Predicting Illicit Opiate Drug Overdoses in the City of Surrey

Impacts of Opioid use in Neighbourhoods

Paul Maxim, Len Garis, Joseph Clare, Hubert Duan, Andrew Fink

February 2019

UNIVERSITY OF THE FRASER VALLEY
SCHOOL OF CRIMINOLOGY & CRIMINAL JUSTICE

UNIVERSITY OF THE FRASER VALLEY
CENTRE FOR SOCIAL RESEARCH

Executive Summary

This study examines the spatial and temporal distribution of the incidence of overdoses and deaths attributable to opioid abuse within the City of Surrey from 2016 to 2018. As the general epidemiological literature reports, the distribution of overdose incidents and deaths is neither random in space nor time. Spatially, these incidents tend to cluster around specific nodes and pathways within a city. In this regard, the City of Surrey is no different. There is also a strong association with the time of day when these occurrences take place and the day in the month when social assistance payments are made.

In the first part of the analysis, we find an association between the incidence of overdoses and deaths and the location of both regulated and unregulated recovery homes. Most overdose incident events are clustered in the northwest section of the City and along the King George Boulevard corridor bordered between 108 Avenue and 64 Avenue. This is where there is a disproportionate clustering of both recovery houses and addicts. Recovery houses are generally located close to where their potential clients exist and, in turn, potential clients are attracted to those same locations.

The micro-spatial association between overdoses, deaths and the location of recovery homes is complex, however. Perhaps the best way to visualize the relationship is to imagine a doughnut. There is a depression in rates of overdoses and deaths in the center of the doughnut (that is, where the house exists). Beyond that centre, there is a steep rise in incidents and then a gradual tapering off. Most overdoses and deaths occur within 500 meters of a recovery house.

In the second part of the analysis, a strong relationship is found between overdoses, deaths, crime and the distribution of social assistance payments. Overdoses and deaths peak within the first three days of the distribution of payments. Inversely, monthly property crime rates decline during that period. This pattern replicates findings from studies in both Vancouver and the United States where a significant "cheque effect" has been found and provides an opportunity for policy reform.

The third part of this analysis addresses the question of whether it is possible to use these findings to assist in the construction of a predictive model of when and where overdoses and deaths are likely to occur. While the results are preliminary in this instance, there is evidence to suggest that efforts to build a predictive model may pay dividends.

The study concludes with a series of policy recommendations based on the above findings.

Introduction

The incidence of deaths due to opioid overdoses in Canada has increased substantially in the past few years (Fischer et al. 2006). In 2017, the national rate for opioid-related deaths was approximately 10.9 per 100,000 population, or about 4,000 deaths in total. In the first six months of 2018, the death rate had increased to an estimated 11.2 per 100,000.[1] British Columbia has experienced the brunt of that pattern with the estimated death rate of 30.9 per 100,000 population for 2017 and 30.6 in 2018. In absolute numbers, illicit drug overdose deaths increased from 294 in 2010 to 1,489 in 2018. The increase in both reported overdose cases and deaths in British Columbia led the Province to declare a public health emergency in 2016 (Otterstatter et al. 2018).

A major driver of that increase in opioid deaths has been the introduction of synthetic narcotics such as oxycontin and fentanyl. Fentanyl, for example, is a stronger analgesic than traditional opioid painkillers (up to 100 times stronger than morphine) and when incorporated into a time-released patch was initially considered minimally addictive. Originally, fentanyl was available through a prescription only but, in recent years, it has become a major component of the illicit drug trade. Users initially learned how to extract and concentrate fentanyl from patches and, more recently, it and several derivatives (e.g., carfentanil) have become available on the black market in powder and pill form. It has been estimated that nearly all street "heroin" sold in Vancouver contains fentanyl (Woo 2018). Regardless, it has been estimated that about one-third of those having died recently due to opioid overdoses had a prescription (Gomes et al. 2018), although current restrictions on opioid-for-pain prescriptions appear to be changing that pattern (Smolina et al. 2019).

The Province has responded in various ways including providing greater availability to Opioid Antagonist Therapy (OAT). In September 2018, more than 21,000 prescriptions were written for an opioid antagonist such as naloxone. This is an increase from slightly more than 15,000 prescriptions written in September 2015.[2] Besides widening the availability of OATs in pharmacies, ambulance attendants, firefighters and police officers have increasingly been supplied with naloxone to respond to overdoses. Unfortunately, some of the more recent opiate analogues such as carfentanil, are sufficiently toxic that they could pose a health risk to emergency responders who might come in physical contact with the substances.

To help curtail the upward trend in opioid overdoses, Health Canada approved two supervised consumption sites in Surrey in 2017. The first, *Safepoint*, is located at 135A Street and the second, the *Quibble Creek Sobering and Assessment Centre*, is located near King George Boulevard and 94 Avenue. The location of supervised consumption sites is often subject to debate due to trade-offs in the needs of users, and local residents and property owners. In the case of *Safepoint*, substantial consideration was given to input from potential users of the site.

---

[1] https://www.canada.ca/en/health-canada/services/substance-use/problematic-prescription-drug-use/opioids/data-surveillance-research/harms-deaths.html

[2] http://www.bccdc.ca/resource-gallery/Documents/Educational%20Materials/Epid/Other/BC_OD_Response_Monthly_Infographic.pdf

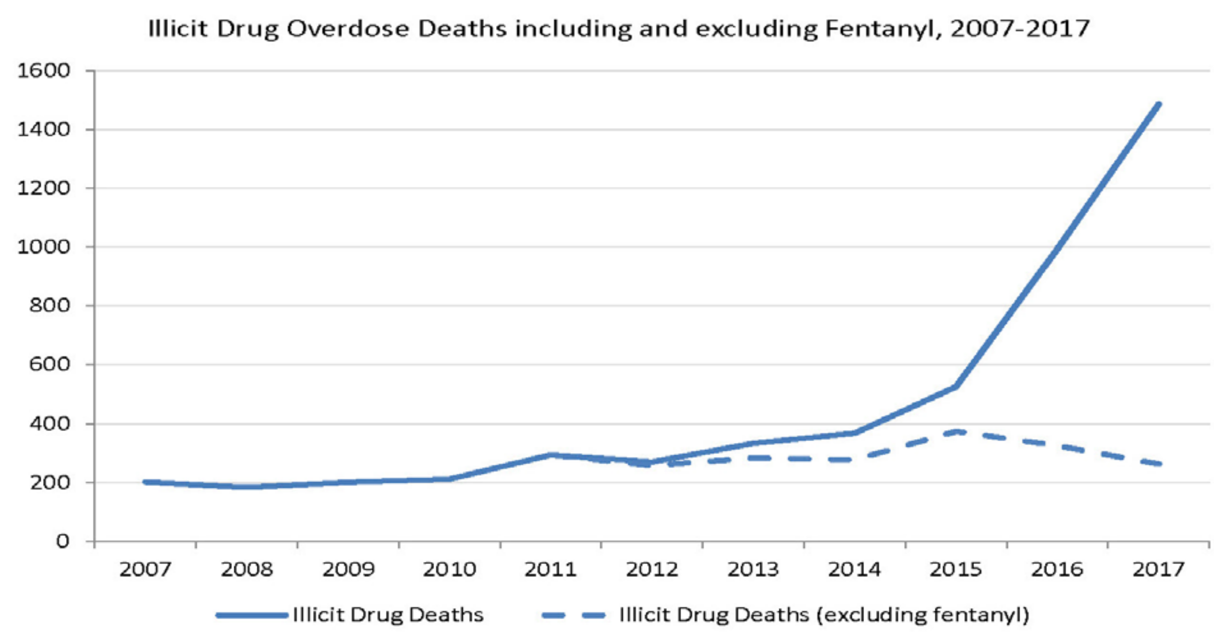
The social implications of opioid dependency and drug use in general go well beyond the impact on individual users: addiction affects the entire community. In this study, we focus on the impact of opioid use on neighbourhoods. Specifically, we will examine three questions. That is,

i. What is the relationship between the location of recovery houses and the location of opioid overdoses in conjunction with a soft treatment?
ii. Is there a relationship between social assistance, opioid overdoses and property crime?
iii. Can the neighbourhood or geo-spatial distribution of overdoses be predicted?

Background

Until recently, the geo-spatial analysis of opioid deaths by epidemiologists and healthcare researchers had been limited to higher geographical aggregates such as cities or, more often, provinces and states (Cordes 2018). The primary reason for this is that, historically, opioid deaths were significantly fewer than is currently the case and rates often varied little from year to year. The introduction of higher potency opioid-based narcotics such as oxycontin and, more recently, fentanyl, acted as a major disruptor to that pattern. Evidence for this can be seen in Figure 1 which illustrates the increased rate in opioid-related deaths in British Columbia from 2007 to 2017 (BC Coroners Service). Currently, BC appears to have the highest rates for both opiate overdoses and deaths in Canada. As previously indicated, the absolute numbers known to public health officials increased from 294 in 2010 to approximately 1,489 in 2018.

FIGURE 1



Source: BC Coroners Service Illicit Drug Overdose Deaths in BC January 1, 2008 to December 31, 2018

Within Canada, British Columbia has faced the brunt of that increase. However, the steep incline in opioid-related deaths is not limited to BC or Canada for that matter. Several parts of the United States have become "hotspots" for synthetic opioid use in recent years. Much of this was due to the relative availability of oxycontin which soon gained the moniker, "hillbilly heroin." Because of the spike in usage in parts of the US, some micro spatial analysis has been used for policy purposes in an attempt to mitigate opioid-related deaths. For example, Dodson et al. (2018) examined the impact of differentially supplying pharmacies with naloxone in Pittsburgh. Here, the researchers identified cases of suspected nonfatal opioid overdoses where naloxone was administered from April 2013 through December 2016 by the city's Bureau of Emergency Medical Services. They used spatial modeling to identify peak use areas to optimize naloxone distribution among pharmacies in the city. Pharmacies were differentially selected to create a geographical solution that minimized travel cost and increased accessibility for communities hit hardest. According to the authors, "this reconfiguration shaved roughly more than two tenths of a mile off the average distance to the closest pharmacy offering naloxone, which may not sound like much, but [it] provides crucial minutes for acquisition and administration."

Analogous research in San Francisco by Rowe and his associates (2016) also confirmed the benefits of having lay-person access to naloxone in selected areas as a key element in reducing overdose-related mortality. On the other hand, the researchers noted that alternative delivery methods appear necessary to address overdoses that occur in areas with a less concentrated risk, such as suburban and rural localities.

Similarly, Des Jarlais and colleagues (2018) identified injection "hotspots" in New York City to focus on HIV and Hepatitis C virus (HCV) transmission. While they concluded that HIV transmission was likely to be a random occurrence largely because it is at an "end of epidemic" stage, HCV transmission still appeared concentrated in certain locations. Using this information, the authors suggested, could allow for a more targeted use of resources to address disease transmission associated with intravenous drug use.

More pertinent to the current analysis, Heavey et al. (2018) examined the impact of New York State allowing police officers and firefighters to administer naloxone in addition to EMS personnel. The study was conducted in Erie County, NY which includes the City of Buffalo. The analysis focused on over 600 instances where either police officers or firefighters were first responders to an overdose incident. Overall, the "results suggest that police and fire personnel are effectively evaluating the scene upon arrival at an overdose and are administering naloxone within the recommended indications."

The study also indicated that while interventions by police or fire personnel were effective in stabilizing patients, secondary or follow-up responses by EMS personnel were often required to fully resuscitate the patient.

Obviously, locating where opioid use and opioid overdose is most likely to occur is a key element to conducting an adequate spatially-focused response to the problem. Some earlier research used calls to poison control centres to obtain that information (Smith et al. 2008). A somewhat different tact was taken by Bearnot and his colleagues (2018). These researchers used crowdsourced data to identify discarded needle hotspots in Boston.

Most recent studies reported in the literature use calls for service (such as through 911) as a primary tool to identify specific neighbourhoods or locations where opioid overdoses are most likely to be concentrated. Tracking 911 calls makes sense because, as the BC Coroners' Service (2018) has noted, over 86% of overdose deaths occurred indoors; 58 % in private residences; 24% in other residences including social and supportive housing, shelters and hotels; 4% in other inside locations; while 12% occurred outside in vehicles, sidewalks, streets, parks and other public spaces.

Theory Directed Responses

To provide an organizational framework to our thinking about how to respond to where and when drug overdoses take place and some of the consequences of drug-taking behaviour, we can turn to a body of theory generated by sociologists over the past century. As far back as the 1920s, social scientists were wondering if there were spatial and temporal patterns to criminal and deviant behaviour. Sociologists at the University of Chicago noted that the application of ecological principles to the distribution of anti-social behaviour explained a substantial amount of the variation in the distribution of such behaviours, including drug abuse (see Park (1967); Hawley (1943); Shaw et al. (1929)) .

One theoretical stream that has descended from the social ecology framework is what is now referred to as crime-pattern theory. Here, the key assertion is that individuals are largely opportunistic and take advantage of easy criminal opportunities as part of their daily routines. As Diplock (2016) notes: "offenders will commit crimes along their typical daily routes (known as paths) between their houses, places of work or school, recreational locations, and other hang-out areas (known as nodes)."

