



## Research paper

## Drug-related overdoses within a medically supervised safer injection facility

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### Abstract

**Background:** In September 2003, North America's first supervised injection facility (SIF) opened in Vancouver, Canada. We sought to examine the incidence and characteristics of overdose events at the SIF.

**Methods:** The Vancouver SIF evaluation involves a comprehensive database within the SIF and the Scientific Evaluation of Supervised Injection (SEOSI) cohort consisting of 1046 SIF users. We examined the incidence and features of overdoses at the SIF and the responses made by SIF staff. Cox regression was used to examine factors associated with time to overdose among SEOSI participants.

**Results:** Between 1 March 2004 and 30 August 2005, there were 336 overdose events at the SIF, yielding a rate of 1.33 (95% CI: 0.0–3.6) overdoses per 1000 injections. The most common indicator of overdose was depressed respiration (60%), and the most common intervention involved the administration of oxygen (87%). In total, 90 SEOSI participants had an overdose at the SIF during the study period. Factors independently associated with time to overdose included fewer years injecting (RH=0.98, 95% CI: 0.96–1.00 per year), daily heroin use (RH=1.82, 95% CI: 1.16–2.85), and having a history of overdose (RH=1.92, 95% CI: 1.21–3.06).

**Conclusions:** There have been a large number of overdoses within the SIF, and it is noteworthy that none of these overdoses resulted in a fatality. These findings suggest that SIF can play a role in managing overdoses among IDU and indicate the need for further evaluation of the impact of SIF on morbidity and mortality associated with overdose.

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**Keywords:** Overdose; Illicit drug use; Safer injection facilities

### Introduction

Illicit drug-related overdose has been recognised as a common cause of morbidity and mortality among injection drug users (IDU) (Davidson et al., 2003; Warner-Smith, Darke, & Day, 2002; Wood et al., 2003). In many countries, fatal overdose is a leading cause of death among IDU, and in response a variety of overdose interventions have been implemented (Perucci et al., 1991; Tyndall et al., 2001). For instance, in New York City drug overdoses have recently overtaken homi-

cide as the number one cause of death (Coffin et al., 2003), and in Baltimore overdose deaths increased by more than 425% between 1990 and 1997 (Garfield & Drucker, 2001).

In light of the ongoing harms associated with overdose, several studies identifying the determinants of overdose have been undertaken, with most of these studies focusing on heroin-related overdoses. Among the more consistent predictors of overdose are: polysubstance use (in particular, the concomitant use of central nervous system depressants); greater number of years injecting; recent release from prison; and injection in public spaces (Bennett & Higgins, 1999; Darke, Ross, & Hall, 1996; Sporer, 1999; van Beek, Dakin, Kimber, & Glimour, 2004; Warner-Smith, Darke, Lynskey, & Hall, 2001). An array of overdose prevention interventions have been initiated, with most of these focused on educating drug users about the risks for overdose (Seal et al., 2003). How-

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ever, the limitations of education-based overdose prevention programs have been highlighted previously, with critics suggesting that these programs fail to consider the social and contextual factors that drive risks such as polysubstance use (Moore, 2004). Such criticisms have led to the call for structural interventions that modify the broader risk environment of IDU (Moore, 2004; Rhodes, 2002).

Medically supervised safer injection facilities (SIF), where IDU can inject pre-obtained illicit drugs, have been implemented in various cities to reduce the public health impacts of injection drug use (Kimber, Dolan, van Beek, Hedrich, & Zurhold, 2003; Kimber, Dolan, & Wodak, 2005). A primary motivation for establishing such facilities is to reduce the incidence and severity of overdose, and a key feature of these facilities involves the provision of emergency response in the event of an overdose. A recent ecological study that employed a time-series analysis involving data from four German cities found a positive effect of SIF on the rate of drug-related deaths (Poschade, Höger, & Schnitzler, 2003).

