The Economic Impact of Poisoning in British Columbia: A Societal Perspective

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Competing interests: There are no competing interests to declare.

Funding: This study was not funded.

Data sharing: Requests for aggregate data should be submitted to the corresponding author.

Abstract

Introduction

The purpose of this study was to examine the health and economic costs of poisoning in British Columbia (B.C.) for 2016 using a societal perspective, to support public health policies aimed at minimising 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; hospitalizations; 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 earning and informal caregiving costs, were also calculated.

Results

Poisonings in B.C. totaled $812.5 million in 2016: $108.9 million in direct health care costs and $703.6 million in indirect costs. Unintentional poisonings accounted for 84% of total costs, 7% of direct costs and 93% of indirect costs. Males accounted for higher proportions of direct costs for all patient dispositions except hospitalizations. Costs among ages 25-64 accounted for higher proportions of direct costs except for calls to BC DPIC, where proportions were highest for children <15 years.

Interpretation

Hospital care expenditures represented the largest direct cost of poisoning while 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.

Introduction

Poisoning is the leading cause of injury-related death and the second leading cause for injury-related hospitalization in British Columbia (B.C.).[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 and/or death. Poisoning-related direct costs incurred by the healthcare system in B.C. in 2003 were estimated at $53.5 million per year in 2003 Canadian dollars and indirect costs, the losses to societal productivity, were estimated at $3.6 million.[2] Children, youth, young adults, older adults, and Indigenous peoples in Canada are considered high-risk populations for poisoning.[3] While unintentional poisoning deaths and hospitalizations increased from 2008 to 2018, suicide by poisoning decreased.[3] More specifically, poisonings involving narcotics and psychodysleptics, particularly opioid-related poisoning, resulting in death, hospitalization, and emergency department (ED) visits have continued to increase since the early 2000's.[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 use of child-resistant packaging.[7,8] For all ages, poison control centers are a cost-effective source for immediate advice in the event of a poisoning, as well as providing surveillance data.[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 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. The purpose of this study was to examine the health and economic costs of poisoning in B.C. using a societal perspective, to include costs that have an impact on society as a whole, including individuals, employers, and the government. The study methods utilized a conservative approach and are therefore an underestimate of the true costs of poisoning incidents in B.C.

Methods

We used an incidence costing, human capital approach;[11] the population of those poisoned in 2016 was costed over each lifetime. Recognizing that future costs are usually less than present costs due to scientific and technological advancement, direct and indirect costs were discounted to 1.5% per annum.[12] Dollar values are for the year 2016, the most recent year available for poisoning injuries and deaths data and population statistics. Average costs were applied using constant 2016 Canadian dollars.

Direct costs are costs to the healthcare system, comprised of all the goods and services consumed by a person treated for a poisoning-related injury and include 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. For the purposes of this study, we used average provincial costs of relevant health services to estimate individual victim costs.

Indirect costs are losses to societal productivity, which account for the injured individual's inability to perform their major activities of daily living and contribute to society, and include the value of time lost from work due to morbidity, disability, and premature death, measured using earnings data. 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.[13] 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 and the net effect of the transfer to society is zero.

Costs were mainly calculated using the Electronic Resource Allocation Tool (ERAT),[14] 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 death data 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 hospitalization data from the Discharge Abstract Database (DAD) at the BC Ministry of Health.

Data were extracted using the 10th revision of the (ICD-10 CA) codes; all poisoning ICD-10 CA codes were extracted and grouped by intent: unintentional (X40-X49); suicide/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) utilized. An average weight and length of stay was applied to the total number of hospitalizations. Furthermore, an average provincial inpatient cost of a standard hospital stay excluding physician care expenditures was applied to these averages to obtain dollar values.[15] An average value of physician care was applied using information from the National Physician Database.[16] In-hospital deaths were excluded from the total hospital count as they were included in the death count.

We obtained ED 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). ED visits by intent were estimated using ratios derived from hospitalization data, as in B.C. 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 treated in ED, hospitalized, or are fatal.[17] We obtained data for calls to the British Columbia Drug and Poison information Centre (BC DPIC) from BC DPIC. BC Emergency Health Services (BC EHS) provided summary tables for the number of cases attended by ambulance, and we obtained population data from BC Stats.

Costs Calculation

We organized direct cost components into five mutually exclusive patient disposition categories: i) fatal poisonings; ii) poisoning hospitalizations with survival to discharge; iii) poisonings treated in an ED without hospitalization; iv) poisonings and exposure events resulting in ambulance attendance without transfer to hospital; and v) calls to BC DPIC emergency/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 five categories. Direct cost components are listed in Table 1. Costs related to mental health and/or psychological services, and other direct costs borne by patients, family, or other payers were not included.

