

Patterns in poisoning hospitalizations and deaths in British Columbia, 2008 to 2013

Findings from a retrospective analysis of unintentional and self-harm poisonings involving illicit drugs, over-the-counter medications, and other substances can help clinicians, academics, and policymakers develop initiatives that prevent poisoning events.

ABSTRACT

Background: Poisoning is a leading cause of hospitalization and death in British Columbia, yet patterns for all-cause poisonings remain unclear. A study was proposed to analyze morbidity and mortality for all causes of poisoning in order to investigate patterns and trends associated with intent, age, sex, health service delivery area, and cause.

Methods: A retrospective analysis was performed on morbidity and mortality data obtained from the BC Discharge Abstract Database and BC Vital Statistics for 2008 to 2013. Cases with poisoning as the primary cause of hospitalization or death were identified by ICD-10 codes and classifications for drugs and other substances, which included antiepileptic, sedative-hypnotic, antiparkinsonism, and psychotropic drugs; narcotics and psychodysleptics; gases and vapors; and nonopioid analgesics, antipyretics, and antirheumatics. Once data were collected, descriptive statistics were generated. Separate multivariable logistic regression analyses were performed

to investigate factors influencing the odds of the following events occurring: hospitalization or death from poisoning rather than from other external causes; hospitalization or death from self-harm poisoning rather than from poisonings involving other intents; deaths from poisoning rather than hospitalizations from poisoning.

Results: Unintentional poisoning hospitalizations and deaths in BC increased significantly during the study period. Males accounted for a majority of poisoning deaths (66%), while females accounted for a majority of poisoning hospitalizations (59%). Poisoning rates tended to be higher in less urban health service delivery areas. Causes of poisoning resulting in hospitalizations and deaths differed, as did intent. Age, sex, and calendar year were significant predictors of the odds of a poisoning event occurring.

Conclusions: Distinct patterns and trends associated with all-cause poisoning were identified by the study. These findings provide valuable insight into poisoning hospitalizations

and deaths in BC for the period 2008 to 2013. By considering these findings and understanding the epidemiology of poisoning, clinicians from across the province can be better equipped to counsel patients and their families on ways to prevent poisonings. Clinicians, academics, and policymakers can also use these study findings to develop prevention initiatives that reduce the burden of poisonings on the health care system and society as a whole.

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Background

Poisoning is a major cause of morbidity and mortality in Canada and around the world. Poisonous substances include, but are not limited to, drugs, pesticides, gases, and household cleaners. However, virtually *any* substance can be poisonous if the dose or exposure is sufficient. The role of intent in a poisoning event varies. Poisoning can be unintention-

ration of a public health emergency,³ with data indicating opioid and illicit drug deaths totaling 993 in 2016⁴ and representing roughly one-third of the 2861 opioid-related deaths nationwide that year.⁵ The trend continued in 2017, with 1452 deaths in BC from illicit drug poisoning.⁴

Though “overdose” is commonly used interchangeably with “poisoning” in both medical literature and

poisonings, targeted prevention initiatives can be developed with the aim of reducing morbidity and mortality. Currently, the research focus in BC has been on poisoning deaths due to illicit drug and opioid use,³ and patterns with respect to other causes of poisoning, especially those that are nonfatal, remain relatively unstudied even though these are undoubtedly also an issue. Since a greater understanding of all-cause poisoning events can provide information for interventions aimed at reducing the overall burden of poisoning on society, a study was proposed to describe trends and patterns for all-cause poisoning hospitalizations and deaths in BC from 2008 to 2013.

Though “overdose” is commonly used interchangeably with “poisoning” in both medical literature and everyday language, it is important to recognize that the term poisoning more accurately describes the toxic effects of substances on the body and is used by ICD-10.

al or intentional (i.e., classified as either self-harm or assault/homicide). The intent of an individual can also be undetermined. It is important to note that poisonings due to illicit drug use are overwhelmingly classified as unintentional poisonings because in most cases, individuals using illicit drugs do not intend to inflict self-harm or commit suicide.