While available evidence and anecdotal reports indicate that SIF have the potential to reduce overdose morbidity and mortality, there have been few formal epidemiological evaluations of overdose events within SIF (van Beek et al., 2004). In light of this, we undertook these analyses to determine the incidence and characteristics of overdose events in North America's first SIF and to provide an account of the overdose interventions undertaken by SIF staff, along with a profile of the characteristics of individuals who overdose within the facility.

## Methods

The Vancouver SIF, known as Insite, is centrally located in Vancouver's Downtown Eastside, which is one of the most impoverished urban neighbourhoods in Canada and home to well documented overdose and infectious disease epidemics among the estimated 5000 IDU who reside there (Strathdee et al., 1997; Wood et al., 2000).

The methods used to examine Insite have been described in detail previously (Wood et al., 2004a). One key component of the evaluation approach is a comprehensive on-site database used to track medical activities and health events at Insite. All users of the SIF are registered in the on-site database using a unique identifier based on actual name or an alias. At time of enrolment, these individuals also provide basic information (e.g., gender, age) that is entered into the database. All activities within the SIF are then tracked and referenced back to individual SIF visitors. Included in the database are detailed records concerning all overdose events, the characteristics of these overdoses, and the interventions undertaken by SIF staff in response to these events.

The federal exemption that allows for the legal operation of Insite was granted on the condition that the health and social impacts of the SIF be rigorously evaluated. However,

the programmatic principles of universal access as well as the ethical approval process surrounding the SIF evaluation required that users of the facility be able to decline participation in research and be able to use the facility without providing any personal information (e.g., name, health number). Thus, the evaluation makes use of a representative cohort of SIF users who have consented to be part of the evaluation. This cohort, known as the Scientific Evaluation of Supervised Injecting (SEOSI) cohort, has been described in detail previously (Wood et al., 2004a). Briefly, the SEOSI cohort is based on a representative sample of Insite users. The sample was derived through random recruitment of Insite users who provide informed consent to enrol into the study. Random recruitment involves using random number generation to select 2-hour blocks of time during the hours that Insite is open (between 10:00 a.m. and 4:00 a.m.). During the first 3 months, there were 12 recruitment blocks used over 5 days per week. In the following 9 months, there were 32 recruitment blocks used over 7 days per week. During these times, existing and new users of the SIF were invited to enrol in the SEOSI study through an external research site, which is approximately one block away from Insite. Among individuals who wish to enrol in the SIF evaluation, a venous blood sample is drawn and an interviewer-administered questionnaire is conducted. The questionnaire solicits information regarding a variety of topics, including demographic characteristics, illicit drug use, HIV risk behaviour, and use of addiction treatment, and all questionnaire data can be linked to information collected through the Insite database. The SEOSI cohort has been ethically approved by the University of British Columbia/Providence Healthcare Research Ethics Board.

As a first step, we examined the frequency of overdoses and the number of unique individuals experiencing an overdose at Insite during the period from 1 March 2004 to 30 August 2005. During the same period, we examined the drugs used prior to each overdose event, the clinical features of the overdoses that occurred, and the interventions undertaken by staff in response to these overdoses. Since these data did not include personal information, we examined all Insite visits during the study period. Second, using data derived from SEOSI, we performed Cox regression analyses to estimate unadjusted and adjusted relative hazards for time to first overdose at Insite. Time zero was the date of enrolment into the SEOSI cohort; overdoses occurring up until 30 August 2005 were considered, and individuals who did not have an overdose within Insite throughout follow-up were censored as non-events as of this date. Socio-demographic variables of interest included gender, age, and ethnicity (self-ascribed as either "aboriginal" or "other"), homelessness, recent incarceration, and involvement in the sex trade. Drug-using characteristics considered included: years injecting, daily cocaine and heroin injection, daily crack and morphine use, requiring help injecting, public drug use, binge use of drugs, alcohol use during binges, enrolment in addiction treatment, current methadone maintenance treatment, his-

tory of overdose, syringe borrowing, and syringe lending. All behavioural variables referred to activities in the preceding 6 months, and behaviours were time-updated based on semi-annual follow-up visits. We then applied an *a priori* defined statistical protocol that examined the factors independently associated with time to overdose within the SIF by fitting a statistical model that included all variables that were significantly associated with first time to overdose at Insite at the  $p \leq 0.1$  level in univariate analyses. In the multivariate analysis, all behavioural variables were treated as time-updated covariates. All  $p$ -values were two-sided.

