cocaine. Probabilities of using opioids and using routes of intake other than smoking were low. The Cocaine Sniffers/Smokers (CSSs) subgroup (class 2; membership probability = 0.218) was primarily composed of cocaine users whose routes of administration were mainly snorting and smoking. The Cocaine Injectors (CIs) subgroup (class 3; membership probability = 0.231) was comprised mostly of cocaine users with a 100% probability of injecting cocaine, a lower but elevated probability of smoking cocaine (0.675), and a moderate probability of heroin injection (0.291). The Cocaine-Opioid Injectors (COIs) subgroup (class 4; membership probability = 0.291) represented the largest group of the sample, with users exhibiting 100% probability of injecting POs, a high probability of injecting and smoking cocaine, and of injecting heroin (0.672). Finally the Cocaine-Opioid Polyroutes (COPs) subgroup (class 5; membership probability = 0.077), the smallest one, was characterised by cocaine and opioid

co-use including heroin and POs and polyroutes of drug administration. Probabilities of smoking cocaine and injecting cocaine, heroin and POs were high. Furthermore, COPs had moderate probabilities of snorting cocaine and using heroin by routes other than injection. COPs also presented the highest probability of PO consumption by various routes of intake.

INSERT TABLE 2

Sociodemographic and behavioural characteristics of the subgroups

Table 3 presents the sociodemographic characteristics and behavioural patterns of the five subgroups. CSs and CSSs presented the highest percentages of participants aged 24 and younger (24.8% and 38.8%) while CIs were older, with more than 92% of participants over 24 years of age. CIs reported the longest duration of cocaine use with an average of 21.83 years while CSSs had the shortest with an average of 14.99 years. COPs and CSSs had the most diverse ethnic backgrounds followed by CSs. COIs and COPs presented the least stable housing status while CIs reported the most stable one.

Regarding types of drugs most frequently used, CIs were the most numerous to report using mostly cocaine (70%). CSs and CSSs mainly used cocaine (59.6% and 50.2%), followed by cannabis (36 % and 41.3%), and amphetamines in a smaller proportion. COIs and COPs were the most numerous to use mainly opioids (46.4% and 25.0%). POs were particularly popular among COIs (34.4%) and COPs (15%).

Results underscore the presence of three types of opioid users: minimal users (CSs and CSSs), low users (CIs), and high users (COIs and COPs), the last type being the subgroup for which the “co-user” label is most appropriate. Although a low percentage of study participants used speedball, a significant proportion of co-users did so (COIs = 24.5%; COPs = 37.5%).

INSERT TABLE 3

Results revealed a high percentage (52.4%) of cocaine and opioid co-use among study participants, with COIs being the largest subgroup of co-users in the sample. Therefore, a multivariate analysis comparing each subgroup to COIs was carried out (Table 4). Compared to COIs, CSs were more likely to have at least one parent born

outside Canada (adjusted odds ratio [AOR] = 1.79) and to engage in riskier sexual practices (AOR = 1.89). They were less likely to be over 24 years old (AOR = 0.35) and to be polydrug users (AOR=0.41). For their part, CSSs were more likely than COIs to have at least one parent born outside Canada (AOR = 2.06) and to report high-risk sexual practices (AOR=1.81). However, they were less likely to be older than 24 years (AOR=0.20) and homeless (AOR=0.62). Compared to COIs, cocaine injectors (CI) were less likely to be homeless (AOR=0.54) and polydrug users (AOR=0.23). Even after controlling for age, CIs were also more likely to have used cocaine for a longer period of time (AOR = 1.04). Finally, COPs were more likely to have at least one parent born outside Canada (AOR = 2.52) and to be polydrug users (AOR=2.41), compared to COIs.