In 2016 an estimated 106 683 deaths occurred worldwide because of unintentional poisonings, which resulted in nearly 6 million years of life lost.¹ Though Canadian national data are sparse and incomplete, findings indicate that unintentional poisonings caused over 1500 deaths, 7800 hospitalizations, and 54 000 emergency department visits in 2010 alone, costing the nation an estimated \$1.26 billion.² In British Columbia, drug poisonings have led to the decla-

everyday language, it is important to recognize that the term poisoning more accurately describes the toxic effects of substances on the body and is used by *ICD-10*. The term overdose specifically refers to scenarios where quantities of a substance are used in excess of a known therapeutic dose (e.g., acetaminophen overdose). However, when the term overdose is used in the context of illicit drugs, it implies that individuals know what the correct dose is, even though none exist for illicit substances, and users are therefore intentionally exceeding this dose and are personally responsible.⁶ This can lead to unnecessary stigma for already marginalized people, and for this reason the term poisoning is preferred.

Poisoning, like other mechanisms of injury, is preventable. By understanding the trends and patterns of

Methods

Data were obtained from the BC Discharge Abstracts Database for all acute-level hospitalizations attributed to poisoning and other external causes (e.g., motor vehicle collisions, falls, fires) for the calendar years 2008 to 2013. Data for all deaths attributed to poisoning and other external causes were also obtained from BC Vital Statistics for the same period. Data from non-BC residents were excluded from all analyses.

Cases with poisoning as the primary cause of hospitalization or death were identified by the *ICD-10* codes X40–X49 (unintentional poisoning), X60–X69 (self-harm poisoning), X85–X90 (homicide/assault by poisoning), and Y10–Y19 (poisoning of undetermined intent). Additional details considered were age, sex, health service delivery area (HSDA) of residence, and cause of poisoning.

With respect to cause, *ICD-10* categories were used for drugs and other substances such as:

- Antiepileptic, sedative-hypnotic, anti-parkinsonism, and psychotropic drugs (e.g., antidepressants, barbiturates).

- Narcotics and psychodysleptics (e.g., opioids, cocaine).
- Gases and vapors (e.g., carbon monoxide, motor vehicle exhaust).
- Nonopioid analgesics, antipyretics, and antirheumatics (e.g., acetaminophen, acetylsalicylic acid).

Once data were collected, descriptive statistics were generated. Age-standardized rates per 100 000 were calculated using 2011 BC population numbers. Trends were analyzed with linear regression models and were deemed statistically significant at $P < .05$. Separate multivariable logistic regression analyses were performed to investigate factors influencing the odds of the following events occurring:

- Hospitalization or death from poisoning rather than from other external causes.
- Hospitalization or death from self-harm poisoning rather than from poisoning involving other intents.
- Death from poisoning rather than hospitalization from poisoning.

After controlling for HSDA of residence, the predictor variables of interest were age, sex, and calendar year. Adjusted odds ratios (AORs) and 95% confidence intervals were calculated and deemed significant at $P < .01$ (Bonferroni correction). Ethics approval for the study was obtained from the UBC Children's and Women's Research Ethics Board.

Results

Poisonings in BC resulted in 26 846 hospitalizations (100.0 per 100 000) and 3120 deaths (11.6 per 100 000) from 2008 to 2013. Males accounted for 66% of poisoning deaths, while females accounted for 59% of poisoning hospitalizations. The majority of poisoning hospitalizations (57%) were classified as the result of self-harm, while one-third (32%) were classified as unintentional. The

majority of poisoning deaths (70%) were classified as unintentional, and one-quarter (25%) were classified as self-harm poisonings.

Analysis of poisoning trends by intent and year indicated that unintentional poisoning hospitalizations increased from 31.4 to 35.9 per 100 000 ($P = .04$) from 2008 to 2013, unintentional poisoning deaths increased from 7.2 to 9.2 per 100 000 ($P = .004$),

In particular, the self-harm poisoning hospitalization rate for females age 15 to 19 was highest across all ages and both sexes, and was over 3 times greater than the corresponding male rate (191.6 vs 57.3 per 100 000).

