



## Full length article

# Changing risk and presentation of overdose associated with consumption of street drugs at a supervised injection site in Vancouver, Canada

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## ABSTRACT

**Background:** British Columbia is experiencing a public health emergency due to overdoses resulting from consumption of street drugs contaminated with fentanyl. While the risk of overdoses appears to be increasing, the overdose rate and severity of overdose presentations have yet to be quantified.

**Methods:** Insite is a supervised injection site in Vancouver. Data from Insite's client database from January 2010 to June 2017 were used to calculate overdose rates as well as the proportion of overdoses involving rigidity and naloxone administration over time in order to estimate changes in the risk and severity of overdose resulting from changes in the local drug supply.

**Results:** The overdose rate increased significantly for all drug categories. Heroin used alone or with other drugs continues to be associated with the highest overdose rate. The overdose rate associated with heroin increased from 2.7/1000 visits to 13/1000 visits over the study period, meaning that clients were 4.8 times more likely to overdose in the most recent period as in the baseline period. The proportion of overdose events involving rigidity, a known complication of intravenous fentanyl use, increased significantly from 10.4% to 18.9%. The proportion of overdoses requiring naloxone administration increased significantly from 48.4% to 57.1% and is now similar across all drug categories.

**Conclusions:** The risk and severity of overdoses at Insite have increased since the emergence of illicit fentanyl. This information derived from supervised injection site data can be used to inform local harm reduction efforts and the response to the overdose emergency.

## 1. Background

British Columbia is experiencing a public health emergency due to the contamination of street drugs with illicit fentanyl and other synthetic, high-potency opioids. Despite coordinated efforts to mitigate the crisis, the number of overdose deaths and the proportion of overdose deaths wherein fentanyl is detected continue to increase; fentanyl was detected in 4% of the 269 overdose deaths in 2012, but was detected in 67% of the 993 overdose deaths in 2016, and 84% of the 1452 overdose deaths in 2017 (BC Coroners Service, 2018a). While the number of overdose deaths in Vancouver has been increasing, changes in the risk, presentation and severity of overdoses following consumption of street drugs have yet to be quantified.

The majority of overdoses in the province appear to have occurred in association with consumption of opioids used alone or in combination with other drugs (BC Centre for Disease Control, 2017). Toxicology

performed by the BC Coroners Service reveals that the most commonly detected drugs in overdose victims include fentanyl, cocaine, and heroin (BC Coroners Service, 2018b); however, it is difficult to determine post-mortem which drugs were contaminated and thus may have been the actual cause of the overdose. Insite's fentanyl drug checking pilot revealed that 79.8% of all samples and 84.1% of heroin samples tested by clients were positive for fentanyl (Karamouzian et al., 2018).

The presentation of overdose following consumption of street drugs has also been changing. Muscle rigidity is a recognized complication of intravenous fentanyl administration in the clinical setting and has been outlined in case reports (Ahmad and Raza, 2017; Coruh et al., 2013; Dimitriou et al., 2014; Rosenberg, 1977; Roy and Fortier, 2003; Phua et al., 2017; Vaugh and Bennett, 1981; Ackerman et al., 1990; Viscomi and Bailey, 1997). Rigidity can affect the chest wall, jaw, and abdominal muscles and can result in respiratory compromise (Ackerman et al.,

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**Table 1**  
Characteristics of visits, clients and overdose events at Insite (2010–2017<sup>+</sup>).

	2010–2011	2012–2013	2014–2015	2016–2017	Trend
Total Visits	368,110	375,043	339,849	215,343	–
Average annual visits	184,055	187,522	169,925	143,562	–
Male:Female ratio	2.8:1	2.7:1	2.6:1	2.6:1	–
Average age of clients (95% CI <sup>*</sup> )	39 (19–60)	39 (18–60)	40 (18–61)	40 (18–62)	–
Total overdose events	568	949	1,134	2,044	–
Average annual overdose events	284	475	567	1363	–
Overdose rate per 1000 visits (95% CI <sup>*</sup> )	1.5 (1.4, 1.7)	2.5 (2.3, 2.8)	3.3 (3.1, 3.6)	9.5 (9.0, 10.0)	p < 0.001
Number (%) of overdose events with rigidity	59 (10.4%)	98 (10.3%)	143 (12.6%)	386 (18.9%)	p < 0.001
Number (%) of overdose events requiring naloxone administration	275 (48.4%)	415 (43.7%)	465 (41.0%)	1168 (57.1%)	p < 0.001

\* CI denotes Confidence Interval.