Typically, crimes are not spatially random events but occur near nodes and gradually taper off as the distance from the node increases. This insight illustrates the importance of knowing where crimes occur and where offenders normally travel, in order to strategically target crime prevention interventions (Diplock 2016). Practical responses to this insight range from differential police patrolling, to the greater physical and electronic surveillance of high crime-prone neighbourhoods, to neighbourhood watch schemes. Wilson and Kelling's broken-windows theory reinforces this notion (Kelling and Coles 1997). By fixing broken windows, cleaning up graffiti and removing other signs of "social disorder," a message is sent to potential offenders that crime and other activities are not acceptable in that area.

It has been suggested that such interventions may lead to crime displacement where offenders travel further to commit crimes (Gallagher and Wilcox 2013). However, displacement also imposes a cost that many potential offenders appear not willing to pay. As Cornish and Clark (1986) noted, offenders tend to be rational actors who examine their environment and immediate situation to estimate a balance of perceived rewards and risks. In the case of drug users, some may find the increased cost an incentive to seek a treatment or maintenance program that alleviates the requirement of raising funds to purchase drugs from street vendors. Recent research examining evaluation studies suggests that the magnitude of displacement effects is over emphasized and that when they do occur, their impact is minimal (Guerette and Bowers 2009).

There is good reason based on the existing research and theory to assume there will be a non-random pattern to the overdose problems even in a small geographic area. There is a likelihood that this is related to 'nodes' that drug users are moving between, which is likely to include recovery houses. Understanding more about the spatial relationships between these patterns is fundamental to undertaking targeted prevention-focused interventions that simultaneously aim to maximize the utility of City resources and minimize the potential for loss of life.

Geographical Distribution of Overdoses: Recovery Houses and the Location of Opioid Overdoses

As indicated in the literature review, drug use and consequent drug overdoses are not randomly distributed in most cities. Significant proportions of overdoses and overdose-related deaths tend to be clustered in certain locations or neighbourhoods. Thus, for example, Dodson et al. (2018) and Rowe (2016) are able to explore models for the optimal distribution of naloxone supplies based on patterns of overdoses.

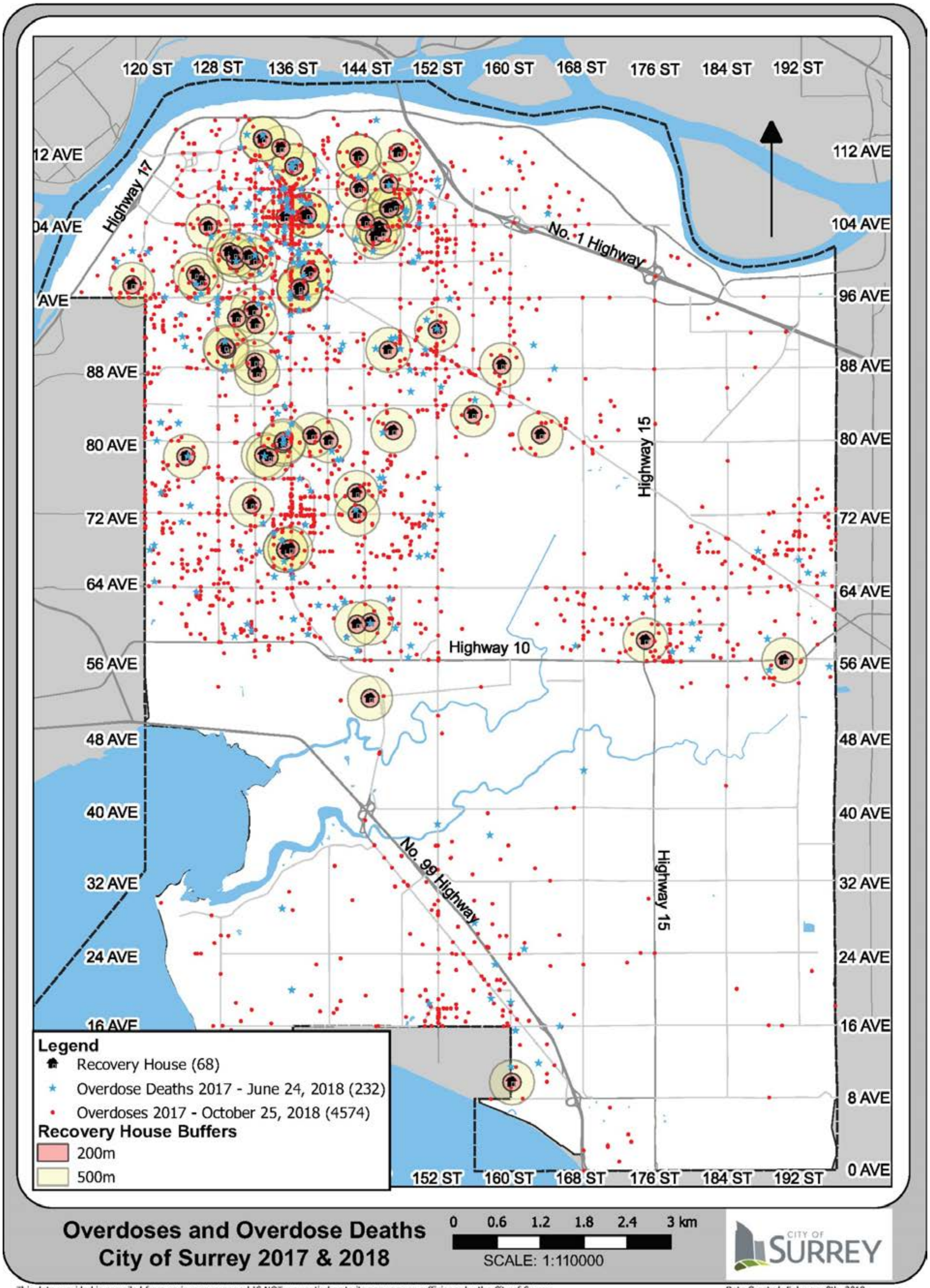
Figure 2 shows the distribution of 4,574 overdoses during the period January 1, 2017 to October 25, 2018, and 232 opioid-related deaths during the period January 1, 2017 to June 24, 2018, in the City of Surrey (the red dots and blue stars respectively). While incidents occur in all residential areas of the City, there is a higher preponderance of events in the northwest sector of the City and along the King George Boulevard corridor bordered between 108 Avenue and 64 Avenue. It is in those areas that responses need to be disproportionately, although not exclusively, focused.

Impact of Recovery Houses

Figure 2 also indicates where recovery houses are located (the black house icons). The relationship between illicit drug use and recovery houses is complex: some have referred to it as the “chicken and egg” situation. On the one hand, agencies tend to locate recovery houses in sections of a city where their potential clients are located. On the other hand, those houses act as a magnet for users seeking assistance. The result is that a strong geo-spatial correlation develops between the location of drug users and recovery houses, and that relationship further strengthens with time. An analysis of data from City of Surrey Fire Services demonstrates that in 2016 and 2017, approximately 70% of reported overdose incidents occurred within 500 meters of recovery houses. Additionally, over 90% of overdose deaths occurred within the same distance Griffioen (2018).

In Figure 2, we have created 200-meter and 500-meter circles around where recovery houses are located (the pink and yellow circles respectively). The recovery houses are identified by the small house icons at the centre of the circles. From this, it is relatively easy to see the clustering of incidents of both overdoses (red dots) and deaths (blue stars). Again, the relationship between recovery houses and overdoses (and deaths) is complex. One of the advantages offered by many recovery houses is that there are staff members who offer programing and oversight of the residents. These staff are also trained to administer naloxone in many instances. Consequently, while overdose calls for service cluster around recovery houses, there is a decrease in incidents within the space immediately adjacent to the houses themselves.

FIGURE 2



This data provided is compiled from various sources and IS NOT warrantied as to its accuracy or sufficiency by the City of Surrey

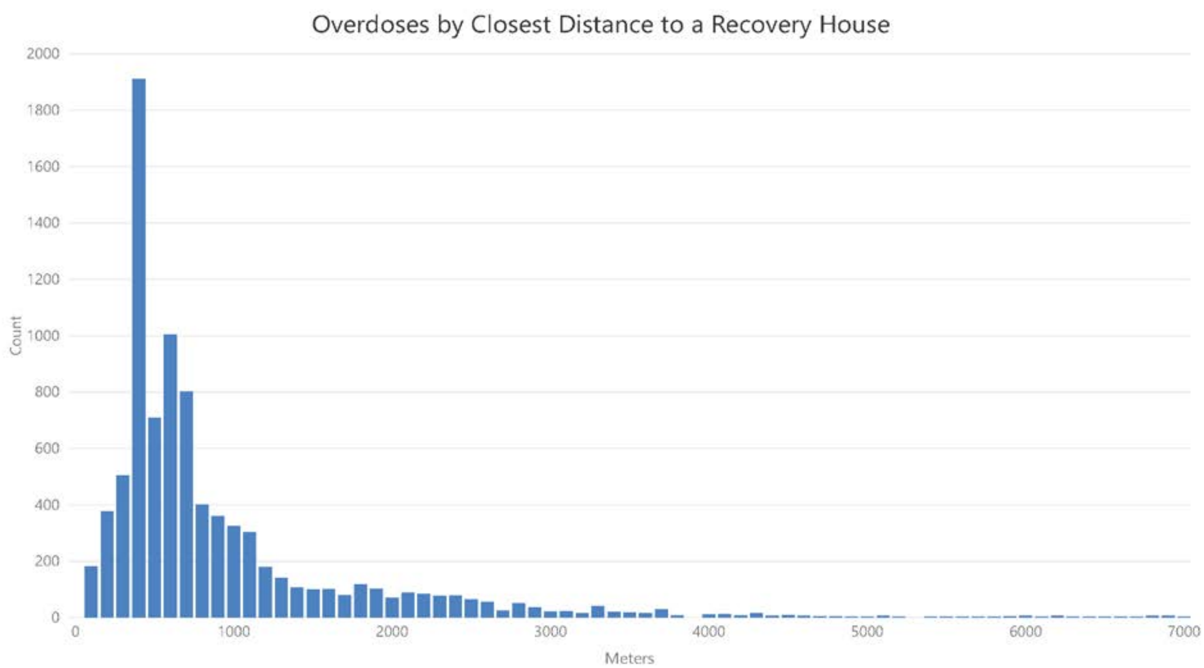
Date Created: February 8th, 2019

As part of the analysis, we measured the point-to-point distances between the exact location of overdose incidents and where they occurred relative to the location of the known recovery houses.[3] From that, we could find the shortest distance between the incident and the *closest* recovery home.[4]

That distribution is illustrated in Figure 3. The bottom or X-axis of Figure 3 presents the distance in meters from the closest recovery house in multiples of 100 meters.

As Figure 3 shows, the first 100 meters in and around the recovery house has few calls to respond to an overdose incident. Overdose incidents, however, spike in the next 100 meters and tend to drop consistently thereafter. This pattern is not uncommon where patterns of events are "accidental" as opposed to systematic. It is also consistent with what we know about the distribution of opioid use as outlined in the theory section above. These results are also consistent with previous studies such as that by Griffioen (2018).

FIGURE 3



We can also examine the spatial distribution of deaths due to overdoses. Again, we are looking at the point-to-point distance from where the death reportedly occurred to the closest recovery house. Figure 4 shows this distribution. Overall, the pattern is very similar to that observed in

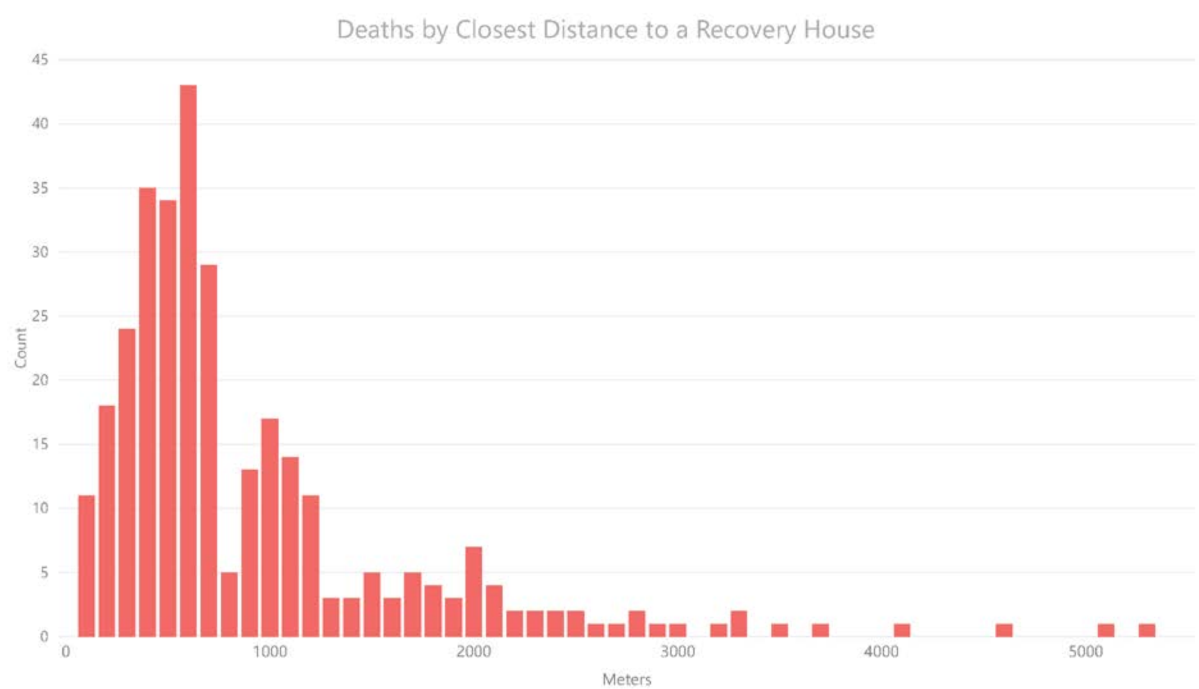
[3] We used the 68 service recovery houses identified by Surrey Fire Department in the City of Surrey including the 55 that were registered through British Columbia's Assisted Living Registry and were allowed under the City of Surrey's Business License Bylaw (Rehal, J. 2016. "Corporate Report: Recovery Houses Update." edited by Bylaw Enforcement & Licensing Services. Surrey, British Columbia: City of Surrey.)