Analyses of poisoning deaths by age, sex, and intent showed that mortality rates were significantly greater for males than for females across multiple age groups for both uninten-

Self-harm poisoning hospitalization rates were considerably higher among females across nearly all age groups. In particular, the self-harm poisoning hospitalization rate for females age 15 to 19 was highest across all ages and both sexes.

and all-intents poisoning deaths increased from 10.7 to 12.7 per 100 000 ($P = .007$). No significant trends were seen regarding self-harm poisonings.

Poisoning hospitalizations analyzed by age, sex, and intent revealed distinct differences between unintentional and self-harm poisonings. Hospitalization rates for unintentional poisonings were relatively similar between males and females and showed a general increase with age, with the lowest rate for children age 5 to 9 years (3.8 per 100 000) and the highest rate for adults age 75 and older (62.4 per 100 000). Notably, the rate for children age 0 to 4 years (both sexes) was nearly 9 times higher than the corresponding rate for children age 5 to 9 years (34.6 vs 3.8 per 100 000). Self-harm poisoning hospitalization rates were considerably higher among females across nearly all age groups.

tional and self-harm poisoning. Notably, unintentional mortality rates for males age 20 to 64 were in the range of 12.9 to 17.3 per 100 000 whereas the corresponding female rates were in the range of 3.9 to 8.5 per 100 000. Unintentional poisoning mortality rates for both sexes were highest in the 25 to 44 and 45 to 64 age groups. Self-harm poisoning deaths among females increased with age and peaked in the 45 to 64 age group at 4.0 per 100 000, while two peaks were identified for males, with the 45 to 64 age group (5.8 per 100 000) and the 75 and above age group (6.1 per 100 000) having the highest self-harm poisoning mortality rates.

Poisoning hospitalization data analyzed by intent and HSDA indicated that unintentional poisoning hospitalization rates (**Figure 1**) were highest in regions of Interior Health

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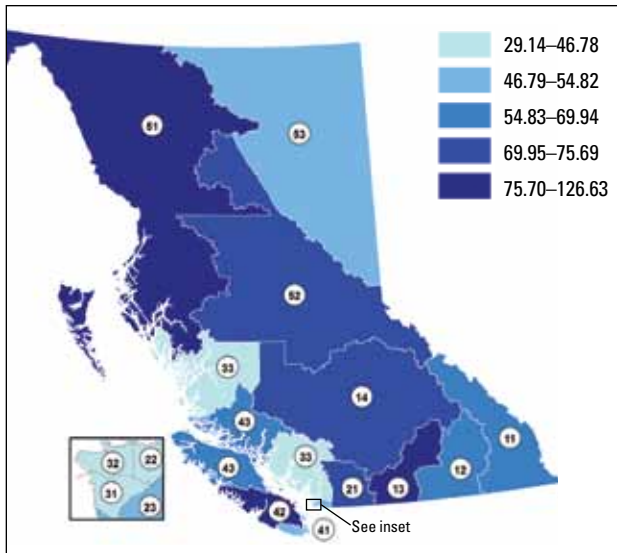


Figure 1. Unintentional poisoning hospitalization rates (age-standardized, per 100 000) by health service delivery area in BC (see box), 2008 to 2013.

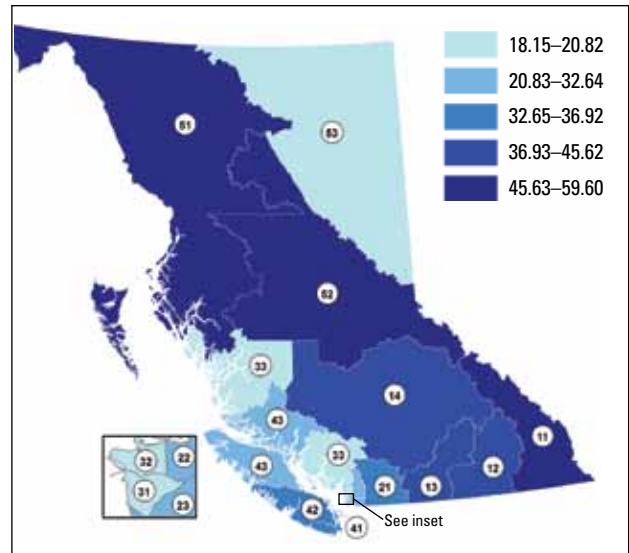


Figure 2. Self-harm poisoning hospitalization rates (age-standardized, per 100 000) by health service delivery area in BC (see box), 2008 to 2013.