INSERT TABLE 4

DISCUSSION

This study is the first to explore the presence of subgroups of regular cocaine users with respect to their concomitant use of opioids and routes of drug administration. Like other studies conducted in Canada and the United States, we observed that cocaine and opioid co-use is common among problematic drug users. (Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Kuramoto et al., 2011; Léri et al., 2005; Monga et al., 2007; Patra et al., 2009). In this study, a significant number of cocaine users consumed few or no opioids. Some almost exclusively inhaled cocaine (CSs) while others were more likely to combine smoking and other routes of drug administration like snorting (CSSs) or injecting (CIs). Also, about half of study participants used both cocaine and opioids, including a significant proportion of POs. This result possibly reflects the increase of non-medical use of POs observed in North America (Compton & Volkow, 2006; McCarthy, 2007; UNODC, 2010). Furthermore, cocaine users who inject the drug were more likely to use opioids, with a subgroup (COIs) injecting mostly POs and, in a smaller proportion, heroin; another subgroup (COPs) consumed both types of drugs through various routes of administration. It is worth stressing that very few users reported consuming POs by means other than injection.

Simultaneous use of cocaine and opioids, as measured by speedball use, was relatively low among study participants (11.5%) although higher proportions were observed among COIs (24.5%) and COPs (37.5%). Co-use of cocaine and opioids seemed to be more of the sequential type. In a review paper on cocaine and opioid co-use, Léri, Bruneau, and Stewart (2003) described a group of sequential co-users as being heavy cocaine users seeking the

depressant effect of heroin to deal with the state of over-excitability produced by frequent cocaine use. Though these users are not necessarily addicted to opioids, addiction could eventually develop. This profile could correspond to many of this study's co-users, especially CIs and COPs, subgroups with few participants reporting opioids as the drug most frequently used. Among COIs, the situation is slightly different since almost half reported opioids as being the drug most frequently used (12.0% heroin; 34.4% PO). This profile may correspond, at least partially, to another group described by Léri et al. (2003), one composed of opioid-dependent users who consume cocaine to reduce withdrawal symptoms. Also, COIs might use cocaine to counteract the physical depressive effects of opioids (Roy, Arruda, Vaillancourt, et al., 2012).

Beyond pharmacological explanations, there may be structural factors underlying cocaine and opioid co-use. In an attempt to understand heroin initiation in the age of crack use in the United States, Chitwood, Comerford, and Weatherby (1998) observed that in the 1990s, changes in heroin production and distribution and in selling strategies at the street level produced favourable conditions to initiation of heroin use by cocaine users in that country. In Canada, recent studies indicate an increasing availability and accessibility of POs on the streets (Firestone & Fischer, 2008; Fischer, Rehm, Patra, & Firestone Cruz, 2006; Roy, Arruda, & Bourgois, 2011; Roy, Arruda, Vaillancourt, et al., 2012). In downtown Montréal, it is easy to find and access POs for non-medical use. Most of the time, one can buy straight from individuals selling their own prescriptions or POs they have bought themselves on the street (Roy et al., 2011). This increased availability of POs, in a neighbourhood where most street-based cocaine users' activities take place, may have contributed to the initiation and/or maintenance of opioid use among some cocaine users.

Based on regression analyses, two important individual factors—ethnic background and age—distinguish the study users' profiles. Compared to COIs, CSs, CSSs and COPs were less likely to be of Canadian ethnic background. Other studies have shown ethnic differences regarding types of drugs used and routes of administration. There could be many explanations for these differences, including genetic differences, cultural attributes, and social structural factors (Agar & Reisinger, 2001; Bourgois et al., 2006; Broz & Ouellet, 2008; Ojeda, Patterson, & Strathdee, 2008; Vega & Gil, 1998). An in-depth examination of such factors is beyond the scope of the present study, but these results, in light of previous ones, deserve further investigation.

CSs and CSSs, who represent two distinct subgroups with minimal co-use and injection drug use, were found to be younger than COIs even after controlling for duration of cocaine use. While this finding could reflect generational differences (Broz & Ouellet, 2008; Gamella, 1994; Golub & Johnson, 1999; Golub, Johnson, & Dunlap,

2005; Van Ameijden & Coutinho, 2001) with new users choosing other modes of drug administration than injection, these results are not necessarily reassuring given that crack smoking has been shown to increase the risk of initiation to drug injection (Irwin et al., 1996; Roy et al., 2003, 2006; Sherman et al., 2005). Young cocaine users who keep consuming, might also evolve towards more intense use, similar to the one observed among older study participants.