[4] Distances are measured using the Haversine formula as the shortest between two points on the map or, to use the vernacular, "as the crow flies." An alternate approach could include driving or street distances as one sees on Google Maps and other mapping applications. Distances between an overdose event and each of the 55 recovery houses in the city were calculated with the shortest absolute distance being selected.

Figure 3, with the main differences being that the number of deaths is significantly smaller than overdose incidents and the peak number of occurrences tends to be somewhat further away from the nearest recovery house.

Both analyses—the one relating to overdoses and the one relating to deaths—suggest that a greater potential exists to use the location of recovery houses as a variable or factor to help mitigate the likelihood of overdoses and opioid-related deaths. The “doughnut hole” phenomenon of fewer than expected events at or immediately proximal to the recovery houses examined in this analysis suggest that the services provided by many recovery houses (such as the availability of counsellors and naloxone) might be having an impact in the immediate geographical area. As we indicated previously, there is a chicken and egg phenomenon relating to the location of recovery houses. Initially, some houses were located in known hotspots where there were significant concentrations of illicit opioid users. This was an attempt to bring a service to potential clients and, clearly, many do so. On the other hand, the presence of a recovery home may serve as a magnet to attract drug users to that general locale.

FIGURE 4



So far, the analysis has focused on formal recovery houses that meet the requirements of British Columbia’s Assisted Living Registry. There are an additional 90 houses that have come to the attention of the Surrey Fire Department, largely through random inspections. Some of these houses may have been full-service locations at one point. Most, however, are primarily lodging spaces for addicts with no on-site staff.

The distribution of overdoses (Figure 5) and deaths (Figure 6) in proximity to these “nonrecovery” houses show a similar pattern to the previous sample of full-service homes. The incidence of both overdoses and deaths are relatively low within the immediate proximity of the residence and then climb steeply to about a half kilometer away. After that point, both overdoses and deaths taper off with distance.

FIGURE 5

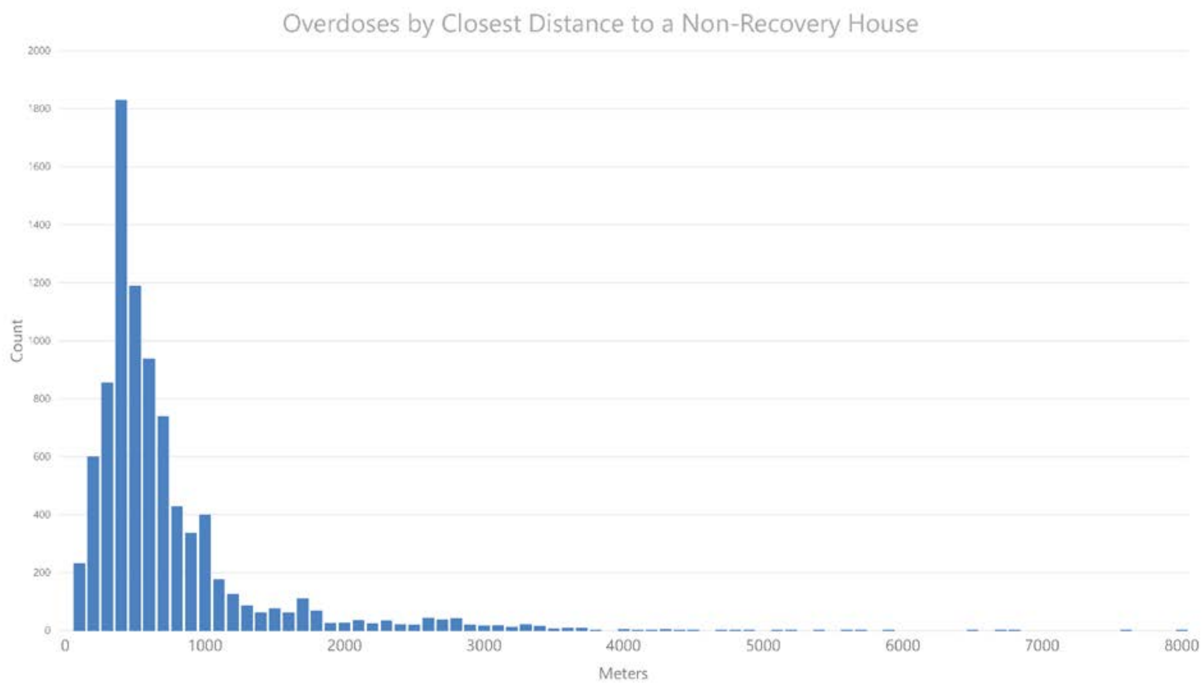
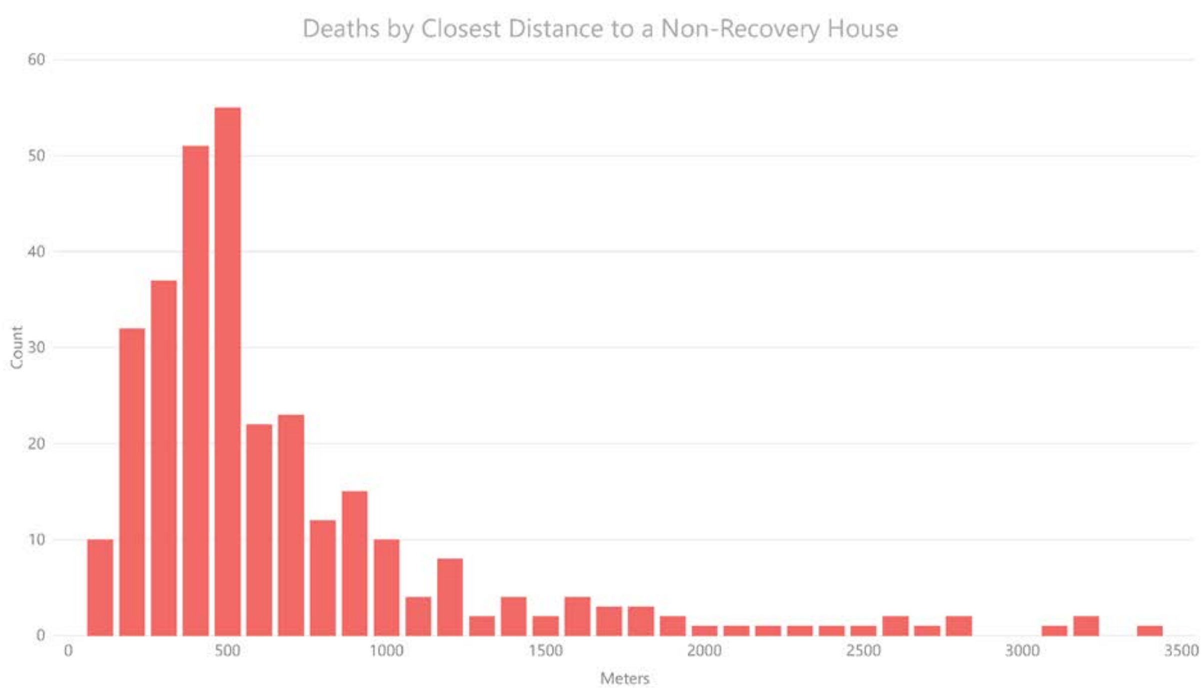


FIGURE 6



The question we might now pose is, theoretically, how can we account for this pattern of overdoses and deaths around recovery houses? Previously in this report, we focused on crime-pattern theory as a model for explaining why addicts might cluster in certain locations within a city. That perspective is a specific element within the broader theoretical context known as routine activities theory.

Routine activity theory as outlined by Cohen and Felson (1979) suggest that three key conditions are required for a crime to occur: a motivated offender, a suitable target or victim, and the absence of a capable guardian. It is the convergence of these three elements, according to Cohen and Felson, that result in a criminal event. Building on this framework, Eck (2003) suggest there is a role for a "handler" and a "place manager"– people or institutions that can exert control over potential offenders and possible crime locations. This theoretical framework can be extended to inform our understanding of the behaviour of addicts and drug consumption sites. Specifically, within the current context, Eck's model suggests that the insertion of a handler could mitigate the behaviour of addicts and a capable guardian can oversee site locations.

Simply put, handlers can influence offenders (or, in this instance, addicts); place managers can control places. Drawing from this perspective, it is possible to see recovery houses and their staff as playing the role of the handler who intervenes with addicts and a "place manager" that provides oversight of the surrounding locale.

The first application of this perspective allows us to appreciate what we have termed the "doughnut" pattern of overdoses and deaths around recovery houses. In their roles as handlers and place managers, recovery houses and their staff have an impact on the behaviour of addicts near their immediate location. The broader implication is that expanding the outreach role of recovery houses could further influence the likelihood of overdoses and deaths in the broader neighbourhood. That is, consideration should be given to expanding the roles and capacities of recovery houses beyond their immediate settings.

Analysis of Incidents Proximal to Pre and Post-Health and Safety Intervention

A "soft intervention" was made by what Eck would refer to as "super controllers"[5] to enhance the capacity of existing recovery houses in being more effective and enhancing their reach. For a sample of recovery houses, inspections were made by Surrey Fire Services in conjunction with a Fraser Heath public health nurse. Standards and by-law infractions were noted by Fire Services and assistance was provided to the site to mitigate any infractions. This included recommendations to improve the overall safety standards of the site as well as providing information and training on such relevant matters as the use of OATs by the Fraser Health public health nurses.

In all there were 166 care workers supervising 565 persons residing in these homes despite having a capacity of 863. Regarding the fire inspections, most of the registered houses were satisfactory on

[5] "Super controllers" are external agencies that have more and significantly broader powers of oversight. Formal super controllers exercise their authority "within an established institutional setting that defines who influences whom, in which ways, and under what circumstances" (Sampson et al. 2010: 41).

most items. For example, of 58 houses, an average of 84% of the inspection items were rated as being "satisfactory." Among the items deemed "unsatisfactory", however, were such things as not having a fire safety plan in place (48% unsatisfactory); where required, the unavailability of a fire department connection (46% unsatisfactory); issues with laundry rooms (39% unsatisfactory); smoke alarm issues (37% unsatisfactory); fire alarm panel issues (36% unsatisfactory); emergency lighting problems (26% unsatisfactory); exit sign and light issues (18% unsatisfactory); and, occupancy load issues (13% unsatisfactory).

Fire Department inspectors were also accompanied by public health nurses from Fraser Health. As with the fire inspectors, they found most homes to be functioning relatively satisfactory. Approximately 93% of the houses had naloxone on site although as part of their inspection activities, the public health nurses distributed an additional 204 kits, or about 3 per location. On a more problematic note, 73% of the houses did not have a training regimen in place. Consequently, training was provided to a total of 256 individuals or about 3.8 per site.

The underlying notion was that this "soft treatment" or intervention approach would improve the effectiveness of the recovery houses by reducing instances of overdoses and mortality at and in the immediate vicinity of the site.

We endeavored to conduct an exploratory study to retrospectively see whether those interventions might have had any impact on overdose and mortality outcomes. In doing this, the data were divided into pre and post-treatment records. That is, we examined the relative incidence of overdose and mortality events at or near the houses before the inspection by Fire Services and the incidence after the inspection. The distribution of overdoses both pre and post intervention is depicted in Figure 7. The results of the quantitative analysis are presented below in Tables 1 and 2 which relate to overdoses and deaths respectively.