## Results

Between 1 March 2004 and 30 August 2005, there were 336 overdose events at the SIF, yielding a rate of 1.33 (95% CI: 0.0–3.6) overdoses per 1000 injections (see Fig. 1). The monthly median number of overdoses was 16, with monthly overdose totals ranging from 9 (September 2004) to 35 (March 2005). In total, 285 unique participants accounted for these overdoses. Data concerning the drugs involved in the overdose were available for 318 (95%) overdoses. Of these, 282 (89%) involved only one injection. Heroin accounted for 201 (71%) of these overdoses, cocaine for 36 (13%), speedballs (heroin and cocaine mixed together) for 28 (10%), morphine for 6 (2%), dilaudid for 5 (1.7%), crack for 4 (1.4%), and methadone for 2 (0.7%). An additional 36 (11%) overdoses involved two successive injections in the same visit. Thirty-three (92%) of the overdoses involving repeat injections involved injection of cocaine and heroin, one involved dilaudid and heroin, one involved heroin and a speedball, and one involved cocaine and crystal methamphetamine. All overdoses considered, opiates were involved in 278 (88%) of overdoses, and stimulants were involved in 104 (33%) of overdoses (total exceeds 100% because of inclusion of over-

doses involving more than one injection). Further, 244 (77%) of overdoses involved exclusive use of opiates, and 41 (15%) involved exclusive use of stimulants.

As indicated in Fig. 2, the most common indicators of overdose included: depressed respiration (60%); limp body (48%); face turning blue, pale, or flushed (46%); and failure to respond to pain stimulus (32%). The most common interventions undertaken in response to overdoses are presented in Fig. 3 and include: the administration of oxygen (87%); calling for an ambulance (39%); and the administration of 0.4 mg of naloxone hydrochloride (27%). Twenty-eight (28%) overdoses resulted in a transfer to hospital. There were no overdose fatalities or persistent vegetative states among these episodes.

There were 1046 SEOSI cohort participants recruited during the study period, enabling a detailed analysis of factors associated with overdose. These individuals were similar by age and gender to the overall population of individuals using the SIF ( $p > 0.1$ ), including 291 (28%) women and 203 (19%) individuals of aboriginal ancestry, and the median age was 39 years. Among these individuals, 395 (38%) reported performing more than 75% of their injections at the SIF, while 350 (33%) reported performing between 26 and 74% of their injections at the SIF, and 299 (29%) reported that they performed less than 25% of their injections at the SIF. In total, 90 SEOSI participants had an overdose at the SIF during the period of 1 March 2004 to 30 August 2005. In univariate Cox regression analyses, fewer years injecting (RH=0.97, [95% CI: 0.95–1.00 per year],  $p=0.015$ ), female gender (RH=1.55, [95% CI: 1.01–2.38],  $p=0.043$ ), daily heroin use (RH=2.12, [95% CI: 1.36–3.30],  $p<0.001$ ), binge drug use (RH=1.64, [95% CI: 1.03–2.61],  $p=0.039$ ), having a prior history of overdose (RH=1.79, 95% CI: 1.14–2.83,  $p=0.005$ ), and sex trade involvement (RH=1.87, 95% CI: 1.21–2.89,  $p=0.005$ ) were associated with time to first overdose at the SIS. In a multivariate Cox regression analysis,

