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Research

The impact of poisoning in British Columbia: a cost analysis

Fahra Rajabali MSc, Kate Turcotte MSc, Alex Zheng MSc, Roy Purssell MD, Jane A. Buxton MBBS MHSc, Ian Pike PhD

Abstract

Background: Poisoning, from substances such as illicit drugs, prescribed and over-the-counter medications, alcohol, pesticides, gases and household cleaners, is the leading cause of injury-related death and the second leading cause for injury-related hospital admission in British Columbia. We examined the health and economic costs of poisoning in BC for 2016, using a societal perspective, to support public health policies aimed at minimizing losses to society.

Methods: Costs by intent, sex and age group were calculated in Canadian dollars using a classification and costing framework based on existing provincial injury data combined with data from the published literature. Direct cost components included fatal poisonings, hospital admissions, emergency department visits, ambulance attendance without transfer to hospital and calls to the British Columbia Drug and Poison Information Centre (BC DPIC) not resulting in ambulance attendance, emergency care or transfer to hospital. Indirect costs, measured as loss of earnings and informal caregiving costs, were also calculated.

Results: We estimate that poisonings in BC totalled $812.5 million in 2016 with $108.9 million in direct health care costs and $703.6 million in indirect costs. Unintentional poisoning injuries accounted for 84% of total costs, 46% of direct costs and 89% of indirect costs. Males accounted for higher proportions of direct costs for all patient dispositions except hospital admissions. Patients aged 25–64 years accounted for higher proportions of direct costs except for calls to BC DPIC, where proportions were highest for children younger than 15 years.

Interpretation: Hospital care expenditures represented the largest direct cost of poisoning, and lost productivity following death represented the largest indirect cost. Quantifying and understanding the financial burden of poisoning has implications not only for government and health care, but also for society, employers, patients and families.

Poisoning is the leading cause of injury-related death and the second leading cause for injury-related hospital admission in British Columbia.[1] Poisonous substances include illicit drugs, prescribed and over-the-counter medications, alcohol, pesticides, gases and household cleaners. Exposure to, or consumption of, these substances can result in unintentional, self-harm or inflicted poisonings leading to severe injury or death. Direct costs related to poisoning incurred by the health care system in BC in 2003 were estimated at Can$53.5 million. Indirect costs, the losses to societal productivity, were estimated at Can$3.6 million.[2] Children, youth, young adults, older adults and Indigenous Peoples in Canada are considered high-risk populations for poisoning.[3] Whereas unintentional deaths from poisoning and hospital admissions increased from 2008 to 2018, suicide by poisoning decreased.[3] More specifically, poisonings involving narcotics and psychodysleptics, particularly opioid-related poisoning resulting in death, hospital admission and emergency department visits have continued to increase since the early 2000s.[4–6]

Recommendations for poisoning prevention include the traditional approach of education, as well as more innovative ideas. To address poisoning among children, physician training in family medicine and pediatrics should include prevention as part of well-baby visits, providing information on safe storage of household products and the use of child-resistant packaging.[7,8] For all ages, poison control centres are a cost-effective source for immediate advice in the event of a poisoning, as well as providing data for the purposes of surveillance.[7,9,10] New recommendations for poisoning prevention in Canada include the need for increased advocacy for the wide range of best practices, a national product-specific information

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Correspondence to: Fahra Rajabali, frajabali@bcchr.ca

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database, responding to emerging poisoning issues (e.g., cannabis products), mandatory use of carbon monoxide detectors and developing national leadership to support the coordination of poisoning prevention.[3]

When poisonings occur, they require considerable societal resources to respond and appropriately address the problem. Pike and colleagues,[2] investigated the cost of poisonings in 2003 in BC. We sought to update and examine the health and economic costs of poisoning in BC using a societal perspective, to include costs that have an effect on society as a whole, including people, employers and the government.

Methods

Study design

We used an incidence costing, human capital approach[11]; the population of people who were poisoned in 2016 was costed over each lifetime. The human capital approach measures costs from lost productivity, based on the value of a person's future earnings. Although this approach excludes intangibles and only counts earnings, undervaluing a person's ability to produce, it is adopted by most cost of illness studies.[12] Recognizing that future costs are usually less than present costs owing to scientific and technological advancement, direct and indirect costs were discounted to 1.5% per annum to reflect the time cost of money as well as the technological advances.[13] Dollar values are for 2016, the most recent year available for data and population statistics of poisoning injuries and deaths. Average costs were applied using constant 2016 Canadian dollars. We reported the results of this study in accordance with the Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) statement (https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-021-02204-0/tables/1).