<sup>+</sup> Data from January 2010 to June 2017.

1990; Ahmad and Raza, 2017; Coruh et al., 2013; Dimitriou et al., 2014; Phua et al., 2017; Rosenberg, 1977; Vaugh and Bennett, 1981). The effect responds to naloxone, but patients may also require ventilation support (Vaugh and Bennett, 1981). There have been limited scientific reports examining rigidity following street drug use (Burns et al., 2016; Buxton et al., 2018; Petrou, 2016), but it is increasingly observed by community partners and staff at Insite in association with illicit drug overdose and has potentially contributed to increases in drug-related mortality (Buxton et al., 2018).

The purpose of this study is to use data from a supervised injection site in Vancouver, Canada to estimate changes in the risk and severity of overdose resulting from changes in the local drug supply during a period of time when the drug supply was thought to be increasingly contaminated with illicit fentanyl. It is hoped that this analysis will inform local harm reduction efforts as well as the ongoing response to the overdose emergency.

## 2. Methods

Insite is a supervised injection site where clients consume pre-obtained street drugs under clinical supervision. It is located in the downtown eastside of Vancouver, an area with high prevalence of drug use, poverty, and homelessness. Data were acquired from Insite's client database from January 2010 – June 2017. Data fields included drug consumed, which must be reported by clients prior to consumption, and clinical outcomes such as overdose, presence of rigidity and whether naloxone was administered. Overdoses are identified and managed by nursing staff according to Insite's clinical protocols. Naloxone is administered if features of opioid overdose are present and other interventions such as stimulation, oxygen and ventilation using a bag-valve mask have not been sufficient to treat the overdose. Data are entered by Insite staff at the time of the clinical encounter. Incomplete records where drug consumed was not recorded were excluded from the analysis. This represented less than 0.07% of records during the study period.

Drug categories and time periods were constructed to examine the potential effect of contamination of street drugs with illicit fentanyl, which was first noted in British Columbia in 2012 (BC Coroners Service, 2018a). Drug categories included Heroin, Other Opioids (which includes any opioids other than heroin), Cocaine (which includes powder cocaine and crack cocaine), Crystal Meth and Mixed Drugs (which consisted mainly of heroin in combination with other drugs). Time periods included a two-year, pre-fentanyl baseline period from 2010 until 2011, the subsequent two-year intervals from 2012 to 2013 and from 2014 to 2015, and the 18-month period from 2016 until the last day of June, 2017.

Risk of overdose was determined by calculating the overdose rate per 1000 visits. Change in the risk of overdose was determined by calculating the relative risk of overdose compared to the baseline period. Severity of overdose was determined by calculating the

proportion of overdoses presenting with rigidity and the proportion of overdoses that required naloxone administration. To examine if rigidity was observed as part of the overdose presentation the clinical record was searched for the keywords “rigid/rigidity”, “clench/clenched”, “decorticate”, “flexion”, “extension”, and/or “stiff.”

For each drug category and time period, overdose rate, relative risk of overdose, proportion of overdoses involving rigidity and proportion of overdoses requiring naloxone were calculated. Relative risk of overdose was calculated as the ratio of overdose rate in a given time period compared to the baseline period. Exact 95% confidence intervals were calculated for the rates, relative risks and proportions. Fisher's exact test was used to determine significant differences between the rates and proportions. A trend analysis was performed to assess whether or not the rates and proportions increased significantly over time. Statistical significance was defined as p < 0.05. All statistical analyses were performed using Stata Statistical Software, Release 15 (StataCorp LP, College Station, Texas, USA).

Following consultation with our local research ethics authorities it was determined that ethics approval was not required as this study involved secondary use of anonymous data.

## 3. Results

The average annual number of visits to Insite declined during the study period from 184,055 visits per year during the baseline period (2010–2011) to 143,562 visits per year in the most recent period (2016–2017). The ratio of male to female clients as well as the average age of clients attending Insite remained stable (Table 1). No fatalities occurred at Insite during the study period.