We applied a 0.02% of formal caregiving cost, as provided by paid workers and organizations, to the health care costs (deaths, hospitalization, ED, and long-term disability) for the first year following poisoning incidence. As caregiving information was not available for B.C., this cost was derived from national level data.[18]

We calculated productivity losses using B.C. unemployment rates, labour force participation rates, and average wage rates. Indirect costs were assigned to those 15 to 64 years of age, as it was assumed that they had all contributed to society, while those under 15 years were not yet part the workforce, and those 65 years and older had left the workforce.

We applied a 0.47% of informal caregiving costs, as provided by family, friends, and neighbours, to the productivity losses. Similar to formal caregiving, this cost was derived from national level data.[18]

Results

Deaths accounted for a small fraction of the incidence of poisonings in B.C. in 2016, followed by hospitalizations, ambulance attended ED visits, and calls to BC DPIC (Table 2). The overall rate of poisoning among males was higher than among females for all patient disposition except hospitalizations and calls to BC DIPC (Table 3).

In total, poisonings cost the province of B.C. $812,485,347 in 2016 (Table 4). Direct healthcare costs totaled $108.9 million: $12.8 million for fatal poisonings; $67.2 million for hospitalizations; $25.8 million for ED treatment; $2.1 million for ambulance attendance without transfer; and just under $1.0 million for calls to the BC DPIC. Hospitalizations represented 62% of direct costs, ED treatments 24%, and fatalities 12%. While ambulance attended without transfer and calls to BC DPIC accounted for the majority of all poisonings, these cases represented only 3% of the direct costs. Indirect costs were $703.6 million, with the costs of death accounting for 99.8% at $702.0 million.

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

Males accounted for 56% of direct costs and 75% of indirect costs (Table 5). Males accounted for higher proportions of direct costs for deaths, ED visits, and ambulance attendance, while females accounted for a higher proportion of costs for hospitalizations. All direct costs were higher among those aged 25-64 years, with the exception of costs for BC DPIC, which were highest among children <15 years old. The per capita costs for both direct and indirect costs were higher among those aged 15-24 years. Males accounted for a higher proportion of indirect

costs for deaths (75%) while females accounted for a higher proportion for hospitalizations (57%). Patient disposition cost breakdowns by age group and sex are presented in Table 5.

Interpretation

Our study estimated the total cost of poisoning in B.C. in 2016 to be $812.5 million: 13% in direct and 87% in indirect costs. Hospital care expenditures represented the largest direct cost at $67.2 million (8% of total cost), while lost productivity following death represented the largest indirect cost at $702 million (86.4% of total). 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.[13] We found that unintentional poisonings lead to disproportionately more death costs while suicide/self-harm lead to more hospitalization costs. Previously, we found that unintentional and suicide/self-harm poisonings in B.C. in 2013 accounted for 14% of all injury costs, and that deaths from unintentional and suicide/self-harm poisonings cost $246 million, as compared to those from suicide/self-harm by other means at $150 million, transport incidences at $118 million, and falls at $42 million.[19]

Not only were poisoning hospitalizations costs high, but these cases may have also required long-term rehabilitation and/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,[20] or brain injury from anoxia due to respiratory depression resulting from opioid overdose, with decreased cognitive ability, depression, or suicide ideation.[21-23] The involvement of narcotics

and psychodysleptics (e.g., opioids) in poisoning-related ED visits increased from 30.4 per 100,000 population in 2012/13 to 105.6 per 100,000 in 2016/17; the most common substances associated with poisoning-related ED visits in 2016/17.[6] It is important to note that 2016 represented only the beginning of the 'opioid crisis'.[24] With the growing number of opioid overdoses, the Provincial Health Officer declared a public health emergency in April 2016, and the crisis ramped-up in November and December.[25] Furthermore, 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 B.C. due to illicit drug toxicity was greater than those resulting from transport incidences, suicides, and homicides, combined.[26] Paramedic-attended overdoses increased from 13,486 in 2019 to 17,159 in 2020, while illicit drug toxicity deaths increased from 985 to 1,724;[27] and a record-breaking 2,224 deaths were reported for 2021.[28]