Direct costs are costs to the health care system, consisting of all the goods and services consumed by a person treated for a poisoning-related injury, including ambulance transportation, emergency care, hospital care, physician services and rehabilitation. Formal caregiving by paid workers and organizations were included in direct costs. Costs for vision care and prescription medications were excluded. Costs for diagnostic and surgical treatment, drug expenditures, clinical treatment, therapy and rehabilitation were not readily available for each patient. Comprehensive searches of hospital health records, medical clinic records and insurance systems would be needed to extract the required information. We used average provincial costs of relevant health services, average length of hospital stay, average hospital resource allocation costs and average disability weights to estimate patient costs.

Indirect costs are losses to societal productivity (measured using earnings data), which account for the inability of the person who was poisoned to perform their major activities of daily living and contribute to society, and include the value of time lost from work owing to hospital stay, disability and premature death. The discount rate affects all indirect costs associated with the loss of income, excluding the indirect costs of a hospital stay that would occur in the current year, and includes the long-term direct costs associated with disability, long-term medical and rehabilitation. A labour productivity growth rate of 1.0%, a labour participation rate of 64.4%, an unemployment rate of 6.0% and an average weekly earning of $897 were applied.[14] It is assumed that the person who was poisoned would have the same productivity and unemployment rate as the general public. We included the cost of informal caregiving provided by family, friends and neighbours. Transfer payments from government or social services were not included as they are a reallocation of resources. There may be instances when the availability of transfer payments can affect a person's incentive to return to work. The transfer payments may vary as a result of economic recessions and various global situations; hence, information may not be as readily available or applicable to a given year. The assumptions underpinning the cost of poisonings are subject to notable variations. To capture the effects of these assumptions, sensitivity analyses were used to illustrate the possible range of indirect cost estimates with variations in discount rate, unemployment rate and participation rate. It was assumed during the analysis of each of these parameters that when the effect of varying 1 condition was changed, the other 2 variations were held constant.

Costs were mainly calculated using the Electronic Resource Allocation Tool,[15] providing a classification and costing framework based on existing provincial injury costs data combined with data from the published injury costing literature.

Data sources

We extracted data pertaining to poisoning deaths from the BC Vital Statistic Agency, through the BC Centre for Disease Control (BCCDC), Chronic Disease and Injury Data Mart (as of August 2020). We obtained hospital admission data from the Discharge Abstract Database (DAD) at the BC Ministry of Health. Data were extracted using the *International Statistical Classification of Diseases and Related Health Problems*, *10th Revision*, *Canada* (ICD-10-CA) codes, originally developed by the World Health Organization, and adapted by the Canadian Institute for Health Information; all poisoning ICD-10-CA codes were extracted and grouped by intent: unintentional (X40–X49), suicide or self-harm (X60–X69), violence (X85–X90) and undetermined (Y10–Y19). The DAD includes information pertaining to the total relative case weight associated with different diagnostic, surgical procedures and resources (drugs and medical supplies) used. An average resource intensity weight and length of stay was applied to the total number of hospital admissions. Furthermore, an average provincial inpatient cost of a standard hospital stay excluding physician care expenditures was applied to these averages to obtain Canadian dollar values.[16] An average value of physician care was applied using information from the National Physician Database.[17] In-hospital deaths were excluded from the total hospital count as they were included in the death count.

We obtained emergency department visits data from the BC National Ambulatory Care Reporting System (NACRS) at the BC Ministry of Health; data were extracted using the

ICD-10-CA diagnosis codes for poisoning and toxic substances (T36–T65). Emergency department visits by intent were estimated using ratios derived from hospital admission data. The NACRS version used does not include mechanism of injury and not all hospitals report to NACRS. These ratio estimates were based on thousands of injury cases over many years, resulting in a well-established and relatively stable injury pyramid representing average counts and ratios between injuries that were fatal or treated in emergency departments or hospital admissions.[18] We obtained data on calls to the British Columbia Drug and Poison information Centre (BC DPIC) from the centre. Summary tables were provided by the BC Emergency Health Services for the number of cases attended to by ambulance. We obtained population data from BC Stats.