### 3.1. Risk of overdose

#### 3.1.1. Overdose rate

The average annual number of overdoses increased from 284 during the baseline period to 1363 during the most recent period. The overdose rate increased significantly from 1.5/1000 visits during the baseline period to 9.5/1000 visits during the most recent period (Table 1).

All drug categories were associated with statistically significant increases in overdose rate from the baseline period to the most recent period, with the most dramatic increases occurring from 2014–2015 to 2016–2017 (Table 2).

In the most recent period, Heroin and Mixed Drugs (which consisted mainly of heroin in combination with other drugs) continued to be associated with the greatest overdose rate. Also, the overdose rate associated with Cocaine in the most recent period is now higher than the rate associated with Other Opioids (Table 2). The overdose rate associated with Crystal Meth continued to be lowest across all drug categories (Table 2).

**Table 2**  
Overdose rate per 1000 visits (95% CI<sup>+</sup>) by drug category at Insite (2010–2017<sup>+</sup>).

Drug Category	2010–2011	2012–2013	2014–2015	2016–2017	Trend
Heroin	2.7 (2.5, 3.0)	4.1 (3.8, 4.4)	4.9 (4.6, 5.3)	13 (12.6, 13.9)	p < 0.001
Other Opioids	0.8 (0.6, 1.1)	1.0 (0.7, 1.3)	1.3 (0.9, 1.7)	2.1 (1.5, 2.8)	p < 0.001
Cocaine	0.4 (0.3, 0.5)	0.5 (0.3, 0.7)	0.7 (0.4, 1.0)	3.7 (2.7, 5.0)	p < 0.001
Crystal Meth	0.2 (0.1, 0.5)	0.5 (0.3, 0.8)	0.7 (0.5, 1.0)	1.3 (0.9, 1.8)	p < 0.001
Mixed Drugs	2.4 (1.9, 3.1)	3.5 (2.9, 4.2)	4.5 (3.8, 5.3)	11.6 (10.4, 13.1)	p < 0.001

\* CI denotes Confidence Interval.

<sup>+</sup> Data from January 2010 to June 2017.

**Table 3**  
Relative risk of overdose (95% CI<sup>+</sup>) compared to 2010–2011 by drug category at Insite (2010–2017<sup>+</sup>).

Drug Category	2010–2011	2012–2013	2014–2015	2016–2017	Trend
Heroin	1	1.5 (1.3, 1.7)	1.8 (1.6, 2)	4.8 (4.3, 5.3)	p < 0.001
Other Opioids	1	1.2 (0.8, 1.8)	1.6 (1.1, 2.3)	2.5 (1.7, 3.8)	p < 0.001
Cocaine	1	1.4 (0.9, 2.2)	1.9 (1.2, 3.3)	10.4 (6.7, 16.1)	p < 0.001
Crystal Meth	1	2.5 (0.9, 7.1)	3.4 (1.2, 9.6)	6.3 (2.3, 17.6)	p < 0.001
Mixed Drugs	1	1.4 (1.1, 2)	1.8 (1.4, 2.5)	4.8 (3.6, 6.2)	p < 0.001

\* CI denotes Confidence Interval.

<sup>+</sup> Data from January 2010 to June 2017.

### 3.1.2. Relative risk of overdose

The relative risk of overdose increased significantly across all drug categories. Compared to the baseline period, clients in the most recent period had 10.4 times the risk of overdose following cocaine consumption, 4.8 times the risk of overdose following heroin consumption and 2.5 times the risk of overdose following consumption of other opioids. Over the study period, Cocaine was associated with the greatest increase in the relative risk of overdose (Table 3).

### 3.2. Severity of overdose

#### 3.2.1. Rigidity

Overall, the proportion of overdoses presenting with rigidity increased significantly from 10.4% in the baseline period to 18.9% in the most recent period (Table 1). There were also statistically significant increases in the proportion of overdoses involving rigidity for all drug categories except Cocaine (Table 4).

#### 3.2.2. Naloxone administration

Overall, the proportion of overdoses requiring naloxone administration increased significantly from 48.4% in the baseline period to 57.1% in the most recent period (Table 1). There were also statistically significant increases in the proportion of overdoses requiring naloxone for all drug categories except Other Opioids. During the baseline period, the proportion of overdoses requiring naloxone associated with Heroin was greater than other categories; however, the proportion of overdoses requiring naloxone in the most recent period is similar across all drug categories (Table 5).