Our findings show heterogeneity among older users in terms of drug use patterns. Though their cocaine use was as intense as that of COIs, the number of CIs using opioids and other drugs was lower. On the other hand, compared to COIs, there was a larger number of polydrug users among COPs. In other words, CIs could be described as *pure* cocaine users while COPs would be more *versatile* both in substances used and routes of administration.

CSs and CSSs, who mainly smoke cocaine, were found to be more likely than COIs to have unprotected sex with occasional and commercial partners. This result is consistent with an extensive body of literature documenting the link between crack use and high-risk sexual practices, (Booth et al., 2000; Edlin et al., 1994; Harzke et al., 2009; Hudgins, McCusker, & Stoddard, 1995; Inciardi, 1995) sexually transmitted infections (McCoy, Lai, Metsch, Messiah, & Zhao, 2004; Ross, Hwang, Zack, Bull, & William, 2002), and HIV infection (DeBeck et al., 2009). Pharmacological effects of crack cocaine, including intense euphoria, reduction of inhibition and enhanced sexual sensations, appear to lead some users to engage in high-risk sexuality (Léonard & Ben Amar, 2002; McCoy & Inciardi, 1995).

Finally, study findings suggest differential links between housing status and subgroups of cocaine users. Both CSSs and CIs were less likely to be homeless than COIs, who exhibited the highest proportion of co-use including PO use. Similar results suggesting an increased risk of homelessness among co-users have been observed among diverse drug user populations, both in Canada and the United States (Kuramoto et al., 2011; Patra et al., 2009). This finding may be explained by the financial pressures associated with dual dependence on cocaine and opioids that lead to a more precarious residential status. The analyses also showed that CSs did not differ from COIs in terms of homelessness. CSs represent the subgroup with the highest percentage of cocaine smoking. This finding is consistent with previous studies conducted elsewhere showing a link between crack use and unstable housing (Fischer et al., 2006, 2010; Palepu, Marshall, Lai, Wood, & Kerr, 2010; Rachlis, Wood, Zhang, Montaner, & Kerr, 2009), although the differential effect of crack smoking and cocaine injection is not clear.

This study presents some limitations. First, the results are not generalizable to all cocaine users since recruitment took place in community-based low-threshold programs usually attended by more problematic users.

Although the study used a convenience sample, we are quite confident that it is representative of the study population, especially judging by the sample's sociodemographic characteristics, which are similar to those of cocaine users attending low-threshold programs in downtown Montréal (Parent et al., 2009). Second, this study relied on self-reported information, which may be subject to social desirability and recall biases. However, evidence shows that drug users' self-reports of drug use behaviours are generally valid and reliable (Darke, 1998).

Implications for intervention

Our results support the importance of offering an array of interventions that address the various needs of problematic cocaine users. Because drug injection was highly prevalent in our sample, the sustainability of harm reduction programmes aimed at IDUs is of great importance. Different substances and forms of substances are known to generate different injection practices and techniques. In this regard, cocaine injection, which three of our subgroups exhibited high probabilities (CI, COI, COP), is characterized by multiple injections in a short period of time. Optimal levels of harm reduction programmes implementation and coverage is critical in order to insure that sufficient sterile injection equipment is available to all injectors. As for PO injection, our recent work carried out in Montréal showed that the logistical aspects of the injection process could raise the risk of injection equipment being contaminated with blood, leading to increased risks of HCV seroconversion (Roy et al., 2011; Bruneau et al., 2012). This is especially worrisome for the COI and COP subgroups that had high probabilities of injecting POs. New intervention strategies and messages should be developed to counter the harms related to PO injection. More specifically, we believe that the sterile injection equipment distributed through harm reduction programmes is poorly adapted to the constraints of capsules or tablets injection. There is a need to constantly reassess and update the equipment based on the evolving and diverse nature of substances used.

Specific interventions promoting safe sexual behaviours and aimed particularly at CSs and CSSs should be developed in order to reduce sexual transmission of HIV and other sexually transmitted infections. Also, in order to minimize the risks of HCV transmission through the multiperson use of crack-smoking implements, crack smoking materials should be made available and easily accessible. Furthermore, since there is a high risk that people who use crack but have never injected drugs initiate injection of cocaine or opioids (Irwin et al., 1996; Roy et al., 2003, 2006; Sherman et al., 2005), intervention programs designed to prevent initiation into drug injection should be implemented and their sustainability guaranteed. This is critical, particularly in the context of the growing popularity of POs.