TABLE 1: OVERDOSE INCIDENTS BY DISTANCE, PRE AND POST-INTERVENTION

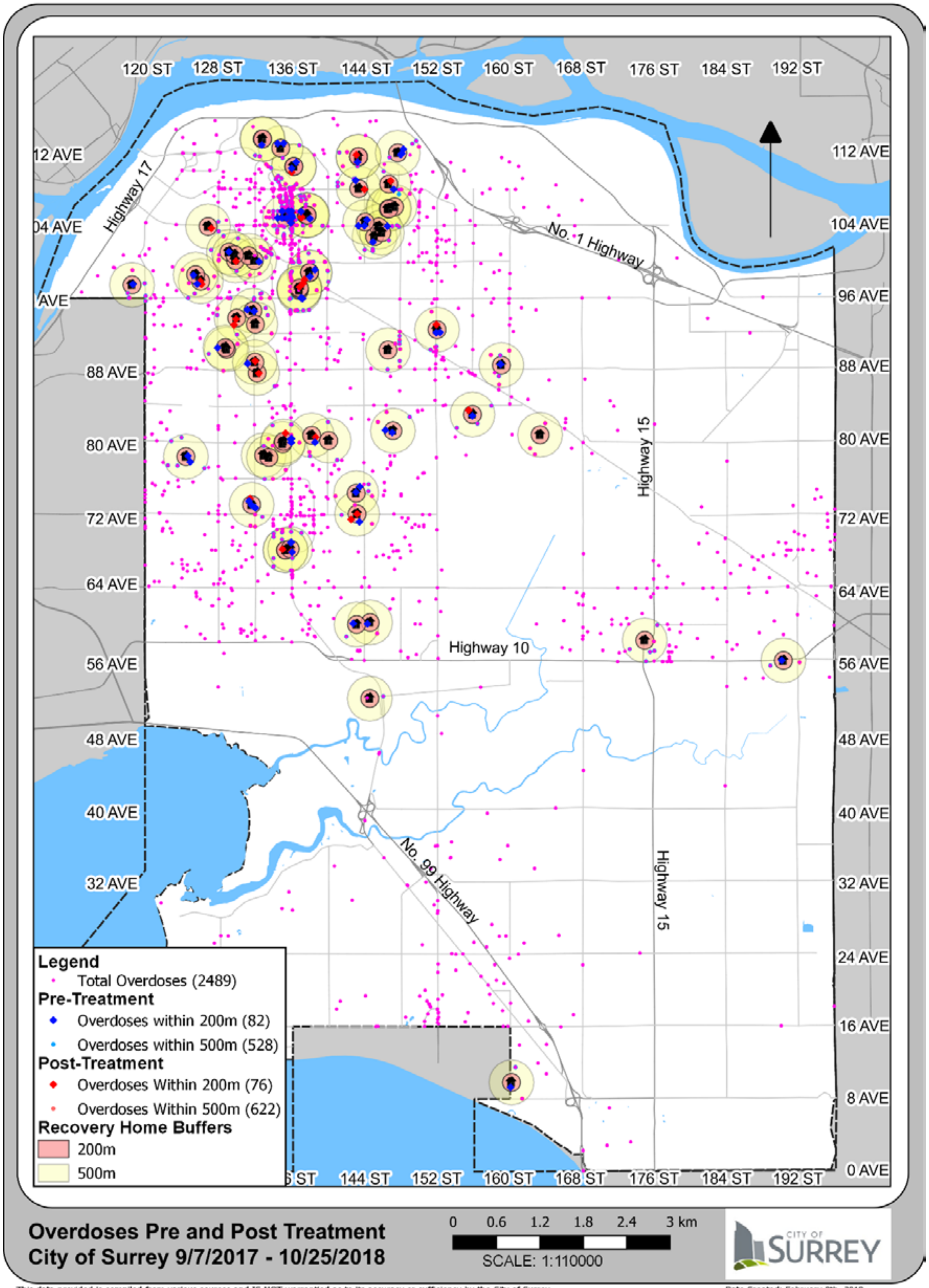
Category	Count	Percent of Total
Incidents Pre-intervention Within 200m	82	6.1
Incidents Post-intervention Within 200m	76	5.7
Incidents Pre-intervention Between 200-500m	446	33.3
Incidents Post-intervention Between 200-500m	546	40.8
Incidents Pre-intervention Within 500m	528	39.4
Incidents Post-intervention Within 500m	622	46.5
Incidents Beyond 500m	189	14.1
Total Incidents Over Period (9/7/17-10/25/18)	1339	100.0

TABLE 2: DEATHS BY DISTANCE, PRE AND POST-INTERVENTION

Category	Count	Percent of Total
Deaths Pre-intervention Within 200m	3	5.4
Deaths Post-intervention Within 200m	5	8.9
Deaths Pre-intervention Between 200-500m	13	23.2
Deaths Post-intervention Between 200-500m	14	25.0
Deaths Pre-intervention Within 500m	16	28.6
Deaths Post-intervention Within 500m	19	33.9
Deaths Beyond 500m	21	37.5
Total Deaths Over Period (12/7/17 - 6/24/18)	56	100.0

Overall, from this analysis, it does not appear that the intervention had the planned effect since there was no appreciable pattern decrease in either the incidence of overdoses or deaths within the vicinity of the recovery houses. For overdoses within 200m of a house, there was a reduction of about 0.4% (82 v. 76). In all other instances, however, the number of incidents increased in the post intervention period. We are somewhat constrained in our conclusions, however, as there was no planned comparison or control group within the analysis. That is, since the observations were made over time, it is not clear if the post period incidences might not have been even higher had the intervention not taken place. We do know, however, that the overall rates of opioid-related overdoses and deaths increased in British Columbia over the period of observation.

FIGURE 7


120 ST
128 ST
136 ST
144 ST
152 ST
160 ST
168 ST
176 ST
184 ST
192 ST
112 AVE
104 AVE
96 AVE
88 AVE
80 AVE
72 AVE
64 AVE
56 AVE
48 AVE
40 AVE
32 AVE
24 AVE
16 AVE
8 AVE
0 AVE
Highway 17
No. 1 Highway
Highway 15
Highway 10
No. 99 Highway
Legend
Total Overdoses (2489)
Pre-Treatment
Overdoses within 200m (82)
Overdoses within 500m (528)
Post-Treatment
Overdoses Within 200m (76)
Overdoses Within 500m (622)
Recovery Home Buffers
200m
500m
0 0.6 1.2 1.8 2.4 3 km
SCALE: 1:110000
Overdoses Pre and Post Treatment
City of Surrey 9/7/2017 - 10/25/2018
This data provided is compiled from various sources and IS NOT warranted as to its accuracy or sufficiency by the City of Surrey
Date Created: February 8th, 2019

Social Assistance, Overdoses and Property Crime

This section examines the relationship between overdoses, selected property crime incidents and income assistance payment dates. Across the City of Surrey and within the Province of British Columbia more generally, the media have reported on large spikes in overdoses which have occurred shortly after the distribution of social assistance payments. The Canadian Press (2018), for example, reported on a spike in drug overdoses occurring on Friday, October 26, 2018, only two days after an income payment date the previous Wednesday, October 24, 2018.[6]

While the literature on the relationship on the timing of social assistance payments and drug overdoses is not extensive, a group of researchers in Vancouver has examined some aspects of the issue (see: Zlotorzynska et al. (2014); Krebs et al. (2016); Wang (2016); and, Otterstatter et al. (2016)). Using data relating to intravenous drug users at Vancouver's *Insite*, Zlotorzynska et al. (2014) found a significant relationship between the rate of nonfatal overdoses and the issuance of assistance payments. Overall, the risk of an injection resulting in an overdose doubled during the three days beginning with the issuance of the assistance payments.

While not focusing on overdosing specifically, the analysis of Krebs et al. (2016) of prospective cohorts of HIV-positive and HIV-negative illicit drug users discovered a strong relationship between social assistance payments and the *intensity* of drug use. As these researchers noted, while the intensity of drug use increased immediately after the receipt of a social assistance payment, there was "a lower likelihood of increased drug use intensity in the 7–10 days prior to cheque issue."

Further analysis by Otterstatter et al. (2016) confirmed this temporal pattern of drug use at the aggregate or provincial level. Using BC Coroner's data for the period 2003-2013, Otterstatter and his colleagues concluded that about "77 avoidable deaths were attributable to the synchronized disbursement of income assistance cheques over the five year period." In aggregate, this research makes a strong case for a relationship between when social assistance payments are received, and both the incidence of drug overdoses and deaths.

In parallel with the notion that overdose incidents are related to social assistance payments, there is also evidence that an inverse relationship exists with rates of property crime. The rationale is relatively straightforward: when social assistance payments are received, individuals have access to a legitimate source of funds to support their addictions, so overdoses increase while property crimes decrease. Once their legitimate monetary sources run out, drug users resort to crime to support their addictions. In this section, we explore this proposition in some detail.

The previously cited literature provides strong evidence for a linkage between the timing of when social assistance is received and drug overdoses (the so-called "cheque effect"). In this study, we are providing a complement to this research by looking at an aggregate relationship between these elements for the City of Surrey. *That is, our focus is not on individual drug users but rather on patterns at the aggregate or community level.* Furthermore, we will also examine the aggregate relationship between the receipt of social assistance payments and crime rates.

[6] For a listing of payment dates, see: British Columbia. 2019. "Income Assistance Payment Dates."

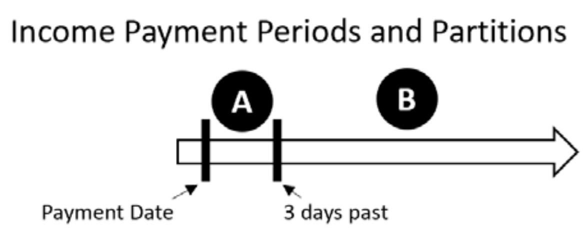
As in the previous analyses, we used overdose data as recorded by Surrey Fire Services. The crime data for the City of Surrey are limited to a series of property crimes only: break and entering into a business; residential break and enter; shoplifting; and, motor vehicle thefts. Crimes against the person and other offences are not considered in this analysis. On average, there were approximately 7.1 known overdoses per day across the city (about 50 per week) and about 45 property crimes per day (around 317 per week). As will be shown in the next section, these statistics vary considerably according to when social assistance payments are made.

We start the next section with a discussion of how a test of the relationship is constructed and then proceed to analyze the relationships between overdoses, crime incidents and social assistance payment dates.

Approach and Hypothesis

There are several ways in which the temporal analysis can be approached. To keep matters relatively straightforward, we chose to partition the daily overdose and crime incidents within the City of Surrey based on income assistance payment dates. That is to say, the data are divided into two temporal segments or partitions. Partition A is the daily incident counts within three days *of* the income assistance payment dates (the payment day plus the three following). Partition B is the daily incidents counts four or more days after those dates (that is, the remainder of the month until the next payment date). Figure 8 illustrates an example of how this partition was created based on the income payment cycles. All incident data would fall either in Partition A or B.

FIGURE 8: EXAMPLE OF DATA PARTITION



City-wide Analysis

For the global date range of October 26, 2016 to October 25, 2018, there have been 5,171 overdoses and 32,454 property crime incidents, during the 2-year period across the entire city of Surrey. This equates to an average of over 7 overdoses and 44 crime incidents a day.

Based on the periodic income assistance payment dates, the daily overdose and crime incident counts are partitioned into A and B as defined in Table 3 across the entire City of Surrey for the global date range of October 26, 2016 to October 25, 2018. Since granularity of the incident counts is at the day level, there are consistent sample sizes for A and B. The sample overdose and crime incident means for A and B are provided in Table 3 as well.

TABLE 3: PARTITION LOGIC FOR CITY-WIDE ANALYSIS

Partition	Logic	Sample Size	Sample Mean (Overdose per day)	Sample Mean (Crime per day)
A	All incidents inclusively within three days of most recent income payment date	98	9.265	38.755
B	All incidents 4 or more days after most recent income payment date until the day prior to next payment	632	6.745	45.342

For example, consider the most recent payment date of January 24, 2018 with the next payment date being February 21, 2018. Incidents occurring inclusively between January 24 to 27 would fall in A, while incidents occurring from January 28 to February 20, 2018 would fall in B. This logic is extended for all payment cycles to partition the crime and overdose data entirely.

In validation of the hypotheses that overdose incidents are higher in A compared to B and that property crime incidents are lower in A compared to B. In other words, we put forward the two working hypotheses:

> For overdose incidents: the mean number of overdoses will be *greater* around the days surrounding assistance payments (A) than the remainder of the month (B).
>
> For property crime incidents: the mean number of crimes will be *lower* around the days surrounding assistance payments (A) than the remainder of the month (B).

Two tests, one parametric and one non-parametric, are used for analysis. The parametric Student's T-Test is considered which relies on the central limit theorem of normality of the mean, though the underlying distribution of incidents need not be normal, e.g. see (Rice, 2006). The non-parametric Wilcox Test is also considered which does not have any normality assumption (Siegel, 1956). Based on Table 3, the sample sizes are sufficient, and there are no concrete social or other indications that we are aware of in terms of questioning variable independence. Thus, assumptions are valid to perform these tests. The R programming language (R Development Core Team, 2008), run through Microsoft's cloud computing analytics platform Azure Databricks (Microsoft, 2018), is used to efficiently and effectively implement these tests.

City-wide Results and Discussion

After partitioning the data, statistical testing was conducted to determine whether there was a significant relationship between social assistance, through income payments, and incidences of drug overdose and crime. The general hypothesis is that within the first three days of the payments being made, the daily overdose counts would be higher in comparison with the remaining days of the month, while inversely, the crime incidents would be lower. This pattern can be visually demonstrated below in Figures 9 and 10, where indicated in red are the first three days of income assistance payments against the remaining days indicated in blue for daily overdoses and crime incidents respectively.