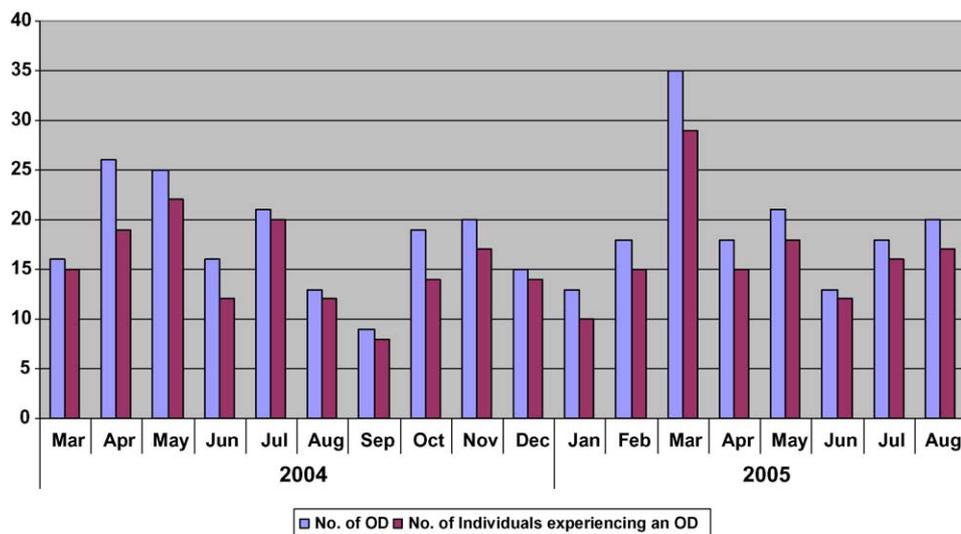


Fig. 1. Frequency of overdoses and number of individuals having an overdose within the SIF.

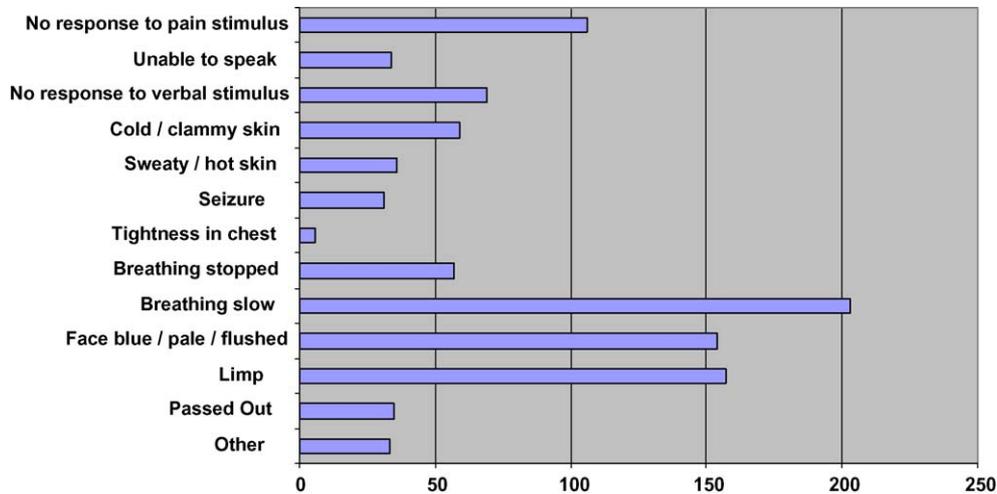


Fig. 2. Characteristics of overdoses observed within the SIF. Three hundred and thirty-six overdoses were included in this analysis. More than one characteristic may apply to each overdose.