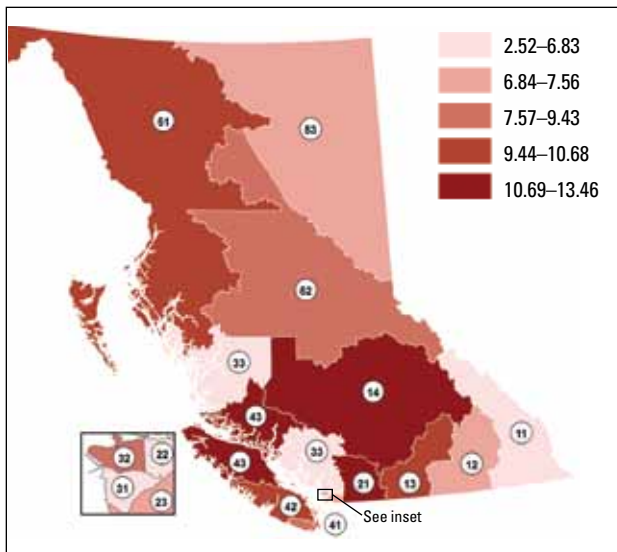


Figure 3. Unintentional poisoning mortality rates (age-standardized, per 100 000) by health service delivery area in BC (see box), 2008 to 2013.

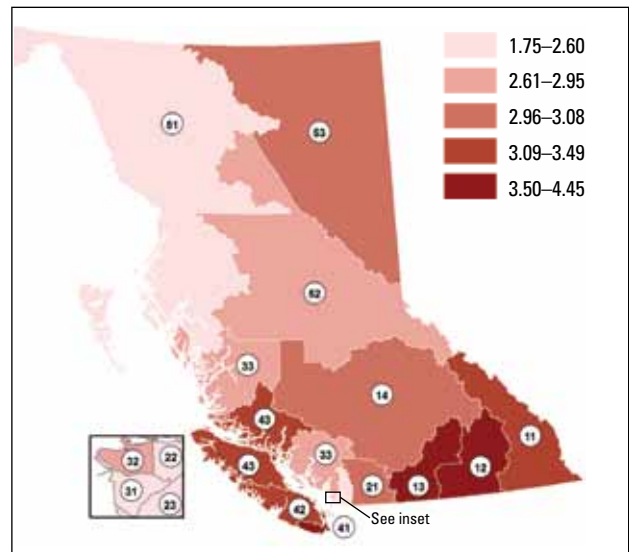


Figure 4. Self-harm poisoning mortality rates (age-standardized, per 100 000) by health service delivery area in BC (see box), 2008 to 2013.

Health service delivery areas in BC

Interior Health

- 11 East Kootenay
- 12 Kootenay Boundary
- 13 Okanagan
- 14 Thompson Cariboo Shuswap

Fraser Health

- 21 Fraser East
- 22 Fraser North
- 23 Fraser South

Vancouver Coastal Health

- 31 Richmond
- 32 Vancouver
- 33 North Shore/Coast Garibaldi

Island Health

- 41 South Vancouver Island
- 42 Central Vancouver Island
- 43 North Vancouver Island

Northern Health

- 51 Northwest
- 52 Northern Interior
- 53 Northeast

Source: All maps were generated by Andy Jiang using ArcMap software version 10.5.1 (ESRI, Redlands CA, USA) and shape files from the Government of British Columbia, available at www2.gov.bc.ca/gov/content/data/geographic-data-services/land-use/administrative-boundaries.

and Northern Health, whereas self-harm poisoning hospitalization rates (Figure 2) were highest in regions of Island Health, Interior Health, and Northern Health. Both unintentional poisoning mortality rates (Figure 3) and self-harm poisoning mortality rates (Figure 4) were high primarily in regions of Island Health and Interior Health.