FIGURE 9: AVERAGE DAILY OVERDOSES BY DAY OF ASSISTANCE

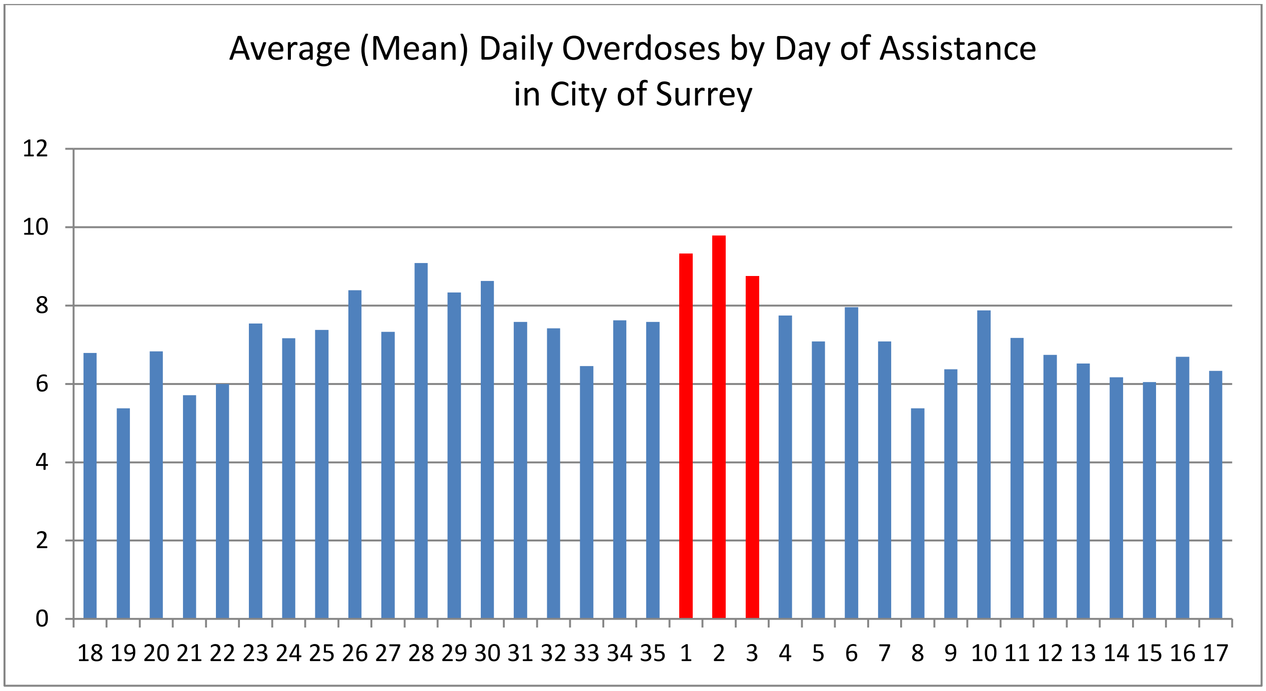


FIGURE 10: AVERAGE DAILY CRIMES BY DAY OF ASSISTANCE

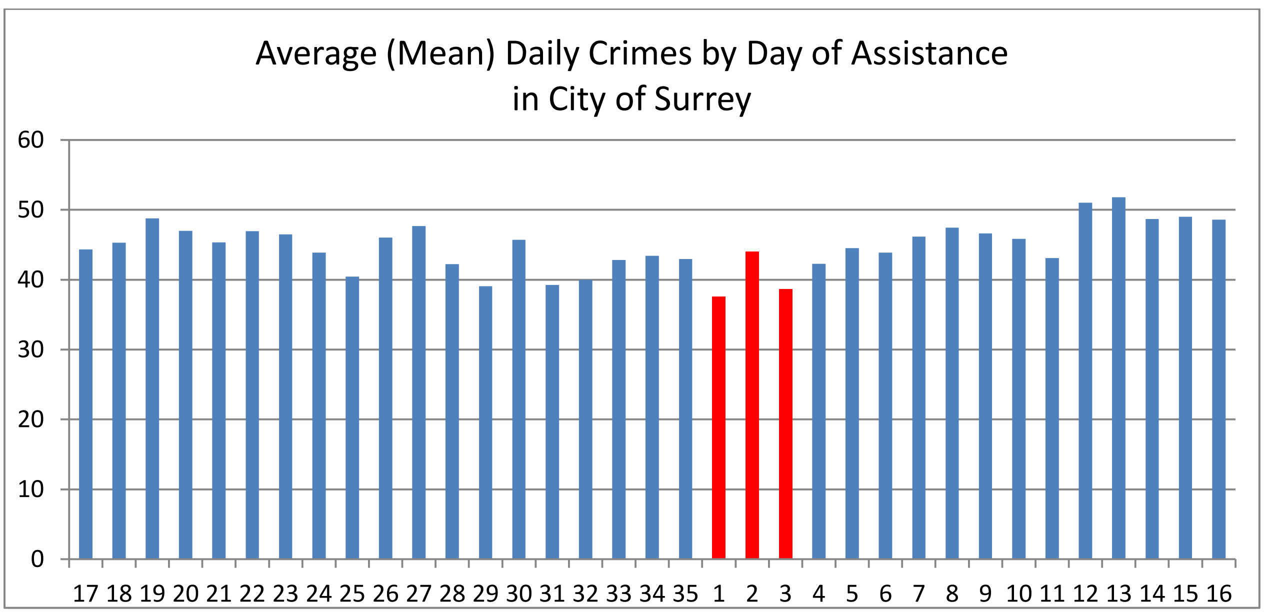
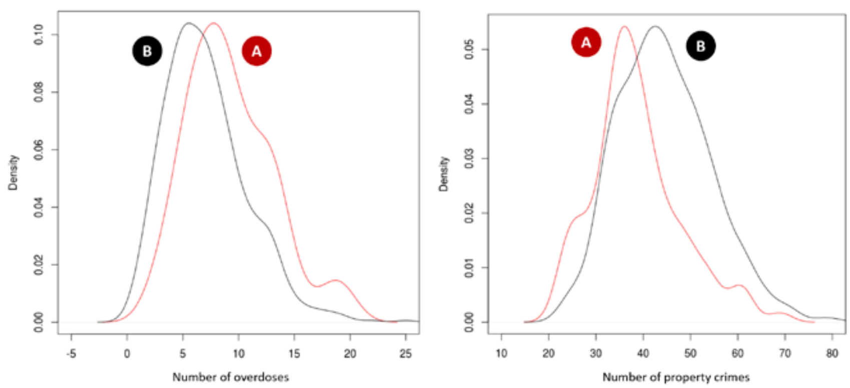


Table 3 shows the difference in sample means. Statistically significant results are found from both the T-Test and Wilcox Test for overdose and property crime incidents. Based on those results, we decided to accept our working hypotheses. That is, overdoses are statistically significantly higher around the days assistance cheques are distributed than in the remainder of the month, while property crimes are significantly lower during the distribution period.

To further illustrate the difference between incident occurrences within three days of income payment dates and occurrences afterwards, Figure11 highlights the density distributions between A and B for overdose and crime daily incidents. These results demonstrate the statistically significant alternative that within the first three days after income payments come out, there are higher overdose and lower property crime incidents across the entire City of Surrey.

In fact, from the statistically significant results found, there is an approximately 37% increase in daily overdoses during the first three days of the most recent income payments. Conversely, there is 15% decrease in daily crime incidents during the three days. These are noteworthy indications on the importance of income payments on overdose and crime rates across the entire city of Surrey.

FIGURE 11: DENSITY DISTRIBUTIONS FOR PARTITION A AND B OF OVERDOSE AND CRIME INCIDENTS



Across the City of Surrey and in the Province of BC, there have been recent media reports on large spikes in overdoses, which have occurred shortly after the assistance payments. One example as noted earlier was the Canadian Press report (Dyck, 2018) on a spike in drug overdoses occurring on Friday, October 26, 2018, only 2 days after an income payment date on Wednesday, October 24, 2018 (BC Government, 2018).

City of Surrey Region-level Analysis

Following city-wide analysis, based on location data as described earlier, specific rectangular regions in City of Surrey are constructed. They are based on varying distributions of recovery houses, as well as well-known concentration areas in Surrey where overdoses occur frequently. The same statistical testing is applied for daily crime and overdose incidents, occurring within each of these zones, partitioned using the income payment dates. The goal would be to determine whether statistically significant results of differing incident rates are present in proximity of recovery houses. This approach is based on report findings from Griffioen (2018).

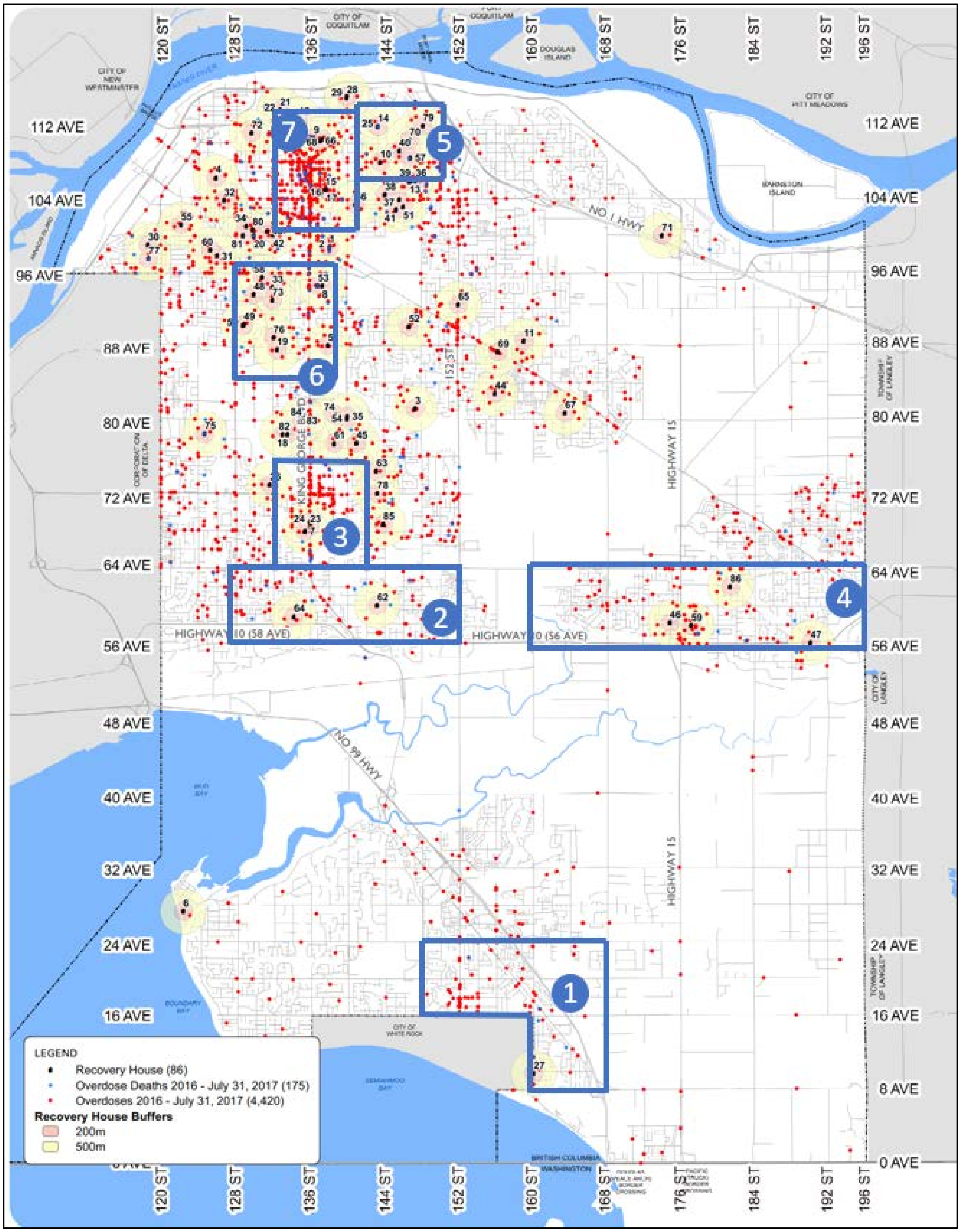
A total of seven regions in the City of Surrey are considered for this analysis. Their descriptions as well as geographical boundaries, given by the upper-left and lower-right boundary points from City of Surrey's COSMOS CAD coordinate system (City of Surrey, 2018), can be found in Table 4. Figure 12 illustrates the boundaries of these regions on a map of Surrey.

TABLE 4: DESCRIPTIONS ON CITY REGIONS CONSIDERED

ID	Upper Left Bound	Lower Right Bound	Approximate area	Description
1	(513722.0, 5432550.8)	(517735.1, 5429343.9)	148 ST / 24 AVE to 168 ST / 8 AVE	1 recovery home
2	(509625.8, 5440728.3)	(514510.4, 5439092.2)	128 ST / 64 AVE to 152 ST / HW 10	2 recovery houses
3	(510421.6, 5443133.6)	(512487.5, 5440735.7)	132 ST / 76 AVE to 142 ST / 64 AVE	3 recovery houses
4	(516124.2, 5440688.3)	(523314.7, 5439117.4)	160 ST / 64 AVE to 196 ST / 56 AVE	4 recovery houses
5	(512183.3, 5450550.8)	(514101.0, 5448778.4)	140A ST / 113 AVE to 150 ST / 104 AVE	7 recovery houses
6	(509624.3, 5447155.6)	(511248.6, 5444766.7)	128 ST / 96 AVE to King George / 84 AVE	10+ recovery houses
7	(510467.6, 5450707.9)	(512077.0, 5448339.7)	132 ST / 113B AVE to 140 ST / 102 AVE	Main King George 104 corridor

For example, Figure 12 illustrates a large concentration of recovery houses and overdoses around the King George corridor between 104th and 108th Avenue. This concentration is contained in Region 7 from Table 4.