Costs calculation

We organized direct cost components into 5 mutually exclusive patient disposition categories: fatal poisonings, hospital admission for poisoning with survival to discharge, poisonings treated in an emergency department without hospital admission, poisonings and exposure events resulting in ambulance attendance without transfer to hospital and calls to the BC DPIC emergency or information line not resulting in ambulance attendance, emergency care or transfer to hospital. The total direct cost of poisoning was estimated by the sum of the costs in these 5 categories. Direct cost components are listed in Table 1. Costs related to mental health or psychological services, and other direct costs borne by patients, family or other payers were not included.

A formal caregiving (care received for injury in the previous year as provided by paid workers and organizations) cost of 0.02% was applied to the health care or direct costs (deaths, hospital admission, emergency department and long-term disability) for the first year after poisoning incidence. As caregiving information was not available for BC, this proportion was derived from national level data.[19]

We calculated productivity losses using BC unemployment rates, labour force participation rates and average wage rates. Indirect costs were assigned to people aged 15–64 years, as it was assumed that they had all contributed to society. People aged younger than 15 years were not yet part of the workforce and those aged 65 years and older had left the workforce. Indirect costs associated with death and long-term disability for people aged younger than 15 years would only include costs for those aged 15–64 years.

Table 1: Direct and indirect cost components of poisoning in British Columbia by patient disposition

Death	Hospital admission	ED	Ambulance	BC DPIC
Direct cost components				
Ambulance service (attendance and transportation, pharmaceuticals, medical supplies)	Calls to BC DPIC and transferred to hospital	Calls to BC DPIC and seen in ED	Calls to BC DPIC and attended by ambulance	Calls to BC DPIC and not attended by ambulance, seen in ED or transferred to hospital
ED treatment (physician care, pharmaceuticals, medical supplies)	Ambulance service (attendance and transportation, pharmaceuticals, medical supplies)	Ambulance service (attendance and transportation, pharmaceuticals, medical supplies)	Ambulance service (attendance, pharmaceuticals, medical supplies)	
Hospital care (physician care, pharmaceuticals, medical supplies)	ED treatment (physician care, pharmaceuticals, medical supplies)	ED treatment (physician care, pharmaceuticals, medical supplies)		
Coroner service and autopsy	Hospital care (physician care, pharmaceuticals, medical supplies)	Long-term medical care		
Funeral cost	Long-term medical care	Long-term rehabilitation		
	Long-term rehabilitation			
Indirect cost components				
Deaths	Hospital admission			
Future income forgone from potential years of life lost and premature death	Time away from work due to hospital admission Years of disability resulting in forgone income			

Note: BC DPIC = British Columbia Drug and Poison Information Centre, ED = emergency department.

Informal caregiving (care received for injury in the previous year as provided by family, friends and neighbours) costs of 0.47% were applied to the productivity losses or indirect costs. Similar to formal caregiving, this proportion was derived from national level data.[19]

Ethics approval

Approval to conduct this study was provided by the University of British Columbia Children's and Women's Research Ethics Board (H13-01321).

Results

There were 45 191 poisonings in BC in 2016 with 3% resulting in death and 10% resulting in hospital admission (Table 2). The overall incidence and rate of poisoning among males was higher than among females for all patient dispositions except hospital admissions and calls to BC DPIC (Table 2, Table 3). Calls to the BC DPIC were highest on behalf of children younger than 15 years at 56% (Table 2).

In total, we estimate that poisonings cost the province of BC $812 485 347 in 2016 (Table 4). Hospital care expenditures represented the largest direct cost at $67.2 million (8% of total cost), whereas lost productivity after death represented the largest indirect cost at $702 million (86.4% of total).

Direct health care costs totalled $108.9 million with $12.8 million for fatal poisonings, $67.2 million for hospital admissions, $25.8 million for emergency department treatment, $2.1 million for ambulance attendance without transfer and about $1 million for calls to the BC DPIC. Hospital admissions represented 62% of direct costs, 24% of emergency department treatments and 12% of deaths. Although ambulance attended without transfer and calls to BC DPIC accounted for most poisonings, these cases represented only 3% of the direct costs. Indirect costs were $703.6 million, with the costs of deaths at $702.0 million (99.8%).