Conversely, route transition interventions that enable injectors to change their routes of administration to less risky methods should be available. Although innovative projects have been developed in Montréal and elsewhere (Des Jarlais, Casriel, Friedman, & Rosenblum, 1992; Hunt, Stillwell, Taylor, & Griffiths, 1998; Pizzey & Hunt, 2008; Roy et al., 2007), their viability has yet to be secured.

Finally, low-threshold addiction treatment programs, including both medical and behavioural approaches, need to be adapted to address the multiples needs of problematic drug users. On the one hand, in the absence of specific treatment, problematic cocaine users should have access to a comprehensive array of primary health care services, including health promotion, hepatitis A and B vaccination, and screening and treatment for HIV, HCV and sexually transmitted infections. Primary care settings should also offer or facilitate access to drug treatment such as OST, help to ensure proper registration to universal health coverage, and contribute to efficient mental health intervention. On the other hand, there is a crucial need for the development of innovative treatment approaches for cocaine users. In the absence of substitution therapy for cocaine, a promising vaccine to hinder the passage of the blood-brain barrier by cocaine is being studied (Martell et al., 2009). However, this strategy does not alleviate craving nor other acute and sub-acute withdrawal symptoms. Behavioral and pharmacological approaches should be developed toward improving the treatment of craving which could prevent relapse, but also reduce distress on emotional, cognitive, and physiological levels. Finally, cocaine, alcohol and other drug use should be systematically assessed and an individual treatment plan adapted to all patients assessed in OST programs. Multidrug use should never be an exclusion criterion in OST programs.

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References

- Agar, M. H., & Reisinger H. S. (2001). Open marginality: Heroin epidemics in different groups. *Journal of Drug Issues, 31*, 729-746.
- Booth, R. E., Kwiatkowski, C. F., & Chitwood D. D. (2000) Sex related HIV risk behaviors: differential risks among injection drug users, crack smokers, and injection drug users who smoke crack. *Drug and Alcohol Dependence, 58*, 219-226.
- Booth, R. E., Watter, J. K., & Chitwood, D. D. (1993) HIV risk-related sex behaviors among injection drug users, crack smokers, and injection drug users who smoke crack. *American Journal of Public Health, 83*, 1144-1148.
- Bourgois, P., & Bruneau, J. (2000). Needle exchange, HIV infection and the politics of science: Confronting Canada's cocaine injection epidemic with participant observation. *Medical Anthropology, 18*, 325-350.
- Bourgois, P., Martinez, A., Kral, A., Edlin, B. R., Schonberg, J., & Ciccarone, D. (2006). Reinterpreting ethnic patterns among white and African American men who inject heroin: a social science of medicine approach. *PLoS Medicine, 3*, e452.
- Broz, D., & Ouellet, L. J. (2008). Racial and ethnic changes in heroin injection in the United States: Implications for the HIV/AIDS epidemic. *Drug and Alcohol Dependence, 94*, 221-233.
- Bruneau, J., Roy, E., Arruda, N., Zang, G., & Jutras-Aswad, D. (2012). The rising prevalence of prescription opioid injection and its association with hepatitis C incidence among street-drug users. *Addiction, 107*, 1318-1327.
- Chitwood, D. D., Comerford, M., & Weatherby, N. L. (1998). *Drugs, health and social policy series*. Thousand Oaks: Sage.
- Coffin, P. O., Galea, S., Ahern, J., Leon, A. C., Vlahov, D., & Tardiff K. (2003). Opiates, cocaine and alcohol combinations in accidental drug overdose deaths in New York, 1990-98. *Addiction, 98*, 739-747.
- Compton, W. M., & Volkow, N. D. (2006). Major increase in opioid analgesic abuse in the United States: concerns and strategies. *Drug and Alcohol Dependence, 81*, 103-107.
- Darke, S. Self-report among injecting drug users: a review. (1998). *Drug and Alcohol Dependence, 51*, 253-263.
- Davidson, P. J., McLean, R. L., Kral, A. H, Gleghorn, A. A., Edlin, B. R., & Moss, A. R. (2003). Fatal heroin-related overdose in San Francisco, 1997-2000: a case for targeting intervention. *Journal of Urban Health, 80*, 261-273.