FIGURE 12: DISTRIBUTION OF FOCUS REGIONS WITHIN CITY OF SURREY



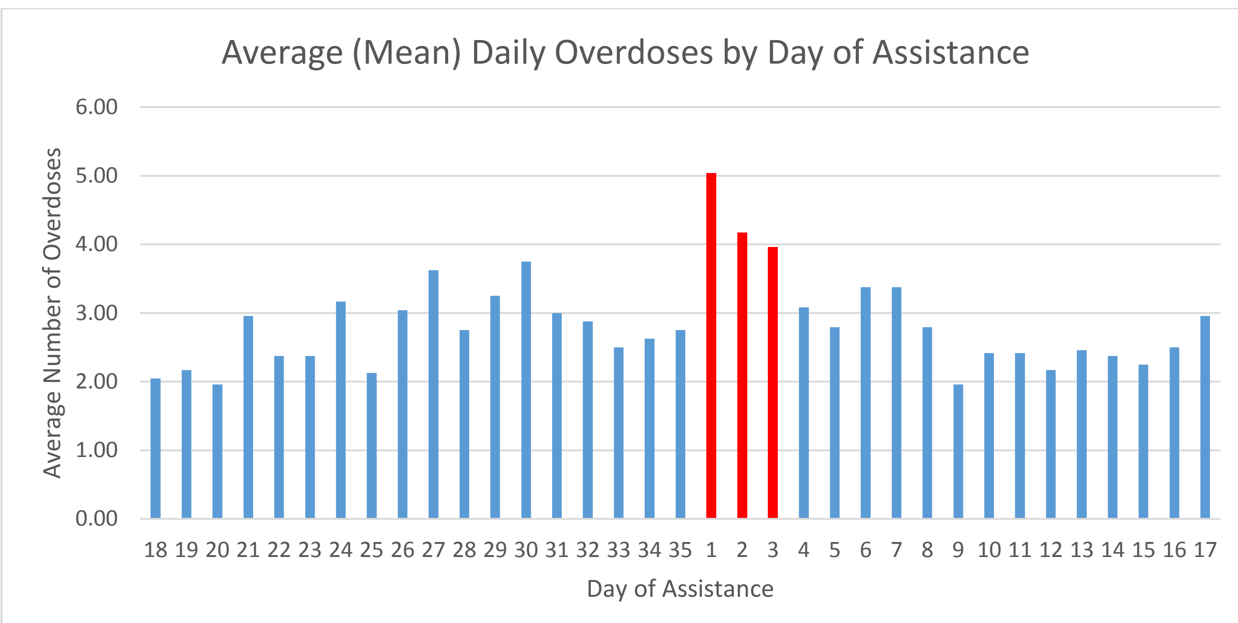
Region 7 Analysis on Overdoses, Crime and Assistance Payment Days

Analysis specific to Region 7, the primary concentration area of overdoses in Surrey, are shown below. A graphical depiction of daily overdose occurrences in this region between the same global date range October 26, 2016 to October 25, 2018, related to assistance payment dates, is illustrated in Figure 13 below. The first three days (social assistance payment date and the two following) are indicated by the red bars while the remaining days of the month are indicated in blue. As Figure 13 suggests, the first three days appear to have higher average overdoses than the remainder of the month. While the overall daily average for overdoses is 2.8, the average for the social assistance period (marked in red in Figure 13) is 4 overdoses per day. That number drops to 2.6 (the blue bars) for the remainder of the month.

From the regular partitions of A and B for daily overdoses in Region 7 as seen in Table 5, our statistical analysis suggests that the difference in the average number of overdoses per day between the partitions is statistically significant.[7]

Despite this difference between the two date partitions, it should be noted that there appears to be considerable cyclical variation from day to day. Regardless, the risk of overdosing is greater on those days associated with the distribution of social assistance payments.

FIGURE 13



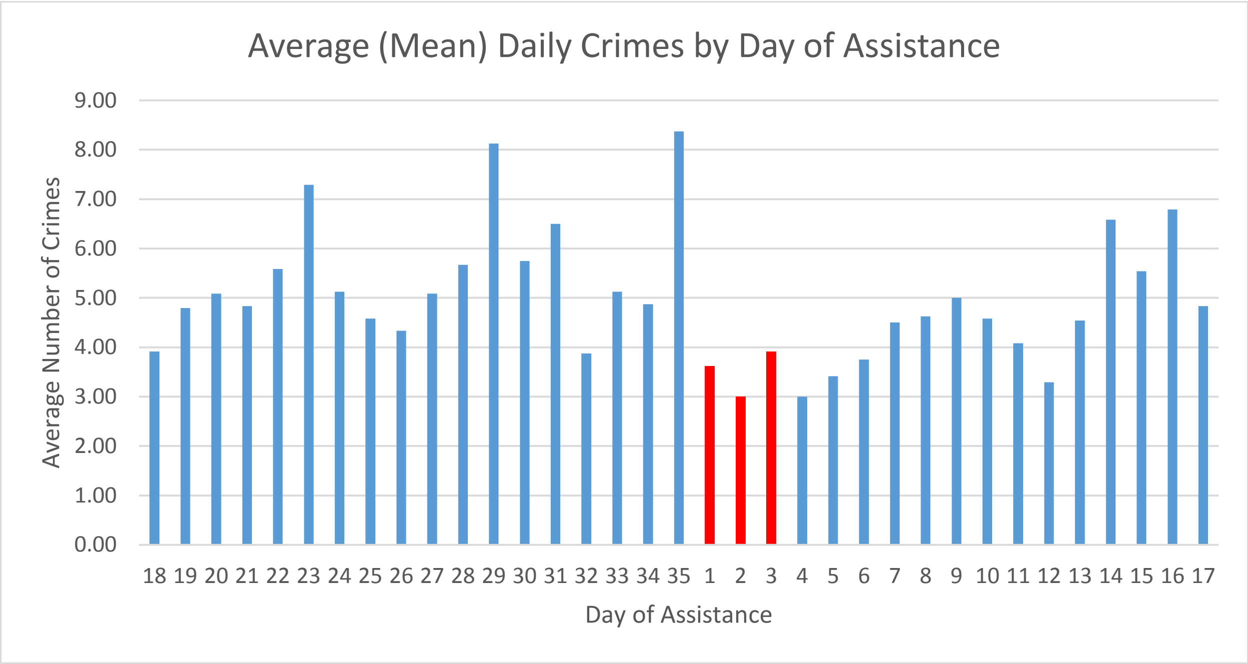
[7] Two-sample t-test, p<.001; Mann-Whitney (Wilcoxon) test, p <.001

TABLE 5: PARTITION LOGIC FOR REGION 7 ANALYSIS OF OVERDOSES

Partition	Description	No. of Days	Mean No. of Overdoses per Day
A	All incidents inclusively within three days of most recent income payment date	98	4.02
B	All incidents 4 or more days after most recent income payment date until the day prior to next payment	632	2.63

Regarding crime rates and income assistance, Figure 14, where as usual red indicates the first three days of income payments and blue the rest, suggests that the crime rates increase as we move beyond the payment dates in Region 7, similar to the city-wide analysis results. The overall trend in Figure 14 is the opposite to the pattern for overdoses.

FIGURE 14: AVERAGE DAILY CRIME BY DAY OF ASSISTANCE



Analysis was performed based on same partition into periods A and B as defined in Table 6 for Region 7. Unlike with overdoses, property crime occurrences increase the further one moves from the assistance payment dates. This is despite the weekday cycle within the data. On average, there are almost 1.5 times more property crime incidents reported in the period of partition B than in partition A. Once again, this difference is statistically significant based on generally accepted criteria.[8]

[8] Two-sample t-test, p<.001; Mann-Whitney (Wilcoxon) test, p <.001.

TABLE 6: PARTITION LOGIC FOR CITY-WIDE ANALYSIS TOTAL PROPERTY CRIMES

Partition	Description	No. of Days	Mean No. of Property Crimes per Day
A	All incidents inclusively within three days of most recent income payment date	98	3.39
B	All incidents 4 or more days after most recent income payment date until the day prior to next payment	632	5.01

All Regions Analysis on Overdoses and Assistance Payment Days

The seven regions for analysis provide a fair representation of the overdose and crime situations in the City of Surrey. Understanding how incident rates change based on income assistance payment dates in these regions, including the main concentration of overdoses in Region 7, could start to provide a generalized foundation with policy implications for the City of Surrey, in different areas or districts with varying socio-economic characteristics.

For regional level analysis, overdose and property crime daily incidents are grouped based on whether they occurred in each of the seven regions, and then partitioned into A and B based on income assistance payment dates. The same null hypotheses and alternatives framework and tests are considered, from the city-wide analysis. The same sample sizes are also present as incident counts are all reported at the day level. Altogether, assumptions for the statistical tests to be applied are valid. Table 7 provides the daily sample overdose and crime incident means for A and B within each of the areas.

TABLE 7: SAMPLE MEANS FOR REGION-LEVEL INCIDENTS

Sample Means Type	Region Partition	1	2	3	4	5	6	7
Overdose	A (pay period)	0.173	0.378	0.490	0.224	0.122	0.265	4.020
Overdose	B (Non pay period)	0.160	0.217	0.487	0.158	0.108	0.178	2.633
Property crime	A (pay period)	1.592	0.969	2.153	1.908	0.561	0.776	3.388
Property crime	B (Non pay period)	1.951	1.274	2.627	2.324	0.698	0.948	5.014

City of Surrey Region-level Results and Discussion

In each of the regions, there is consistently higher sample mean for overdoses in A compared to B, and lower sample mean of crime incidents. After applying the T-Test and Wilcox Test, three out of the seven regions demonstrated statistical significance in rejecting the null hypotheses and favoring the alternative of higher overdose incidents within three days of income payments. Even more, as a conservative measure of needing to reach the same conclusion from both tests, five out of the seven regions demonstrated statistical significant (based on the standard threshold of p = 0.05) in favoring the alternative of lower property crime incidents in A. If only the T-Test is considered, results from all seven regions would favor the alternative. Table 7 lists all the results on analysis for each of the areas.

These results, reported in Table 8, again demonstrate, even at the region-level, the clear data-driven insights that in areas with recovery houses, even ones with varying concentrations and number of houses, individuals are getting regular social assistance payments, presumably through the houses' landlords, to support their drug addictions and then overdosing, particularly in Regions 2, 6, and 7. They do not to turn to crime when legitimate money is available, thus contributing to lower crime rates across all of the City of Surrey, and within most regions within the city as well. As soon as it runs out, a few days from the payments coming in, crime rates go up again. More details on policy implications for these results will be addressed in the final section.

TABLE 8: REGION-LEVEL STATISTICAL RESULTS

Region	Overdose Working hypothesis: A (pay period) = B (Non-pay period)			Property Crime Working hypothesis: A (pay period) = B (Non-pay period)		
	P-Value (T-Test)	**P-Value (Wilcox)**	**Conclusion (p = 0.05)**	**P-Value (T-Test)**	**P-Value (Wilcox)**	**Conclusion (p = 0.05)**
1	0.385	0.372	No significant difference	0.009	0.009	**Statistically significant**
2	0.008	0.003	**Statistically significant**	0.004	0.021	**Statistically significant**
3	0.486	0.239	No significant difference	0.014	0.003	**Statistically significant**
4	0.110	0.112	No significant difference	0.018	0.004	**Statistically significant**
5	0.359	0.507	No significant difference	0.039	0.233	No significant difference
6	0.049	0.008	**Statistically significant**	0.049	0.057	No significant difference
7	< 0.001	<0.001	**Statistically significant**	<0.001	<0.001	**Statistically significant**

Can the Neighbourhood or Geo-spatial Distribution of Overdoses be Predicted?

Predictive Modeling

Part of this project was conducted in conjunction with Microsoft which provided access to their Azure platform to address the question of whether daily overdose incidents could be predicted with any degree of certainty. Predictive modeling techniques are applied for Region 7, which has the main concentration of overdoses in City of Surrey.[9] This paper highlights the high-level steps to perform predictive modeling on overdose incident data. A more extensive overview on the modeling techniques can be gathered from (Duan 2014). The iterative process in applying model techniques can be reviewed at Microsoft (2017) using the Team Data Science Process.

The general goal of predictive modeling is to develop a statistical algorithm or model to predict a specific data field, known as the label. In the case of this paper, the label is the number of daily overdose incidents within a region. A widely used algorithm for this type of analysis is known as Random Forest, which builds an ensemble of decision trees or nodes. The individual trees reflect predictions for specific characteristics or variables through binary logic (such as yes or no). The Random Forest approach provides an overall prediction based on a democratic voting process, known as the ensemble approach (Breiman 2001).[10]

To develop such a model, historical data, known as a training set, is used that contains the known label field along with other variables or characteristics, known as features. The trained algorithm can then be applied to new data to predict the label. In practice, to evaluate and understand how accurate the algorithm performs, historical data are divided into a training and a testing set. The model would be built from the training set and it would make predictions based on the testing data. Since the labels from the testing set are known, they can be compared against the algorithm's predictions to determine accuracy and performance of the overall model.

In the context of this paper, the label or characteristic of interest is the number of daily overdose incidents that take place within a given location. The historical dataset contains daily incident counts along with the following predictive characteristics:

- Seasonality, including month and day
- Day of the week
- Days since last income assistance payment
- Property crime type incident counts (that is, Break and Enter, Shoplifting, Motor Vehicle Theft)
- Total property crime incident counts

---

[9] A similar approach could be applied for other regions and even for the entire city given sufficient data.

[10] Other examples of algorithms used in industry and academy are linear regression, support vector machines, and neural network, which are usually defined in a mathematical nature. An excellent introduction to these techniques is provided in Bishop, Christopher M. 2006. *Pattern recognition and machine learning*. New York: Springer.

- Crime and overdose incidents for previous day, the previous two days, and the previous week

The training data set is drawn from incidents that occurred from October 26, 2016 to August 31, 2018, while the testing data drawn from incidents that occurred from September 1, 2018 to October 25, 2018. This distinction is illustrated in the following Table 9.