**Table 4**  
Proportion (95% CI<sup>+</sup>) of overdose events involving rigidity by drug category at Insite (2010–2017<sup>+</sup>).

Drug Category	2010–2011	2012–2013	2014–2015	2016–2017	Trend
Heroin	10.4% (7.5, 13.8)	10.5% (8.3, 12.9)	13.7% (11.4, 16.1)	18.5% (16.6, 20.5)	p < 0.001
Other Opioids	3.5% (0.4, 12.1)	2.3% (0.1, 12.0)	6.4% (1.3, 17.5)	16.7% (7.0, 31.4)	p < 0.02
Cocaine	13.5% (4.5, 28.8)	14.3% (4.8, 30.3)	8.7% (1.1, 28.0)	23.8% (12.1, 39.5)	p > 0.05
Crystal Meth	0.0% (0.0, 60.)	0.0% (0.0, 14.2)	7.1% (1.5, 19.5)	16.7% (7.0, 31.4)	p < 0.02
Mixed Drugs	16.7% (8.6, 27.9)	11.9% (6.5, 19.5)	10.7% (6.4, 16.6)	21.1% (16.7, 26.1)	p < 0.05

\* CI denotes Confidence Interval.

<sup>+</sup> Data from January 2010 to June 2017.

## 4. Discussion

Consistent with what has been observed in the community and described in recent reports, the risk of overdose associated with various types of street drugs has increased at Insite since the emergence of fentanyl in British Columbia (BC Centre for Disease Control, 2017; BC Coroners Service, 2018a,b). Various studies have suggested that street drugs are increasingly contaminated with fentanyl (Amlani et al., 2015; Karamouzian et al., 2018; Tupper et al., 2018) and that fentanyl is detected in an increasing proportion of overdose deaths (BC Coroners Service, 2018a). Although our data cannot prove that fentanyl is the cause, they confirm that the risk of overdose has increased and help to quantify that risk across a variety of drug categories. Heroin used alone or in combination with other drugs continues to be associated with the greatest risk of overdose; however, the greatest relative increase in the risk of overdose was seen in association with cocaine.

The increased risk of overdose associated with cocaine also correlates with data from local drug checking studies suggesting that simulants such as cocaine and crystal meth can also be contaminated with fentanyl (Karamouzian et al., 2018; Tupper et al., 2018). Such findings are also relevant in light of recent media reports of clusters of overdoses occurring after the consumption of stimulants contaminated with fentanyl (Azipiri, 2015; CBC News, 2016; Judd, 2016).

Rigidity as a complication of intravenous fentanyl use has been reported in the anesthesia literature (Ackerman et al., 1990; Ahmad and Raza, 2017; Coruh et al., 2013; Dimitriou et al., 2014; Phua et al., 2017; Rosenberg, 1977; Roy and Fortier, 2003; Vaugh and Bennett, 1981; Viscomi and Bailey, 1997), with limited reports in association with illicit fentanyl use (Burns et al., 2016; Buxton et al., 2018; Petrou, 2016). The proportion of overdose events involving rigidity at Insite increased

**Table 5**  
Proportion (95% CI<sup>\*</sup>) of overdose events requiring naloxone by drug category at Insite (2010–2017<sup>+</sup>).

Drug Category	2010–2011	2012–2013	2014–2015	2016–2017	Trend
Heroin	54.8% (49.7, 59.8)	46.1% (42.4, 49.8)	42.6% (39.3, 46.0)	58.1% (55.6, 60.5)	p < 0.001
Other Opioids	33.3% (21.4, 47.1)	45.5% (30.4, 61.2)	38.3% (24.5, 53.6)	47.6% (32.0, 63.6)	p > 0.24
Cocaine	21.6% (9.8, 38.2)	17.1% (6.6, 33.6)	21.7% (7.5, 43.7)	54.8% (38.7, 70.2)	p < 0.001
Crystal Meth	25.0% (0.6, 80.6)	12.5% (2.7, 32.4)	22.0% (10.6, 37.6)	57.1% (41.0, 72.3)	p < 0.001
Mixed Drugs	43.9% (31.7, 56.7)	41.3% (31.9, 51.1)	40.9% (33.2, 48.9)	53.6% (47.8, 59.2)	p < 0.02

\* CI denotes Confidence Interval.