- de Lima, M. S., de Oliveira Soares, B. G., Perreira Reisser, A. A., & Farrell, M. (2002). Pharmacological treatment of cocaine dependence: a systematic review. *Addiction, 97*, 931-949.
- DeBeck, K., Kerr, T., Li, K., Fischer, B., Buxton, J., Montaner, J., et al. (2009). Smoking of crack cocaine as a risk factor for HIV infection among people who use injection drugs. *Canadian Medical Association journal, 181*, 585-589.
- Des Jarlais, D. C., Casriel, C., Friedman, S. R., & Rosenblum, A. (1992). AIDS and the transition to illicit drug injection: results of a randomized trial prevention program. *British Journal of Addiction, 87*, 493-498.
- Edlin, B. R., Irwin, K. L., Faruque, S., McCoy, C. B., Word, C., Serrano, Y., et al. (1994). Intersecting epidemics—crack cocaine use and HIV infection among inner-city young adults. Multicenter crack cocaine and HIV infection study team. *New England Journal of Medicine, 331*, 1422-1427.
- Fareed, A., Vayalapalli, S., Casarella, J., Amar, R., & Drexler, K. (2010). Heroin anticraving medications: A systematic review. *American Journal of Drug and Alcohol Abuse, 36*, 332-341.
- Farré, M., Mas, A., Torrens, M., Moreno, V., & Cami, J. (2002). Retention rate and illicit opioid use during methadone maintenance interventions: A meta-analysis. *Drug and Alcohol Dependence, 65*, 283-290.
- Firestone, M., & Fischer, B. (2008). A qualitative exploration of prescription opioid injection among street-based drug users in Toronto: behaviours, preferences and drug availability. *Harm Reduction Journal, 5*, 30.
- Fischer, B., Rehm, J., Patra, J., & Firestone Cruz, M. (2006). Changes in illicit opioid use across Canada. *Canadian Medical Association Journal, 175*, 1385-1387.
- Fischer, B., Rehm, J., Patra, J., Kalousek, K., Haydon, E., Tyndall, M., et al. (2006). Crack across Canada: comparing crack users and crack non-users in a Canadian multi-city cohort of illicit opioid users. *Addiction, 101*, 1760-1770.
- Fischer, B., Rudzinski, K., Ivsins, A., Gallupe, O., Patra, J., & Krajden, M. (2010). Social, health and drug use characteristics of primary crack users in three mid-sized communities in British Columbia Canada. *Drugs: Education, Prevention and Policy, 17*, 333-353.
- Gamella, J. F. (1994). The spread of intravenous drug use and AIDS in a neighbourhood in Spain. *Medical Anthropology, 8*, 131-160.
- Golub, A. L., & Johnson, B. D. (1999). Cohort changes in illegal drug use among arrestees in Manhattan: from the heroin injection generation to the blunts generation. *Substance Use & Misuse, 34*, 1733-1763.