Poisoning hospitalization and death data analyzed by intent and cause indicated that antiepileptic, sedative-hypnotic, antiparkinsonism, and psychotropic drugs (*ICD-10* code X41) were the leading cause of both unintentional poisoning hospitalizations (28%) and self-harm poisoning hospitalizations (50%). Data also indicated that 49% of unintentional poisoning deaths were due to narcotics and psychodysleptics (*ICD-10* code X42), whereas 23% of self-harm poisoning deaths were due to gases and vapors (*ICD-10* code X47). Lastly, data indicated that nonopioid analgesics, antipyretics, and antirheumatics (*ICD-10* code X40) were a major cause of self-harm poisoning hospitalizations (25%).

Trend analyses of poisoning with narcotics and psychodysleptics compared with all other causes of poisoning revealed that deaths due to these drugs increased significantly during the study period from 4.9 per 100 000 in 2008 to 7.3 per 100 000 in 2013 ($P = .01$), whereas deaths due to all other causes remained relatively stable, ranging between 5.7 and 4.8 per 100 000. A similar analysis of hospitalizations showed no significant trends.

Multivariable logistic regression analysis of factors associated with hospitalization due to poisoning compared with hospitalization due to other external causes indicated that advancing age decreased the odds of being hospitalized (AOR = 0.971;

95% CI, 0.970–0.971), but female sex increased the odds of being hospitalized (AOR = 2.178; 95% CI, 2.118–2.240), as did a calendar year later in the study period (AOR = 1.023; 95% CI, 1.015–1.031).

When comparing cases of hospitalization due to self-harm poisoning with cases of hospitalization due to poisoning of other intents, advancing age decreased the odds of being hospitalized (AOR = 0.981; 95% CI,

found to be a significant factor (AOR = 1.039; 95% CI, 1.033–1.045).

Lastly, analyses comparing poisoning deaths with poisoning hospitalizations (all intents) indicated that advancing age increased the odds of dying as opposed to being hospitalized (AOR = 1.010; 95% CI, 1.008–1.012), but female sex decreased the odds of dying (AOR = 0.373; 95% CI, 0.345–0.404). Calendar year was not a significant factor.

Trend analyses of poisoning with narcotics and psychodysleptics compared with all other causes of poisoning revealed that deaths due to these drugs increased significantly during the study period from 4.9 per 100 000 in 2008 to 7.3 per 100 000 in 2013 ($P = .01$), whereas deaths due to all other causes remained relatively stable.

0.980–0.983) and later calendar year decreased the odds of being hospitalized (AOR = 0.957; 95% CI, 0.943–0.971), while female sex increased the odds of being hospitalized (AOR = 1.670; 95% CI, 1.587–1.758).

Similarly, analyses of factors associated with deaths due to poisoning compared with deaths due to other external causes indicated that advancing age decreased the odds of dying due to poisoning (AOR = 0.971; 95% CI, 0.969–0.973), but female sex increased the odds of dying due to poisoning (AOR = 1.298; 95% CI, 1.184–1.423), as did a later calendar year (AOR = 1.074; 95% CI, 1.047–1.101). When analyzing poisoning deaths due to self-harm rather than other intents, only advancing age was

Conclusions

Poisoning is a significant cause of mortality and morbidity in BC. This study reveals several patterns in poisoning hospitalizations and deaths associated with intent, age, sex, health service delivery area, and cause. Notably, unintentional poisoning deaths have increased since 2008—a trend driven primarily by poisonings due to narcotics and psychodysleptics. Comparing poisoning with other external causes of mortality and morbidity also shows that poisoning events increased from 2008 to 2013, consistent with research in the US that found poisonings surpassed motor vehicle collisions as the leading cause of injury death in 2008.⁷ Furthermore, this study found the odds of dying rather

than being hospitalized due to poisoning increased over time, suggesting that not only the burden of poisoning but also the acuity of poisoning increased during the study period.

Age and sex

In BC, the unintentional poisoning hospitalization rate of children age 0 to 4 is high relative to other age groups. While this is a concerning finding, it also reflects other study results that indicate the risk of unintentional poisonings may be intrinsically linked to a particular developmental stage.⁸ For example, toddlers may be at increased risk of poisoning because they tend to explore their environments by placing objects in their mouths. In addition, research has found that poisoning from drugs taken orally may be linked to imitative behaviors as young children watch and copy their caretakers.⁹ Though child-resistant medication packaging has been proven to reduce childhood poisoning risk,¹⁰ household members may choose not to use such packaging and instead store medications in pill boxes that are not child-resistant. Physicians and pharmacists engaged in prescribing and dispensing drugs are ideally positioned to counsel patients in contact with young children to be mindful of poisoning dangers.