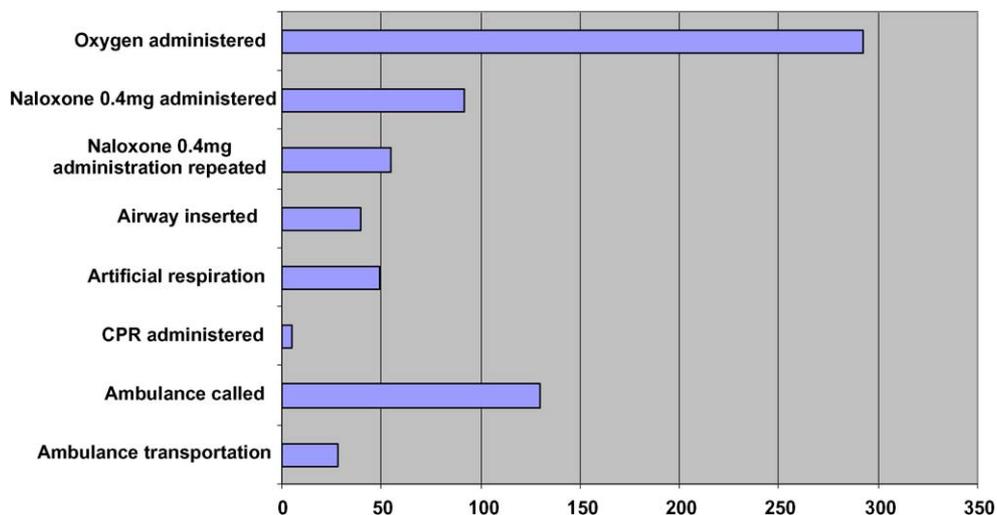


Fig. 3. Interventions undertaken in response to overdoses within the SIF. Three hundred and thirty-six overdoses were included in this analysis. More than one intervention may apply to each overdose.

fewer years injecting (RH=0.98, [95% CI: 0.96–1.00 per year],  $p=0.034$ ), daily heroin use (RH=1.82, [95% CI: 1.16–2.85],  $p=0.009$ ), and having a history of overdose (RH=1.92, [95% CI: 1.21–3.06],  $p=0.006$ ) were independently associated with time to first overdose.

## Discussion

In the present analysis we found that overdose events were not uncommon at the Vancouver safer injection facility. During an 18-month period, 285 individuals accounted for 336 overdose events, yielding an overdose rate of 1.33 (95% CI: 0.0–3.6) overdoses per 1000 injections. Heroin was involved in approximately 70% of all overdoses, and opiates considered together were involved in 88% of overdoses. It is notable, however, that approximately one-third of overdoses involved

stimulants. The most common indicators of overdose were depressed respiration, limp body, face turning blue, and a failure to respond to pain stimulus. The majority of overdoses were successfully managed in the SIF, with the most common overdose interventions undertaken by SIF staff involving the administration of oxygen, a call for ambulance support, and the administration of naloxone hydrochloride via injection. Among a randomly selected sample of SIF users, factors associated with time to overdose at the SIF included fewer years injecting, daily heroin use, and having a history of overdose. None of the overdose events occurring at the SIF resulted in a fatality.

The rate of overdose observed at the Vancouver SIF is within the range of rates observed in an international review of SIF which estimated the rates of overdose typically to be between 0.01 and 3.6 per 1000 injections (Kimber et al., 2005). However, the rate observed in Vancouver is lower

than rates observed recently in Münster, Germany (6.4 per 1000 injections) and Sydney, Australia (7.2 per 1000 injections) (Kimber et al., 2003). This may reflect differences in threshold for coding and intervention by staff, and differences in drug consumption patterns across cities, especially as it pertains to the use of opioids and other central nervous system depressants. The number of overdoses in the Vancouver SIF varied considerably from month to month, with monthly totals varying from 9 to 35 overdoses. This may reflect changes in local supply and purity of heroin, which is known to fluctuate considerably. Considering previous data concerning drug use patterns at the SIF, it is significant that the rate of overdose for injections involving heroin appears to be far greater than the rate of overdose for injections involving other forms of opiates (e.g., morphine, dilaudid). Injection of opioid analgesic tablets has been observed as a risk factor for fatal overdose because injection route of administration involves near instantaneous saturation of central opiate receptors as compared to more gradual saturation when taken orally (Kintz, 2001, 2002). Additionally, because of the high first-pass metabolism of these drugs, tablets intended for oral consumption are typically of higher doses than necessary to induce the same effects via injection, further increasing risk for overdose (Kintz, 2001, 2002). However, our findings regarding overdoses involving tablets may reflect the fact that these particular opiates are obtained in standard dosages (i.e., are diverted pharmaceuticals), and therefore IDU are more likely to be able to accurately predict the strength of the dose when injecting these opiates. These findings suggest the need for further evaluation of the use of prescription opiates as a means of reducing overdose among the IDU community. As well, the high proportions of opiate-related overdose and naloxone administration within the SIF suggest the need for further evaluation of naloxone distribution programs. Consistent with the experience in the Sydney SIF, the majority of overdoses were successfully managed within the SIF, with only 8% of all overdoses involving a transfer to hospital (Table 1).