Unintentional poisoning injuries accounted for 84% of total costs (Table 4). Total direct costs were accounted for primarily by unintentional (46%) and suicide or self-harm poisonings (45%), whereas unintentional poisoning accounted for 89% of indirect costs. Average costs per case by patient disposition are presented in Table 4.

Males accounted for 56% of direct costs and 75% of indirect costs (Table 5), as well as higher proportions of direct costs for deaths, emergency department visits and ambulance attendance, whereas females accounted for a higher proportion of costs for hospital admissions. All direct costs were higher among people aged 25–64 years, with the exception of costs for BC DPIC, which were highest among children younger than 15 years. The per capita costs for both direct and indirect costs were higher among people aged 15–24 years. Males accounted for a higher proportion of indirect costs for deaths (75%), whereas females accounted for a higher proportion of hospital admissions (57%). Patient disposition cost breakdowns by age group and sex are presented in Table 5.

Sensitivities to proportionate changes in total and indirect costs of poisonings were identified when varying the discount rate. Indirect costs increased by 6%, increasing the total costs by 5.2% when the discount rate was reduced to 1% from 1.5% (Table 6). The indirect costs decreased by 15% and 29.8% when the discount rate was increased to 3% and 5%, respectively. High variations are seen when participation rates are increased or decreased (Table 6). Minimal variations are observed with fluctuations in employment rates.

Table 2: Incidence of poisoning and characteristics of patients in British Columbia by patient disposition, 2016

Characteristic	Patient disposition, no. (%)					
	Deaths *n* = 1224 (3%)	Hospital admission* *n* = 4657 (10%)	ED† *n* = 13 764 (30%)	Ambulance‡ *n* = 4135 (9%)	BC DPIC§ *n* = 21 411 (47%)	Total¶ *n* = 45 191 (100%)
Sex						
Male	920 (75)	1921 (41)	9256 (67)	2090 (51)	10 221 (48)	24 408 (54)
Female	304 (25)	2736 (59)	4508 (33)	1136 (27)	10 974 (51)	19 658 (43)
Age group, yr						
< 15	0	237 (5)	581 (4)	94 (2)	11 885 (56)	12 797 (28)
15–24	127 (10)	1074 (23)	2772 (20)	543 (13)	1200 (6)	5716 (13)
25–64	1031 (84)	2765 (59)	8668 (63)	2118 (51)	2642 (12)	17 224 (38)
65–74	47 (4)	317 (7)	941 (7)	264 (6)	484 (2)	2053 (5)
> 75	19 (2)	264 (6)	803 (6)	206 (5)	526 (2)	1818 (4)

Note: BC DPIC = British Columbia Drug and Poison Information Centre, ED = emergency department.
*Excludes in-hospital deaths.
†Excludes patients admitted to the hospital.
‡Patients not transported to the hospital. There were 909 (22%) ambulance patients with missing information on sex and 910 (23%) for age group.
§Patients who had called the BC DPIC and who were not seen by the ambulance or transferred to the hospital. There were 218 (1%) BC DPIC patients with missing information on sex and 4674 (22%) for age group.
¶There were 1125 (3%) of all patients with missing information on sex and 5583 (12%) with missing information on age.

Table 3: Poisoning in British Columbia by patient disposition, age group (years) and sex, 2016 (rate per 100 000 population)

Age group and sex	Patient disposition rate per 100 000 population				
	Deaths	Hospital admission	ED	Ambulance	BC DPIC
Total	25.2	95.8	283.3	85.1	440.6
< 15	0	33.7	82.6	13.4	1690.2
15–24	21.6	182.3	470.3	92.2	203.6
25–64	37.9	101.6	318.5	77.8	94.8
65–74	9.6	64.7	192.2	53.9	111.1
> 75	5.3	74.2	225.5	58.0	148.3
Males	38.2	79.9	384.8	86.9	346.4
< 15	0	16.7	80.3	11.0	1754.2
15–24	28.6	102.7	494.7	93.8	163.1
25–64	58.6	96.6	465.6	108.7	83.0
65–74	13.8	55.3	266.6	70.0	90.5
> 75	7.7	74.0	356.8	86.3	115.5
Females	12.4	111.5	183.7	46.3	339.7
< 15	0	51.6	85.0	15.9	1614.2
15–24	13.9	269.2	443.6	90.5	245.8
25–64	17.7	106.5	175.4	47.8	103.7
65–74	5.6	73.7	121.4	38.5	130.3
> 75	3.5	74.2	122.3	35.7	175.1

Note: BC DPIC = British Columbia Drug and Poison Information Centre, ED = emergency department.