- Golub, A. L., Johnson, B. D., & Dunlap, E. (2005). Subcultural evolution and illicit drug use. *Addiction Research and Theory, 13*, 217-229.
- Guindalini, C., Vallada, H., Breen, G., & Laranjeira, R. (2006). Concurrent crack and powder cocaine users from Sao Paulo: Do they represent a different group? *BMC Public Health, 6*, 10.
- Harrell, P. T., Mancha, B. E., Petras, H., Trenez, R.C., & Latimer, W. W. (2012). Latent classes of heroin and cocaine users predict unique HIV/HVC risk factors. *Drug and Alcohol Dependence, 122*, 220– 227.
- Harzke, A. J., Williams, M. L., & Bowen, A. M. (2009). Binge use of crack cocaine and sexual risk behaviors among African-American, HIV positive users. *AIDS and Behavior, 13*, 1106-1118.
- Hosmer, D. W., & Lemeshow, S. (2000). *Applied Logistic Regression 2nd edition*. New York: John Wiley and Sons, Inc.
- Hudgins, R., McCusker, J., & Stoddard, A. (1995). Cocaine use and risky injection and sexual behaviors. *Drug and Alcohol Dependence, 37*, 7-14.
- Hunt, N., Stillwell, G., Taylor, C., & Griffiths, P. (1998). Evaluation of a brief intervention to reduce initiation into injecting. *Drugs: Education, Prevention & Policy, 5*, 185-193.
- Inciardi, J. A. (1995). Crack, crack house sex, and HIV risk. *Archives of Sexual Behavior, 24*, 249-269.
- Irwin, K. L., Edlin, B. R., Faruque, S., McCoy, H. V., Word, C., Serrano, Y., et al.. (1996). Crack cocaine smokers who turn to drug injection characteristics, factors associated with injection, and implications for HIV transmission. *Drug and Alcohol Dependence, 4*, 85-92.
- Jones, D. L., Irwin, K. L., Inciardi, J., Bowser, B., Schilling, R., Word, C., et al. (1998). The high-risk sexual practices of crack-smoking sex workers recruited from the streets of three American cities. *Sexually Transmitted Diseases, 25*, 187-193.
- Kuramoto, S. J., Bohnert, A. S., & Latkin, C. A. (2011). Understanding subtypes of inner-city users with a latent class approach. *Drug and Alcohol Dependence, 118*, 237-243.
- Latkin C.A, Knowlton A.R., & Sherman S. (2001). Routes of drug administration, differential affiliation, and lifestyle stability among cocaine and opiate users: Implications for HIV prevention. *Journal of Substance Abuse, 13*, 89-102.
- Léonard, L., & Ben Amar, M. (2002). *Les Psychotropes: Pharmacologie et Toxicomanie*. Montréal: Les Presses de l'Université de Montréal.

- Léri, F., Bruneau, J., & Stewart, J. (2003). Understanding polydrug use: review of heroin and cocaine use. *Addiction, 98*, 7-22.
- Léri, F., Stewart, J., Fischer, B., Jürgen, R., Marsh, D. C., Brissette, S., et al. (2005). Patterns of opioid and cocaine co-use: a descriptive study in Canadian sample of untreated opioid-dependent individuals. *Experimental and Clinical Psychopharmacology, 13*, 303-310.
- Léri, F., Stewart, J., Tremblay, A., & Bruneau, J. (2004). Heroin and cocaine co-use in a group of injection drug users in Montréal. *Journal of Psychiatry & Neuroscience, 29*, 40-47.
- Magidson, J., & Vermunt, J. K. (2007). *The Sage Handbook of Quantitative Methodology for the Social Sciences*. Thousand Oakes: Sage Publications.
- Marsch, L. A. (1998). The efficacy of methadone maintenance interventions in reducing illicit opiate use, HIV risk behavior and criminality: A meta-analysis. *Addiction, 93*, 515-532.
- Martell, B. A., Orson, F. M., Poling, J., Mitchell, E., Rossen, R. D., Gardner, T., et al. (2009). Cocaine vaccine for the treatment of cocaine dependence in methadone maintained patients: a randomized, double-blind, placebo-controlled efficacy trial. *Archives of General Psychiatry, 66*, 1116-1123.
- McCarthy, M. (2007). Prescription drug abuse up sharply in the USA. *Lancet, 369*, 1505-1506.
- McCoy, C., & Inciardi, J. (1995). *Sex, drugs, and continuing spread of AIDS*. Los Angeles: Roxbury Publishing Company.
- McCoy, C. B., Lai, S., Metsch, L. R., Messiah, S. E., & Zhao, W. (2004). Injection drug use and crack cocaine smoking: independent and dual risk behaviors for HIV infection. *Annals of Epidemiology, 14*, 535-542.
- McCutcheon, A. L. (1987). *Latent Class Analysis*. Newbury Park: Sage Publications, Inc.
- Monga, N., Rehm, J., Fischer, B., Brissette, S., Bruneau, J., El-Guebaly, N., et al. (2007). Using latent class analysis (LCA) to analyse patterns of drug use in a population of illegal opioid users. *Drug and Alcohol Dependence, 88*, 1-8.
- Muthén, B., & Muthén, L. K. 2010. *Mplus: Statistical Analysis with Latent Variables (Version 6.1)*. Los Angeles: Muthén and Muthén, Inc.
- Nelson, K. E., Galai, N., Safaean, M., Strathdee, S. A., Celentano, D. D., & Vlahov, D. (2002). Temporal trends in the incidence of human immunodeficiency virus infection and risk behavior among injection drug users in Baltimore, Maryland, 1988-1998. *American Journal of Epidemiology, 156*, 641-653.