The finding that less experienced injectors were more likely to overdose at the SIF is inconsistent with previous studies suggesting that it is the more experienced injectors, in particular experienced heroin injectors, who are at highest risk for non-fatal overdose (Darke & Hall, 2003). The associ-

ation between daily heroin use and overdose is consistent with previous analyses from this setting involving a community-recruited sample that indicated that daily heroin users are at heightened risk for non-fatal overdose in the community (Kerr et al., 2005), and is also consistent with a previous study of overdose in the SIF in Sydney, Australia (van Beek et al., 2004). The association between prior history of overdose and overdose at the SIF is also consistent with the study of overdose at the Sydney SIF (van Beek et al., 2004), and suggests that individuals with a history of overdose could be targeted upon entry to the SIF with interventions, such as safer injecting education, that may be effective at reducing non-fatal or fatal overdoses.

There are limitations associated with this study. Most importantly, there are no clear criteria for determining when an overdose has occurred, so that categorization varied somewhat between staff members. Second, the SIF database does not capture information regarding the state of participants prior to entering the SIF, including the substances consumed, and so there is only limited information concerning the factors that contributed to the overdose events described herein. Third, the data derived from the cohort of SIF users is based on self-report and therefore may be susceptible to socially desirable responding. However, the study design was such that participants provided data prior to overdosing in the SIF, and we believe this would serve to limit socially desirable responding in this instance. Further, because we can think of no reason why measurement error resulting from socially desirable responding would be different based on risk for overdose, this type of limitation would not introduce bias but rather would result in underestimates of association.

In summary, there have been many overdose events within Vancouver's SIF, although the rate of overdoses is similar to rates observed in SIF in other settings. The majority of these overdoses involved the injection of opiates, and most events were successfully managed within the SIF through the provision of oxygen. It is noteworthy that none of the overdose events occurring at the SIF resulted in a fatality. These findings suggest that SIF can play a role in managing overdoses among IDU and indicate the potential of SIF to reduce morbidity and mortality associated with illicit drug-related overdoses. This study should make a contribution to the ongoing debates over the value of SIF and prove useful to

Table 1  
Factors associated with time to first overdose in the SIF among SEOSI participants ( $n = 1046$ )

Variable	Unadjusted relative hazard (RH)			Adjusted relative hazard <sup>a</sup> (RH)		
	RH	95% CI	<i>p</i> -value	RH	95% CI	<i>p</i> -value
Years of injecting (per year injecting)	0.97	0.95–1.00	0.015	0.98	0.96–1.00	0.034
Gender (female vs. male)	1.55	1.01–2.38	0.043	1.12	0.65–1.92	0.692
Daily heroin use <sup>b</sup> (yes vs. no)	2.12	1.36–3.30	<0.001	1.82	1.16–2.85	0.009
Binge drug use <sup>b</sup> (yes vs. no)	1.64	1.03–2.61	0.039	1.40	0.87–2.24	0.167
Ever overdosed (yes vs. no)	1.79	1.14–2.83	0.012	1.92	1.21–3.06	0.006
Sex trade <sup>b</sup> (yes vs. no)	1.87	1.21–2.89	0.005	1.45	0.83–2.52	0.190

<sup>a</sup> Model was fit adjusting for all variables significant in univariate analyses.

<sup>b</sup> Behaviours refer to activities in the last 6 months and variables are time-updated.

the large number of cities in Canada and elsewhere that are considering initiating SIF trials (Gandey, 2003; Green et al., 2004; Strang & Fortson, 2004; Wood et al., 2004b; Wright & Tompkins, 2004; Yamey, 2000).

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