TABLE 9: TRAINING AND TESTING SPLIT INFORMATION

	Split Date Range	Sample Size	Number of Features
Training set	October 26, 2016 to August 31, 2018	675	29 + label
Testing set	September 1, 2018 to October 25, 2018	55	29

A technique known as Random Forest is used as the modeling algorithm and to evaluate accuracy, the absolute difference between daily actual and predicted overdoses is calculated. This difference is known as the error. The analysis was run on Microsoft's cloud computing analytics platform, Azure Databricks (Microsoft 2018), that allows for efficient and effective calculations.[11]

Modeling results and discussion

After the predictive modeling algorithm was built from the training set, data from the testing set was applied to the model algorithm. The error, which is the absolute difference between actual and predicted number of events, was then calculated. The predictive modelling error rate was estimated to be **1.13**.

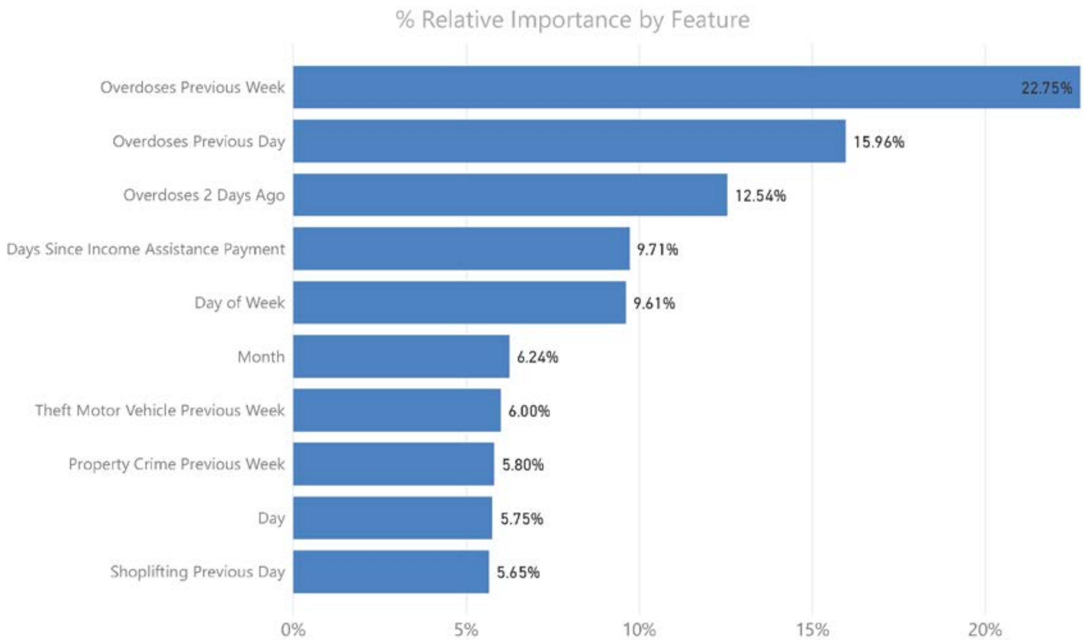
The interpretation of this result is that had the model been used to predict overdoses from September 1, 2018 to October 25, 2018 in Region 7, it would have been only slightly over an overdose off from predicting the actual outcomes. Considering a daily average of approximately three overdoses in this region, and seven overdoses across the city, we feel this is a significant accomplishment. The question remains, however, as to whether this magnitude is sufficient to warrant operational interventions. That is, whether this estimate would warrant the financial and resource costs to have a significant impact on the number of overdose occurrences.

Figure 15 provides the relative importance of the top features in driving opioid overdose prediction as determined by Random Forest. The relative importance score of features are calculated as a function of how often the features are considered in the model's training process of individual Decision Trees that contribute to the most decisive splits in predicting number of overdoses.

---

[11] The specific routines were drawn from the Random Forest R library (Liaw & Wiener, 2002)

FIGURE 15: MAIN FEATURES RELATED TO OPIOID OVERDOSES



In addition, since the Random Forest model builds several Trees through ensemble modeling, a single Decision Tree can be visualized in order to illustrate the logic flow in starting to understand how Random Forest makes predictive decisions. Figure 16 shows the structure of decision-making that is constructed through a single Decision Tree. Random Forest is more complex since multiple Trees are considered with other variations. This approach is common in attempting to unravel the "black-box" of predictive modeling.

As expected from Random Forest's feature importance rankings, overdoses in the previous week and day, as well as days since last income payments are critical in driving overdose predictions. In addition, the structure of the Decision Tree in Figure 16 also reveals crucial information in splitting thresholds that may have genuine policy impacts. For example, if it is less than 2.5 days since last income payments, there would generally be higher overdoses, which aligns with the significant findings previously noted in this paper.

Below are some key thresholds in determining whether number of overdoses would be high as determined through the Decision Tree structure in Figure 16:

- Over 30.5 overdoses in the previous week
- Over 10.5 overdoses in previous day
- Week of day is Saturday or Sunday
- Over 5.5 property crimes in previous day

FIGURE 16: HIERARCHY OF CHARACTERISTICS RELATED TO OPIOID OVERDOSES

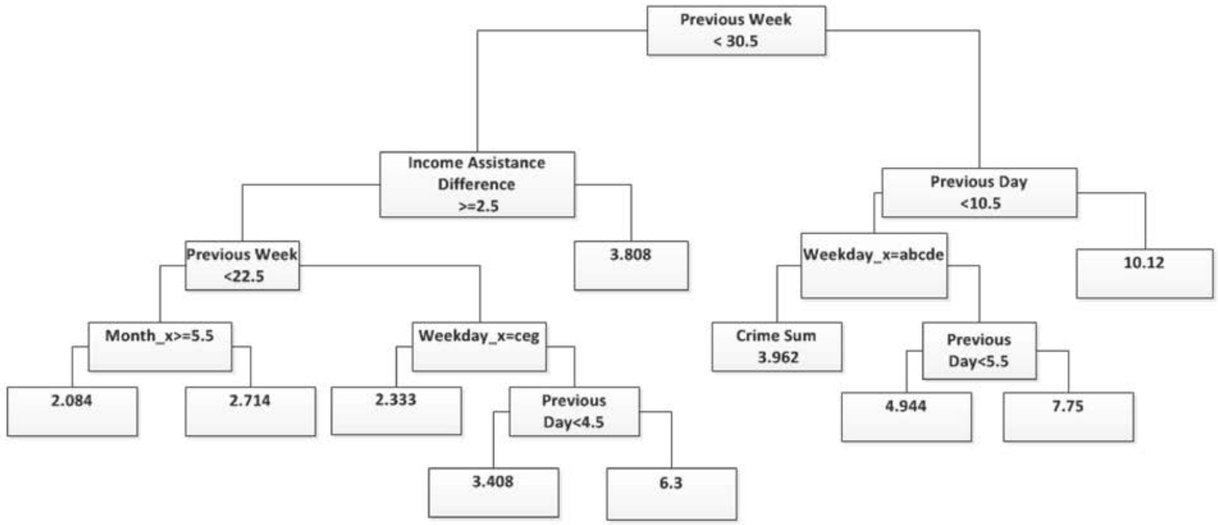
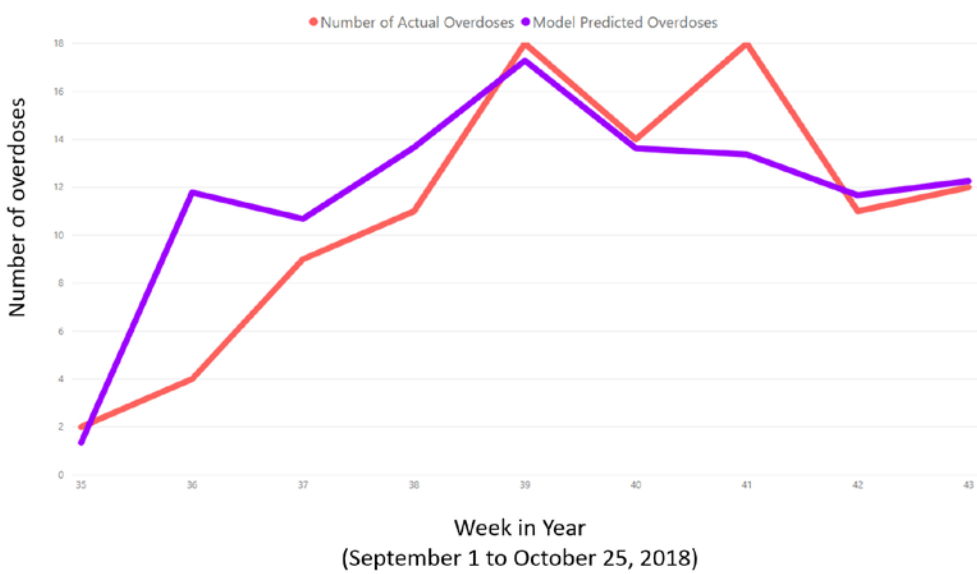


Figure 17 illustrates the weekly average of actual overdose incidents during the period of September 1, 2018 to October 25, 2018 and how the predictions compare. The predictive model can recognize the upward trend of overdoses from September 1 into a peak, namely, the next income payment date. The model can also return key features that contribute to predicting overdose occurrences (Liaw and Wiener 2002). Evidently, seasonality as well as days since last income payment are very important in the algorithm's predictions. Other key drivers include:

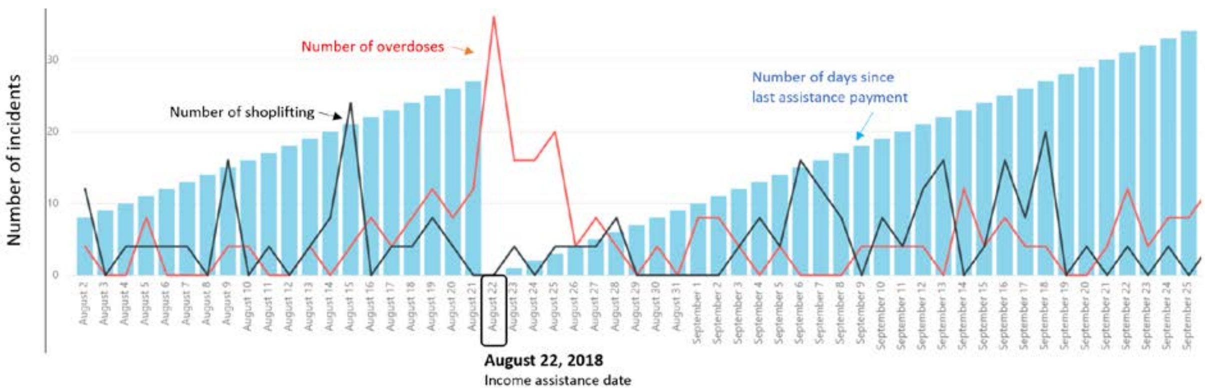
- Day of week
- Overdose incidents occurring in the previous day, 2 days, and week
- Shoplifting incidents
- Property crime incidents occurring in the previous week

FIGURE 17: PLOT COMPARING ACTUAL AGAINST PREDICTED OVERDOSES PER WEEK



The predictive modeling results for Region 7 look to be promising and worthy of future development to improve the model's accuracy and to expand into different regions. These results could be used to foster the start of data-driven discussions on how to enable responders to be more proactive on overdose incidents. Equipping them with possible predictive knowledge on where overdoses may occur next could allow for faster and more effective responses. The ability to marginally increase the accuracy of overdose occurrences predictions at specific locations and regions could enable responders to provide in-advance educational treatments, drop off overdose naloxone kits, or even have ambulances ready for response in high-risk areas.

FIGURE 18: PATTERN OF OVERDOSE AND CRIME



In conclusion, this section has highlighted the unfortunate pattern of income payments, overdose rates, and crime incidents of the opioid crisis in the City of Surrey. Whether it is across the entire city, or localized to specific regions with nearby recovery homes, individuals are overdosing at much higher rates once social assistance payments come in. Property crime rates go down as legitimate sources of money flow into the City. Based on the modeling analysis performed, shoplifting and overall recent property crime incidents are also found to be correlates of overdose occurrences. In other words, as soon as social assistance monetary sources run out, crime increases, particularly shoplifting, which would appear to further support drug consumption and sometimes overdosing. Figure 18 illustrates this pattern through a visualization between August 2 and September 25, 2018 in Region 7.

Policy Recommendations

Based on our analysis of the distribution of opioid-related deaths, overdoses and crime, we have concluded that there are several major policy directions that might affect a reduction in incidents.

Social Assistance Payments, Overdoses and Crime

For opioid addicts, there are two major concerns: the first is obtaining a reliable supply of drugs, and the second is obtaining the resources to obtain that supply. For addicts who are at the stage where they wish to make a transition away from harmful opioids such as heroin, oxycontin or fentanyl, we have largely addressed the problem. Methadone therapy is readily provided through clinics nationwide and it is available at a reasonable price. Addicts on methadone maintenance therapy can lead functioning lives by satisfying the craving for alternate opioids.[12] Similarly, current pharmaceutical prices for methadone are not exorbitant even for those on social assistance. Newer therapeutic drugs, such as suboxone, are often less available and somewhat more expensive, but are still available to a substantial proportion of addicts seeking treatment.

The issue we have not addressed successfully is that of addicts who are not at the stage where they are willing or able to make the transition from what we typically refer to as "street drugs." For addicts, obtaining street drugs on the underground economy is fraught with problems relating to availability, quality assurance, and price. In the extreme, quality assurance issues lead to many of the overdose and mortality incidents we have addressed earlier. Price issues force many addicts, even those with regular employment or on social assistance, to seek ways to supplement their income. Typically, drug addicts resort to criminal or other forms of socially dysfunctional behavior to obtain the resources to buy their drugs.