Table 4: Costs of poisoning in British Columbia by patient disposition and intent, 2016

Patient disposition	Intent, cost, $				Total costs, $	Average cost per case, $
	Unintentional	Suicide or self-harm	Violence	Undetermined		
Direct costs*						
Total	**50 602 083**	**49 065 296**	**104 880**	**9 098 550**	**108 870 809**	**2409**
Deaths	10 477 741	1 637 934	0	659 361	12 775 036	10 437
Hospital admission	26 781 476	34 494 494	54 972	5 869 147	67 200 090	14 430
ED	11 594 162	11 817 653	8806	2 383 395	25 804 015	1875
Ambulance	873 134	1 070 241	3751	184 495	2 131 621	516
BC DPIC	875 570	44 973	37 351	2152	960 047	45
Indirect costs*						
Total	**629 238 926**	**66 669 581**	**1711**	**7 704 320**	**703 614 538**	**15 570**
Deaths	628 747 121	65 677 574	0	7 585 509	702 010 205	573 538
Hospital admission	491 805	992 007	1711	118 811	1 604 333	344
Total costs*	**679 841 009**	**115 734 877**	**106 591**	**16 802 870**	**812 485 347**	**17 979**
Deaths	639 224 862	67 315 508	0	8 244 870	714 785 241	583 975
Hospital admission	27 273 281	35 486 501	56 683	5 987 958	68 804 423	14 774
ED	11 594 162	11 817 653	8806	2 383 395	25 804 015	1875
Ambulance	873 134	1 070 241	3751	184 495	2 131 621	516
BC DPIC	875 570	44 973	37 351	2152	960 047	45

Note: BC DPIC = British Columbia Drug and Poison Information Centre, ED = emergency department.
*Bolded values are total values for direct costs, indirect costs and total costs.

Table 5: Costs of poisonings in British Columbia by patient disposition, age group (years) and sex, 2016

Age group (population) and sex	Patient disposition, cost, $					Total direct costs, $	Per capita cost, $
	Deaths	Hospital admission	ED	Ambulance	BC DPIC		
Direct costs*							
Total* (4 859 250)	**12 498 167**	**67 174 801**	**25 801 820**	**2 125 344**	**750 654**	**108 350 785**	**22.30**
< 15 (703 176)	0	2 051 030	784 021	71 172	531 563	3 437 786	4.89
15–24 (589 297)	1 186 425	11 344 913	4 401 531	357 789	54 119	17 344 777	29.43
25–64 (2 721 148)	10 456 162	41 992 987	16 577 542	1 387 134	116 291	70 530 116	25.92
65–74 (489 618)	608 735	5 980 987	2 175 265	172 653	24 651	8 962 292	18.30
> 75 (356 011)	246 845	5 804 884	1 863 461	136 595	24 030	8 075 816	22.68
Male (2 405 364)	**9 303 546**	**31 279 613**	**18 312 276**	**1 371 506**	**375 990**	**60 642 931**	**25.21**
< 15 (360 168)	0	512 236	359 625	31 324	283 281	1 186 467	3.29
15–24 (307 750)	844 537	3 647 082	2 488 168	189 146	22 834	7 191 766	23.37
25–64 (1 342 218)	7 949 242	22 027 025	12 657 557	953 496	51 677	43 638 997	32.51
65–74 (238 563)	361 378	2 900 353	1 582 795	108 847	9912	4 963 285	20.80
> 75 (156 665)	148 389	2 192 917	1 224 131	88 693	8286	3 662 416	23.38
Female (2 453 886)	**3 194 621**	**35 895 187**	**7 489 544**	**753 837**	**374 664**	**47 707 854**	**19.44**
< 15 (343 008)	0	1 538 794	424 396	39 847	248 282	2 251 319	6.56
15–24 (281 547)	341 889	7 697 831	1 913 363	168 643	31 285	10 153 011	36.06
25–64 (1 378 930)	2 506 920	19 965 961	3 919 985	433 638	64 614	26 891 118	19.50
65–74 (251 055)	247 357	3 080 634	592 470	63 806	14 739	3 999 007	15.93
> 75 (199 346)	98 455	3 611 967	639 330	47 903	15 744	4 413 399	22.14
Indirect costs*							
Total (4 859 250)	**702 010 205**	**1 604 333**	**N/A**	**N/A**	**N/A**	**703 614 538**	**144.80**
15–24 (589 297)	143 391 615	341 970				143 733 584	243.91
25–64 (2 721 148)	558 618 590	1 262 364				559 880 954	205.75
Male (2 405 364)	**525 000 709**	**697 236**				**525 697 944**	**218.55**
15–24 (307 750)	98 586 712	100 694				98 687 406	320.67
25–64 (1 342 218)	426 413 997	596 542				427 010 538	318.14
Female (2 453 886)	**177 009 496**	**907 098**				**177 916 594**	**72.50**
15–24 (281 547)	44 804 902	241 276				45 046 178	160.00
25–64 (1 378 930)	132 204 594	665 822				132 870 416	96.36