<sup>+</sup> Data from January 2010 to June 2017.

significantly over the study period. This increase in rigidity may reflect increasing contamination of the drug supply with fentanyl as it is associated with synthetic lipid soluble opioids such as fentanyl and its analogues and is uncommon with other opioids (Coruh et al., 2013). The increase in severe overdose presentations involving rigidity at Insite may be indicative of similar trends in the community.

The findings of this study contribute to our awareness of rigidity as a potential complication of street drug use as there is currently very little literature describing this phenomenon. The findings also inform clinical practice as chest wall rigidity may make ventilation difficult emphasizing the need for rapid naloxone administration and ventilation support.

Not only has the risk of overdose increased over the study period, but so has the proportion of overdoses that require naloxone administration. This could be reflective of the fact that fentanyl and other synthetic opioids are typically more potent than heroin and thus more likely to result in severe overdoses that require naloxone administration. The proportion of overdoses requiring naloxone administration is also now similar across all drug categories providing further evidence that non-opioid drugs may also be contaminated with fentanyl.

The findings of this study help characterize the risk of overdose associated with a variety of street drugs during a period of time where street drugs were thought to be increasingly contaminated with fentanyl. They can be used to inform clinical practice when translating overdose risk to patients during the current overdose emergency. This characterization of overdoses may also inform harm reduction practices, as a variety of drugs categories are associated with increased overdose risk and thus extra caution should be exercised when using any street drug. Use of supervised consumption sites and take-home naloxone kits should be recommended for individuals using any street drug, not just opioids.

Finally, this study contributes to current literature by demonstrating how data from a supervised injection site can be used to help characterize the impact of changes to the local drug supply and brings forward the potential for other supervised consumption sites to use their data in a similar fashion. Moreover, the study relies on client report to determine the drug being consumed. The drugs were not tested, which mimics real-world conditions where people rarely know with certainty which drug they are consuming.

A limitation of this study is that it was restricted to one supervised injection site. Drugs consumed at Insite may not necessarily be representative of drugs consumed in other areas. Another limitation is that documentation included only drugs that the client consumed on site. Drugs, alcohol or medications that clients consumed before coming to Insite that could contribute to risk or severity of overdose were not documented. Additionally, the study did not examine the health status of clients visiting Insite.

Identification and management of overdose was based on clinical judgement. The true cause of an overdose was not determined and it is possible that not all overdoses where naloxone was administered were due to opioids. Documentation of rigidity was done in clinical notes and subject to bias in documentation and possible underreporting. Finally, as this is an observational study, causation between fentanyl contamination and overdose outcomes could not be determined.

## 5. Conclusion

The results of this study help characterize the changing risk and severity of overdose associated with street drugs in Vancouver since the emergence of fentanyl in British Columbia; there is an increased risk of overdose across all drug categories with a greater proportion of overdoses requiring naloxone. The clinical presentation of overdoses has also changed with an increased proportion of overdoses now involving rigidity, a known consequence of intravenous fentanyl use. This highlights the importance of harm reduction practices when using a variety of street drugs and promotes understanding of how fentanyl contamination may be changing the risk, severity and clinical presentation of overdose. It also means that overdose prevention education should focus on people using all substances, as people using non-opioid drugs such as cocaine may not be aware of their risk of opioid overdose.

This study used data from a supervised injection site to generate knowledge about risks associated with the local drug supply. Future steps include continuing to monitor the risk of overdose at this and other supervised consumption sites. Findings from this study also support the implementation of drug checking services at supervised injections sites. Providing clients and health authorities with better information about the drugs they plan to consume may help reduce harms such as overdose.

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## Contributors

ML was involved in all aspects of this article from inception to completion. TC completed all data analysis. BB and DN participated in interpretation of the data and writing of the manuscript. ML, BB, DN, TC and RJ all were involved in review of the manuscript. All authors approved the final manuscript before submission.

## Conflict of interest

The authors have no conflicts of interest to declare.

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