With respect to self-harm poisonings, this study suggests that individuals age 15 to 64 are at risk. In particular, females age 15 to 19 had the highest rate of self-harm poisoning hospitalization. Findings from the US are similar, indicating that emergency department visit rates for self-harm poisoning were highest among females age 15 to 19.¹¹ The observation that females generally have substantially higher poisoning hospitalization rates than males may be explained by gendered patterns of suicide attempts and completions. Previ-

ous studies have found that females are more likely than males to choose poisoning as a method of suicide.¹² This is supported by our finding that females were significantly more likely than males to be hospitalized or die from poisoning rather than other external causes, and that poisoning hospitalization was more likely to result from self-harm than other intents. However, research has also shown that when males choose poisoning as a method of self-harm, they are more likely to die than females.¹³ Likewise, with respect to self-harm poisoning hospitalizations rates, those for females in this study were greater than for males but the reverse was true for self-harm death rates. The overall odds of dying compared with being hospitalized due to poisoning (all intents) were also lower for females in this study, supporting the notion that while females are at greater risk for poisoning events, these events are less likely to result in death.

Lastly, the results of this study indicate that deaths due to unintentional poisoning disproportionately affect males age 20 to 64, and that males are more likely to die as a result of a poisoning event when compared with females. This pattern may be further amplified as the growing opioid crisis in BC leads to a corresponding increase in unintentional poisoning deaths. It is not exactly clear why poisonings overwhelmingly affect males, suggesting the need for further research on the complex interactions between social, behavioral, and biological factors in the context of poisoning. Importantly, active participation in the workforce and peak economic productivity occur from age 20 to 64. Premature deaths and prolonged hospitalizations from poisoning in this age group in BC have a substantial human and economic impact,¹⁴ and should be a prevention

priority not only for physicians and health care providers but for policymakers and elected leaders.

Health service delivery area

This study identified poisoning hotspots in the province, predominantly in less-urban health service delivery areas. Although these findings suggest a difference between rural and urban areas with respect to poisoning hospitalization and death rates, a previous Canadian 10-year cohort study analyzing poisoning deaths across the country found no differences in unintentional or self-harm poisoning rates across the urban-rural continuum.¹⁵ In contrast, research in BC has found significant differences, specifically among cocaine-related poisonings when comparing urban and rural communities.¹⁶ Such discrepancies suggest the need for further research to determine if these geographic differences in poisoning are related to specific substances or other factors such as ethnic clustering, drug prescription practices, or lack of access to mental health services in the case of self-harm poisonings.

Cause of poisoning

Between 2008 and 2013, narcotics and psychodysleptics (e.g., opioids, cocaine) were the leading cause of unintentional poisoning deaths and the second leading cause of unintentional poisoning hospitalizations behind antiepileptic, sedative-hypnotic, antiparkinsonism, and psychotropic drugs (e.g., antidepressants, barbiturates).

Opioids are of particular relevance in BC in light of the recent public health emergency.³ While this study did not find opioids to be the leading cause of hospitalization, more recent research shows that poisoning hospitalizations due to opioids have increased 53% nationwide from

2007/08 to 2016/17,¹⁷ suggesting that the pattern found in this study may no longer reflect current trends. The causes and factors driving the recent opioid crisis are complex. However, one major factor is the increasing number of illicit drug deaths involving ultra-potent opioids such as fentanyl, with data indicating fentanyl was detected in 84% of illicit drug deaths in BC in 2017.¹⁸ Research has also shown that prescription opioid consumption in BC has increased 31% from 2005 to 2013,¹⁹ suggesting a possible link between opioid poisonings and increases in the dispensing of stronger opioids.