Note: BC DPIC = British Columbia Drug and Poison Information Centre, ED = emergency department, N/A = not applicable.
*Bolded values are total values for direct costs, indirect costs and total costs.

Interpretation

Our study estimated the total cost of poisoning in BC in 2016 to be $812.5 million with 13% in direct and 87% in indirect costs. We used a conservative approach that represented an underestimate of the true costs of poisoning incidents in BC. The per capita cost for poisoning of $167 exceeded the BC government spending on recreational and sporting services, cultural services and broadcasting and publishing services at $163.[14] We found that unintentional poisonings lead to disproportionately more costs in deaths whereas suicide or self-harm lead to more hospital admission costs. Previously, we found that unintentional and suicide or self-harm poisonings in BC in 2013 accounted for 14% of all injury costs, and that deaths from unintentional and suicide or self-harm poisonings cost $246 million, as compared with those from suicide or self-harm by other means at $150 million, transport incidents at $118 million and falls at $42 million.[20] Since the 2003 report, methods for costing injury and poisoning have evolved. The previous report methods were based on separate manual calculations, which have since been updated and automated into a cost application tool. The 2016 cost calculations in this study are more sophisticated than those of the previous study, and therefore, direct comparisons should be made with caution.

Table 6: Sensitivity analysis, effects of changes in discount rate, unemployment rate and participation rate in economic costs of poisoning (Can$ million), British Columbia, 2016

Key driver	Direct costs	Indirect costs	Total costs
Discount rate			
1%	$108.87	$746.06	$854.93
1.5% (base case)	**$108.87**	**$703.61**	**$812.49**
3%	$108.87	$597.97	$706.84
5%	$108.87	$494.02	$602.89
change (1.5–1.0), %	0	6.0	5.2
change (1.5–3.0), %	0	–15.0	–13.0
change (1.5–5.0), %	0	–29.8	–25.8
Unemployment rate			
4%	$108.87	$718.59	$827.46
6% (base case)	**$108.87**	**$703.61**	**$812.49**
8%	$108.87	$688.64	$797.51
change (6.0–4.0), %	0	2.1	1.8
change (6.0–8.0), %	0	–2.1	–1.8
Participation rate			
54.4%	$108.87	$594.36	$703.23
64.4% (base case)	**$108.87**	**$703.61**	**$812.49**
74.4%	$108.87	$812.87	$921.74
change (64.4–54.4), %	0	–15.5	–13.4
change (64.4–74.4), %	0	15.5	13.4

*Bolded values are the key drivers (base case) that were used to calculate the costs in this study. This table is showing the sensitivity of what the costs would have been using key driver values below or above the base case values.