- Nylund, K. L., Asparouhov, T., Muthén, B. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling. A Monte Carlo simulation study. *Structural Equation Modeling, 14*, 535-569.
- Ochoa, K. C., Hahn, J. A., Seal, K. H., & Moss, A. R. (2001). Overdosing among young injection drug users in San Francisco. *Addictive Behaviors, 26*, 453-460.
- Ojeda, V. D., Patterson, T. L., & Strathdee, S. A. (2008). The influence of perceived risk to health and immigration-related characteristics on substance use among Latino and other immigrants. *American Journal of Public Health, 98*, 862-868.
- Palepu, A., Marshall, B. D. L., Lai, C., Wood, E., & Kerr, T. (2010). Addiction treatment and stable housing among a cohort of injection drug users. *PLoS ONE, 5*, e11697.
- Parent, R., Alary, M., Morissette, C., Roy, É., Leclerc, P., & Blouin, K. (2009). Surveillance des maladies infectieuses chez les utilisateurs de drogue par injection. Épidémiologie du VIH de 1995 à 2008. Épidémiologie du VHC de 2003 à 2008. Institut national de santé publique du Québec. Retrieved June 12, 2011, from http://www.inspq.qc.ca/pdf/publications/1021_SurvMalInfecUDI_VIHVHC2008.pdf
- Patra, J., Fischer, B., Maksimowska, S., & Rehm, J. (2009). Profiling poly-substance use typologies in a multi-site cohort of illicit opioid and other drug users in Canada, a latent class analysis. *Addiction Research and Theory, 17*, 168-185.
- Patrick, D. M., Tyndall, M. W., Cornelisse, P. G. A., Li, K., Sherlock, C. H., Rekart, M. L., et al. (2001). Incidence of hepatitis C virus infection among injection drug users during an outbreak of HIV infection. *Canadian Medical Association Journal, 165*, 889-895.
- Pizzey, R., & Hunt, N. (2008). Distributing foil from needle and syringe programmes (NSPs) to promote transitions from heroin injecting to chasing: An evaluation. *Harm Reduction Journal, 5*, 24.
- Prinzleve, M., Haaasen, C., Zurhold, H., Matali, J. L., Bruguera, E., Gerevich, J., et al. (2004). Cocaine use in Europe – a multi-centre study: Patterns of use in different groups. *European Addiction Research, 10*, 147-155.
- Rachlis, B. S., Wood, E., Zhang, R., Montaner, J. S., & Kerr, T. (2009). High rates of homelessness among a cohort of street-involved youth. *Health & Place, 15*, 10-17.
- Ross, M. W., Hwang, L. Y., Zack, C., & Bull, L., & Williams, M.L. (2002). Sexual risk behaviors and STIs in drug abuse treatment population whose drug of choice is crack cocaine. *International Journal of STD & AIDS, 13*, 769-774.