A large proportion of self-harm poisoning hospitalizations and deaths in this study were caused by antidepressants. This suggests that individuals with depression and/or other mental health issues may form a significant portion of the population at risk for self-harm poisonings. Rates of suicide among those with depression are known to be higher than the general population.²⁰ Although antidepressant medications are the cornerstone of therapy, research has shown that certain antidepressants may paradoxically increase the risk for suicide in certain populations.²¹ Thus, clinicians should be acutely aware of any potential risks associated with prescribing psychotropic drugs in hopes of mitigating suicide attempts.

Substances classified as nonopioid analgesics, antipyretics, and antirheumatics (e.g., acetaminophen, acetylsalicylic acid) were also a major cause of self-harm poisoning hospitalizations. Acetaminophen preparations are commonly available over-the-counter, which could explain the high involvement of these medications in self-harm poisonings. Research conducted in Calgary, Alberta, found that females age 10 to 29 experienced the

highest hospitalization rates due to intentional acetaminophen poisoning.²² While the study was limited to Alberta, the results of the present study suggest the findings apply to BC, and that physicians should be alert to the potential for self-harm among adolescents and young adults and counsel patients about the risks of certain over-the-counter medications.

Study limitations

Defining a poisoning event is often difficult as poisoning may occur in isolation or with other mechanisms of injury, as in the case of motor vehicle collisions that occur when the driver is under the influence of drugs or alcohol. In such cases, the primary cause is often coded as a motor vehicle collision despite the fact that poisoning may have played a pivotal role. Thus, analyzing cases with poisoning as the main cause of hospitalization or death can result in an underestimation of the true magnitude of the problem. Furthermore, the overall accuracy of the *ICD-10* codes used to describe causes of poisoning is unknown. While this may be a limiting factor, previous research examining prescription opioid death data has found that national vital statistics datasets using *ICD-10* codes are fairly accurate when compared with the gold standard of coroners' data,²³ suggesting that the results of this study using administrative datasets and *ICD-10* codes are valid, and supporting the utility of such datasets for public health surveillance.

Another limitation of this study concerns the use of data from 2008 to 2013, which means the findings may not reflect more recent patterns. The findings do, however, provide a useful picture of all-cause poisonings in BC just before the exponential increase in opioid-related poisonings. Analyzing data from before the major increases

in opioid-related poisonings reduces the risk of patterns being skewed by the large number of opioid-related cases and provides greater insight into all other causes of poisoning that are undoubtedly still relevant during the current opioid crisis. Future studies may seek to determine whether the patterns found in this study are similar to those seen in the years following 2013.

Lastly, the intent of a poisoning event can be classified incorrectly, particularly with suspected suicide cases. A self-harm poisoning event may not be registered as such because victims or their families wish to avoid this designation for cultural or religious reasons, or because of the stigma associated with suicide. Though this study found roughly 5% of poisoning deaths and 11% of hospitalizations in BC between 2008 and 2013 were classified as the result of undetermined intent, research has indicated that poisonings of undetermined intent constituted some 47% to 80% of all undetermined deaths in Canada.²⁴

Summary

The results of this study provide valuable insight into trends and patterns of poisoning hospitalizations and deaths in BC with respect to age, sex, health service delivery area, cause, and intent for the period 2008 to 2013. The unintentional poisoning hospitalization rate for children age 0 to 4 (both sexes) was high relative to other age groups, and the self-harm poisoning death rates for adult males and females were found to increase with advancing age. Males accounted for a majority of poisoning deaths while females accounted for a majority of poisoning hospitalizations. Poisoning rates tended to be higher in less-urban health service delivery areas. Causes of poisoning included drugs such as

antidepressants, opioids, cocaine, and acetaminophen, and substances such as motor vehicle exhaust.

Unintentional poisonings have been on the increase since 2008, emphasizing the importance of early surveillance and prevention. By understanding the epidemiology of poisoning within their communities, clinicians from across the province can be better equipped to counsel patients and their families on ways to prevent poisonings for themselves and their loved ones. Although the hospitalizations and deaths considered in this study are fewer in number than those seen with the recent opioid crisis in BC, they represent the most serious cases, and the findings can help clinicians, academics, and policymakers develop prevention initiatives that reduce the burden of poisonings on the health care system and society as a whole. **BMJ**

Competing interests

None declared.

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