While opioid overdoses and overdose-related deaths are an ongoing phenomenon, it is evident that a "spike" exists in these occurrences following the dates when social assistance payments are made. Similarly, crime rates fall when assistance payments are made. This observation is not unique to Surrey since the pattern has been noted in other jurisdictions. In parts of the US, this phenomenon is known as the "cheque effect."

We also note that in the period immediately prior to the distribution of social assistance payments, property crimes tend to increase. While property crimes are committed by many different types of people for many different reasons, it is logical to assume that some portion of that is due to addicts foraging for resources to support their habits as assistance payments have run out.

While there is currently little empirical evidence to show that altering assistance payments has a major effect, it is conceivable that a redistribution of social assistance payments would mitigate and, to some degree, "level out" the spikes in overdosing and property crime.

We do not know what the optimal distribution of payment might be; however, economic theory would suggest that redistributing payments over more periods would likely serve to smooth out

[12] We recognize the fact that, as opioid drugs themselves, methadone, buprenorphine, and Suboxone all have some inherent potential for abuse. For a substantial proportion of the addict population, however, they do provide a functional treatment option.

opioid purchases. This, in turn, would likely reduce the spike in overdoses. Clearly, a balance needs to be struck between the mechanics of distributing payments and the needs of the recipients. Currently, assistance payments are made monthly. Within the general labour market, however, salary payments are typically made weekly, biweekly, or monthly. A pilot project might be considered where assistance payments are increased to weekly and biweekly periods in tandem with general labour market practices.

Making "regulated" supplies of opiates available to addicts who are not ready to make the transition away from harmful drugs is another alternative. British Columbia has recognized this as a viable alternative with the creation of several safe consumption sites. The number of such sites, however, is clearly not adequate to undermine the underground economy in opiates.[13]

Recovery House Standards

In this study, we noticed that recovery houses appear to act as what Eck would term handlers and site controllers. Consequently, overdoses and deaths are lower in the immediate vicinity of the recovery house locations. Based on this finding, we might suggest that the role and responsibility of recovery houses be extended beyond their immediate confines. This would likely necessitate increasing the capacity of the homes by providing increased functional responsibility and training to staff and others associated with the houses.

Currently, there are two general groups of recovery houses operating in the City of Surrey. There are those that are registered through British Columbia's Assisted Living Registry (n=55) plus another group (n=12) that are allowed under the City of Surrey's Business License Bylaw. There are also houses that are essentially residential locations only that are not regulated (n=90) . While the latter group clearly fulfils a residential need for opiate addicts, greater oversight and regulation of those locations could have an impact on rates of overdose, deaths and crime rates at or near those sites. Besides ensuring that existing municipal and provincial health and safety standards for multiple dwelling units are enforced, standards relating to the availability of OATs, professional counselling, and the availability and disposal of drug paraphernalia might be considered or services be illuminated through active enforcement.

---

[13] Almost two decades ago, the government of Portugal instituted a policy of decriminalizing drug use and making legal supplies more available. While there have been implementation issues, the program has been considered largely successful. See: Domoslawski, A. (2011) Drug Policy in Portugal: The Benefits of Decriminalizing Drug Use. Warsaw: Open Society Foundation. Available at https://www.tni.org/files/publication-downloads/drug-policy-in-portugal-english.pdf

Authors

Paul Maxim obtained his MA in criminology at the University of Ottawa and his PhD in sociology at the University of Pennsylvania where he specialized in criminology and research methods. He is formerly a professor in the Department of Economics and the Balsillie School of International Affairs at Wilfrid Laurier University in Waterloo, Ontario and is a Professor Emeritus in the Department of Sociology at Western University in London, Ontario. His primary areas of research interest are population and labour economics. Contact him at pmaxim@wlu.ca

Len Garis is the Fire Chief for the City of Surrey, British Columbia, an Adjunct Professor in the School of Criminology and Criminal Justice & Associate to the Centre for Social Research at the University of the Fraser Valley (UFV), a member of the Affiliated Research Faculty at John Jay College of Criminal Justice in New York, and a faculty member of the Institute of Canadian Urban Research Studies at Simon Fraser University. Contact him at Len.Garis@ufv.ca.

Joseph Clare, PhD formerly of the Surrey Fire Service, is a Senior Lecturer in Criminology at The University of Western Australia University, and an international member of the Institute of Canadian Urban Research Studies, Simon Fraser University. Contact him at joe.clare@uwa.edu.au

Hubert Duan is a Technology Solutions Professional at Microsoft, a Canadian Microsoft AI Ambassador, and a professional Data Scientist. His professional area of focus is working with government and commercial organizations to solve business problems through data science and machine learning. Contact him at hubert.duan@microsoft.com

Andrew Fink is a student at the University of British Columbia (UBC) completing a bachelor's degree in Geographic Sciences in May of 2019, and a former member of the Data Science for Social Good (DSSG) research fellowship at the UBC Data Science Institute. Contact him at andy.fink55@gmail.com

Acknowledgments

Thank you to Fraser Heath Dr. Victoria Lee, Dr Shovita Padhi and the RCMP Assistant Commissioner Dwayne McDonald for their partnership and support in our combined efforts to combat the opioid crisis in Surrey.

References

Bearnot, Benjamin, John F. Pearson, and Jorge A. Rodriguez. 2018. "Using Publicly Available Data to Understand the Opioid Overdose Epidemic: Geospatial Distribution of Discarded Needles in Boston, Massachusetts." American Journal of Public Health 108(10):1355-57.

Belzak, Lisa, and Jessica Halverson. 2018. "Evidence synthesis - The opioid crisis in Canada: a national perspective." Health Promotion and Chronic Disease Prevention in Canada 38(6):224-33.

Bishop, Christopher M. 2006. Pattern recognition and machine learning. New York: Springer.

Breiman, Leo. 2001. "Random Forests." Machine Learning 45(1):5-32.

British Columbia. 2019. "Income Assistance Payment Dates."

British Columbia, Coroner's Service. 2018. "Illicit Drug Overdose Deaths in BC: Findings of Coroners' Investigations." edited by Ministry of Public Safety and Solicitor General. Victoria, BC.

Canadian Press. 2018. "Spike in drug overdoses reported in north Surrey, B.C.": The Canadian Press, Toronto.

Cohen, Lawrence E. and M. Felson. 1979. "Social change and crime rate trends: A routine activity approach." American Sociological Review 44(4): 588–605.

Cordes, Jack. 2018. "Spatial Trends in Opioid Overdose Mortality in North Carolina: 1999–2015." Southeastern Geographer 58(2):193-211.

Cornish, Derek B., and R. V. G. Clarke. 1986. The Reasoning Criminal: Rational Choice Perspectives on Offending. New York: Springer-Verlag.

Des Jarlais, D. C., H. L. F. Cooper, K. Arasteh, J. Feelemyer, C. McKnight, and Z. Ross. 2018. "Potential geographic "hotspots" for drug-injection related transmission of HIV and HCV and for initiation into injecting drug use in New York City, 2011-2015, with implications for the current opioid epidemic in the US." PloS One 13(3):e0194799.

Diplock, Jordan. 2016. "Designing out opportunities for crime." in Designing out Crime, edited by Len Garis and Paul Maxim. Abbotsford, BC: University of the Fraser Valley.

Dodson, Zan M., Eun-Hye Enki Yoo, Christian Martin-Gill, and Ronald Roth. 2018. "Spatial Methods to Enhance Public Health Surveillance and Resource Deployment in the Opioid Epidemic." American Journal of Public Health 108(9):1191-96.

Duan, Hubert. 2014. "Applying Supervised Learning Algorithms and a New Feature Selection Method to Predict Coronary Artery Disease." Pp. 102: University of Ottawa.

Eck, John E. 2003. “Police problems: The complexity of problem theory, research and evaluation.” Crime Prevention Studies 15: 79–113.

Fischer, Benedikt, Jürgen Rehm, Jayadeep Patra, and Michelle Firestone Cruz. 2006. "Changes in illicit opioid use across Canada." Canadian Medical Association Journal 175(11):1385-85.

Gallagher, Kathleen, and Pamela Wilcox. 2013. "Crime, Displacement of." Pp. 107-09 in Encyclopedia of Street Crime in America, edited by Ian Jeffery Ross. Thousand Oaks, California: SAGE Publications, Inc.

Gomes, Tara, Wayne Khuu, Diana Martins, Mina Tadrous, Muhammad M. Mamdani, J. Michael Paterson, and David N. Juurlink. 2018. "Contributions of prescribed and non-prescribed opioids to opioid related deaths: population based cohort study in Ontario, Canada." British Medical Journal (Clinical research ed.) 362:k3207.

Griffioen, Mark 2018. “Recovery Home Pilot Project” Combined Surrey Fire Service / Fraser Health Community Safety Initiative”

Guerette, Rob T., and Kate J. Bowers. 2009. "Assessing the extent of crime displacement and diffusion of benefits: a review of situational crime prevention evaluations." Criminology 47(4):1331-68.

Hawley, Amos H. 1943. "Ecology and Human Ecology." Social Forces 22(1):398.

Heavey, Sarah Cercone, Alan M. Delmerico, Gale Burstein, Cheryll Moore, William F. Wieczorek, R. Lorraine Collins, Yu-Ping Chang, and Gregory G. Homish. 2018. "Descriptive Epidemiology for Community-wide Naloxone Administration by Police Officers and Firefighters Responding to Opioid Overdose." Journal of Community Health 43(2):304-11.

Kelling, George L., and Catherine M. Coles. 1997. Fixing Broken Windows: Restoring Order and Reducing Crime in our Communities. New York: Simon & Schuster.

Krebs, Emanuel, Linwei Wang, Michelle Olding, Kora DeBeck, Kanna Hayashi, M.-J. Milloy, Evan Wood, Bohdan Nosyk, and Lindsey Richardson. 2016. "Increased drug use and the timing of social assistance receipt among people who use illicit drugs." Social Science and Medicine 171(Complete):94-102.

Liaw, Andy, and Matthew Wiener. 2002. "Classification and regression by randomForest." R News 2(3):18-22.

Microsoft. 2017. "What is the Team Data Science Process? ."—. 2018. "Azure Databricks."

Otterstatter, Michael C., Ashraf Amlani, Hugh Guan, Lindsey Richardson, and Jane A. Buxton. 2016. "Illicit drug overdose deaths resulting from income assistance payments: Analysis of the ‘check effect’ using daily mortality data." International Journal of Drug Policy 33:83-87.

Otterstatter, Michael C., Alexis Crabtree, Sabina Dobrer, Brooke Kinniburgh, Salman Klar, Anthony Leamon, Jennifer May-Hadford, Christopher Mill, Mina Park, Andrew W. Tu, and Lu Zheng.

2018. "Patterns of health care utilization among people who overdosed from illegal drugs: a descriptive analysis using the BC Provincial Overdose Cohort." Health promotion and chronic disease prevention in Canada : research, policy and practice 38(9):328-38.

Park, Robert Ezra, E. W. Burgess, Roderick Duncan McKenzie, and Louis Wirth. 1967. The City. Chicago: University of Chicago Press.

Rehal, J. 2016. "Corporate Report: Recovery Houses Update." edited by Bylaw Enforcement & Licensing Services. Surrey, British Columbia: City of Surrey.

Rowe, Christopher, Glenn-Milo Santos, Eric Vittinghoff, Eliza Wheeler, Peter Davidson, and Philip O. Coffin. 2016. "Neighborhood-Level and Spatial Characteristics Associated with Lay Naloxone Reversal Events and Opioid Overdose Deaths." Journal of Urban Health 93(1):117-30.

Sampson, Rana, John E. Eck, and Jessica Dunham. 2010. "Super controllers and crime prevention: A routine activity explanation of crime prevention success and failure." Security Journal 23 (1):37–51.

Shaw, C.R., F.M. Zorbaugh, H.D. McKay, and L.S. Cotrell. 1929. Delinquency Areas: A Study of the Geopraphic Distribution of School Truants, Juvenile Delinquents, and Adult Offenders In Chicago. Chicago: University of Chicago Press.

Smith, Meredith Y., William Irish, Jianmin Wang, J. David Haddox, and Richard C. Dart. 2008. "Detecting signals of opioid analgesic abuse: application of a spatial mixed effect poisson regression model using data from a network of poison control centers." Pharmacoepidemiology and Drug Safety 17(11):1050-59.

Smolina, K., et al. (2019) "Patterns and history of prescription drug use among opioid-related drug overdose cases in British Columbia, Canada, 2015-2016." Drug and Alcohol Dependence, 194: 151-158.

Wang, L., E. Krebs, M. Olding, K. DeBeck, K. Hayashi, M.J. Milloy, L Richardson, and B. Nosyk. 2016. "Increased drug use and the timing of social assistance receipt among people who use illicit drugs." Drug and Alcohol Dependence 171:e211.

Woo, Andrea. 2018. "Nearly all drugs sold as heroin in Vancouver contain fentanyl, study finds." in Globe and Mail. Canada.

Zlotorzynska, Maria, M. -J S. Milloy, Lindsey Richardson, Paul Nguyen, Julio S. Montaner, Evan Wood, and Thomas Kerr. 2014. "Timing of Income Assistance Payment and Overdose Patterns at a Canadian Supervised Injection Facility." International Journal of Drug Policy 25(4):736-39.

UNIVERSITY OF THE FRASER VALLEY
SCHOOL OF CRIMINOLOGY & CRIMINAL JUSTICE

UNIVERSITY OF THE FRASER VALLEY
CENTRE FOR SOCIAL RESEARCH