- Roy, E., Arruda, N., & Bourgois, P. (2011). The growing popularity of prescription opioid injection in downtown Montréal: new challenges for harm reduction. *Substance Use & Misuse, 46*, 1142-1150.
- Roy, E., Arruda, N., Leclerc, P., Haley, N., Bruneau, J., & Boivin, J.-F. (2012). Injection of drug residue as a potential risk factor for HCV acquisition among Montréal young injection drug users. *Drug and Alcohol Dependence*, <http://dx.doi.org/10.1016/j.drugalcdep.2012.05.018>
- Roy, E., Arruda, N., Vaillancourt, E., Boivin, J. -F., Morissette, C., Leclerc, P., et al. (2012). Drug use patterns in the presence of crack in downtown Montréal. *Drug and Alcohol Review, 31*, 72–80.
- Roy, É., Denis, V., Gutiérrez, N., Haley, N., Morissette, C., and Boudreau, J. -F. (2007). Evaluation of a media campaign aimed at preventing initiation into drug injection among street youth. *Drugs: Education and Prevention Policy, 14*, 401-414.
- Roy, É., Haley, N., Leclerc, P., Cédras, L., Blais, L., & Boivin J. -F. (2003). Drug injection among street youths in Montreal: Predictors of initiation. *Journal of Urban Health, 80*, 92-105.
- Roy, É., Morissette, C., Haley, N., Gutiérrez, N., Rousseau, L., & Denis, V. (2006). Pourquoi commencer? L'initiation à l'injection de drogues selon les jeunes de la rue. *Drogues, Santé et Société, 2*, 45-75.
- Schönnesson, L. N., Atkinson, J., Williams, M. L., Bowen, A., Ross, M. W., Timpson, S. C. (2008). A cluster analysis of drug use and sexual HIV risks and their correlates in a sample of African-American crack cocaine smokers with HIV infection. *Drug and Alcohol Dependence, 97*, 44-53.
- Shaw, S. Y., Shah, L., Jolly, A. M., & Wylie J. L. (2008). Identifying heterogeneity among injection drug users: a cluster analysis approach. *American Journal of Public Health, 98*, 1430-1437.
- Sherman, S. G, Fuller, C. M., Shah, N., Ompad, D. V., Vlahov, D., & Strathdee, S. A. (2005). Correlates of initiation of injection drug use among young drug users in Baltimore, Maryland: the need for early intervention. *Journal of Psychoactive Drugs, 37*, 437-443.
- Sullivan, L. E., Moore, B. A., O'Connor, P. G., Barry, D. T., Chawarski, M. C., Schottenfeld, R. S., et al. (2010). The association between cocaine use and treatment outcomes in patients receiving office-based buprenorphine/naloxone for the treatment of opioid dependence. *American Journal on Addictions, 19*, 53-58.
- Tortu, S., McMahon, J. M., Pouget, E. R., & Hamid, R. (2004). Sharing of noninjection implements as a risk factor for hepatitis C. *Substance Use and Misuse, 39*, 211-224.

- Tyndall, M. W., Currie, S., Spittal, P., Li, K., Wood, E., O'Shaughnessy, M. V., et al. (2003). Intensive injection cocaine use as the primary risk factor in the Vancouver HIV-1 epidemic. *AIDS*, *17*, 887-893.
- UNODC (United Nations Office on Drugs and Crime). (2010). *World Drug Report 2010*. Retrieved March 14, 2011, from http://www.unodc.org/documents/wdr/WDR_2010/World_Drug_Report_2010_lo-res.pdf
- UNODC (United Nations Office on Drugs and Crime). (2011a). *World Drug Report 2011. Résumé analytique. Évolution mondiale de la consommation, de la production et du trafic illicites de drogues*. Retrieved from [http://www.unodc.org/documents/data-and-analysis/WDR2011/ExSum-translations/WDR_2011 - FR.pdf](http://www.unodc.org/documents/data-and-analysis/WDR2011/ExSum-translations/WDR_2011_FR.pdf)
- UNODC (United Nations Office on Drugs and Crime). (2011b). *2011 World Drug Report 2011. Overview of global and regional drug trends and patterns*. Retrieved from http://www.unodc.org/documents/data-and-analysis/WDR2011/Global_and_regional_overview.pdf
- Van Ameijden, E. J., & Coutinho, R. A. (2001). Large decline in injecting drug use in Amsterdam, 1986-1998, explanatory mechanisms and determinants of injecting transitions. *Journal of Epidemiology and Community Health*, *55*, 356-363.
- Vega, W., & Gil A. G. (1998). *Drug use and ethnicity in early adolescence*. New-York: Plenum Press.
- Williamson, A., Darke, S., Ross, J., & Teesson, M. (2006). The association between cocaine use and short-term outcomes for the treatment of heroin dependence, findings from the Australian Treatment Outcome Study (ATOS). *Drug and Alcohol Review*, *25*, 141-148.