Not only were costs for hospital admissions (for poisoning) high, but these cases may have also required long-term rehabilitation or mental health and psychological services, further contributing to the overall economic burden. Poisonings can also result in long-term health consequences not captured in the indirect costs, such as myocardial injury from carbon monoxide poisoning[21] or anoxic brain injury due to respiratory depression resulting from opioid overdose, with decreased cognitive ability, depression or suicide ideation.[22–24] The involvement of narcotics and psychodysleptics (e.g., opioids) in poisoning-related emergency department visits increased from 30.4 per 100 000 population in 2012–2013 to 105.6 per 100 000 in 2016–2017. These were the most common substances associated with poisoning-related emergency department visits in 2016–2017.[6] It is important to note that 2016 represented only the beginning of the opioid crisis.[25] With the growing number of opioid overdoses, the Provincial Health Officer declared a public health emergency in April 2016, and the crisis increased in November and December.[26] During the COVID-19 pandemic, characterized by physical distancing, decreased access to services and increased toxicity of drug supply, this crisis continued to grow. In 2020, the number of deaths in BC from illicit drug toxicity was greater than those resulting from transport incidents, suicides and homicides, combined.[27] Paramedic-attended overdoses increased from 13 486 in 2019 to 17 159 in 2020, whereas illicit drug toxicity deaths increased from 985 to 1724;[28] and a record-breaking 2224 deaths were reported for 2021.[29]

Identifying the costs of poisoning will support policies aimed at minimizing injuries, disability, death and losses to society. As the number of poisonings continues to increase, prevention programs, specifically those addressing the complexities of substance and opioid use disorder, are increasingly important. These may extend to access to take-home naloxone kits, supervised consumption sites and overdose prevention services, opioid agonist therapy and prescribed alternatives.[26,30,31] Primary and secondary prevention efforts, such as poison prevention packaging, education programs and social marketing campaigns, have been shown to be effective in preventing poisonings among children and overall.[32–34] In addition, poison information centres are seen to range from 3- to 13-fold return on investment in health resources.[35–37] Our next focus is to assess the national costs of poisonings and determine the effectiveness of services provided by drug and poison information centres in Canada.

Limitations

The most recent BC DPIC and BC Emergency Health Services data were for the year 2016, at the time of analysis in 2020. Due to the lengthy time and delay in data access, as well as the complicated data analysis, costs are calculated for 2016 data (in 2016 Canadian dollar values), which may not be generalizable to 2023. To understand the cost estimates produced in this study in current Canadian dollar values, the Bank of Canada inflation calculator is recommended (https://www.bankofcanada.ca/rates/related/inflation-calculator/). Future studies will involve poisoning costing to include more recent years. Data sources for this study are largely reliant on the expertise of professional data coders, interpreting written descriptive information into ICD-10-CA codes, which may lack detail about the injury event, as such, information pertaining to the circumstances around which the poisoning event occurred were not available and would have been useful in identifying key areas for prevention. Only certain ICD-10 codes have been validated for their accuracy in classifying a poisoning event within the administrative data sets, which may have allowed for some misclassification bias. Validated codes include poisoning from acetaminophen (X40, X60, Y10),[38] suicide or self-harm (X60–X69) and undetermined intent (Y10–Y19).[39] Randall and colleagues[39] found that instances of suicide or self-harm are underestimated in administrative data sets using ICD-10 coding. Injury data are available for deaths, hospital admissions and emergency department visits. Data on injuries treated at a doctor's office or walk-in clinic are not available, and therefore, poisoning incidence is underestimated. A data gap exists for injuries requiring ongoing care outside of the hospital setting, ranging from short periods to long-term disability; as a result, cost estimates are underestimated as they do not take these additional costs into account. Intangible costs, such as

pain and suffering, economic dependence and social isolation are difficult to quantify in economic terms and were excluded from the cost calculations, therefore underestimating the costs for poisoning. Although it is the standard approach not to include indirect costs for people aged 65 years and older, under the assumption that they are retired from working, this is not reflective of older adults in the workforce, which is continuing to grow, and as a result, the indirect costs are underestimated.[40] Finally, the indirect costs are underestimated as future technological innovation and advancement may increase productivity, which are not reflected in the indirect cost calculations.

Conclusion

Hospital care expenditures represented the largest direct cost of poisoning whereas lost productivity after death represented the largest indirect cost. Quantifying and understanding the financial burden of poisoning has implications not only for government and health care expenditures and resources, but also for society, employers, patients and families. Targeted prevention programs can reduce both economic costs and long-term health consequences.

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Affiliations: BC Injury Research and Prevention Unit (Rajabali, Turcotte, Zheng, Pike), BC Children's Hospital; Department of Emergency Medicine (Purssell), University of British Columbia; BC Drug and Poison Information Centre (Purssell, Buxton); School of Population and Public Health (Buxton), University of British Columbia; Department of Pediatrics (Pike), University of British Columbia, Vancouver, BC

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