Identifying the costs of poisoning will support policies aimed at minimising injuries, disability, death, and losses to society. As the number of poisonings continues to increase, prevention programs, specifically those addressing the complexities of substance/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 to the toxic drug supply.[25,29,30] Primary and secondary prevention efforts, such as poison prevention packaging, education programs, and social marketing campaigns, have shown to be effective in preventing poisonings among children and overall.[31-33] In addition, poison information centres are seen to range from 3- to 13-fold return on investment in health

resources.[34-36] 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

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. Injury data are available for deaths, hospitalizations, and ED visits. Data on injuries treated at a doctor's office or walk-in clinic are not available. A large data gap exists for injuries requiring ongoing care outside of the hospital setting, ranging from short periods to long-term disability. 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. While it is the standard approach not to include indirect costs for those 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.[37]

Conclusion

Hospital care expenditures represented the largest direct cost of poisoning while 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 expenditures and resources, but also for society, employers, patients, and families. Targeted prevention programs can reduce both economic costs and long-term health consequences.

Data-Sharing Statement

Aggregate data tables are available to others. Data can be accessed by contacting the corresponding author.

Word count: 2348

Abbreviations:

B.C.	British Columbia
BCCDC	BC Centre for Disease Control
BC DPIC	British Columbia Drug and Poison Information Centre
BC EHS	BC Emergency Health Services
DAD	Discharge Abstract Database
ED	Emergency Department
ERAT	Electronic Resource Allocation Tool
ICD-10 CA	International Statistical Classification of Diseases and Related Health Problems, Canadian Adaptation
NACRS	National Ambulatory Care Reporting System

Table 1. Direct Cost Components of Poisoning in B.C. by Patient Disposition

Deaths	Hospitalizations	ED	Ambulance	BCDPIC
Ambulance Service (attendance and transportation, pharmaceuticals, medical supplies)	Calls to BCDPIC and transferred to hospital	Calls to BCDPIC and seen in ED	Calls to BCDPIC and attended by ambulance	Calls to BCDPIC 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		

Table 2. Incidence of Poisoning in B.C. by Patient Disposition, 2016

Patient Disposition	N	(%)
Deaths	1,224	(3%)
Hospitalizations	4,657	(10%)
ED	13,764	(30%)
Ambulance	4,135	(9%)
BCDPIC	21,411	(47%)
Total	**45,191**	**(100%)**

Table 3. Poisoning in B.C. by Patient Disposition, Age Group (years) and Sex, 2016 (rate per 100,000 Population)

Age Group & Sex	Patient Disposition Rate per 100,000 Population				
	Deaths	Hospitalizations	ED	Ambulance	BCDPIC
Total	25.2	95.8	283.3	85.1	440.6
<15	0.0	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	0.0	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	0.0	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

Table 4. Costs of Poisoning in B.C. by Patient Disposition and Intent, 2016

Patient Disposition	Intent				Total Costs	Average Cost/Case
	Unintentional	Suicide/ Self-harm	Violence	Undetermined		
DIRECT COSTS						
Total	**$50,602,083**	**$49,065,296**	**$104,880**	**$9,098,550**	**$108,870,809**	**$2,409**
Deaths	$10,477,741	$1,637,934	$0	$659,361	$12,775,036	$10,437
Hospitalizations	$26,781,476	$34,494,494	$54,972	$5,869,147	$67,200,090	$14,430
ED	$11,594,162	$11,817,653	$8,806	$2,383,395	$25,804,015	$1,875
Ambulance	$873,134	$1,070,241	$3,751	$184,495	$2,131,621	$516
BCDPIC	$875,570	$44,973	$37,351	$2,152	$960,047	$45
INDIRECT COSTS						
Total	**$629,238,926**	**$66,669,581**	**$1,711**	**$7,704,320**	**$703,614,538**	**$15,570**
Deaths	$628,747,121	$65,677,574	$0	$7,585,509	$702,010,205	$573,538
Hospitalizations	$491,805	$992,007	$1,711	$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
Hospitalizations	$27,273,281	$35,486,501	$56,683	$5,987,958	$68,804,423	$14,774
ED	$11,594,162	$11,817,653	$8,806	$2,383,395	$25,804,015	$1,875
Ambulance	$873,134	$1,070,241	$3,751	$184,495	$2,131,621	$516
BCDPIC	$875,570	$44,973	$37,351	$2,152	$960,047	$45

Table 5. Costs of Poisonings in B.C. by Patient Disposition, Age Group (years) and Sex, 2016

Age Group (Population) & Sex	Patient Disposition					Total Direct Costs	Per Capita Cost
	Deaths	Hospitalizations	ED	Ambulance	BCDPIC		
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	$9,912	$4,963,285	$20.80
75+ (156,665)	$148,389	$2,192,917	$1,224,131	$88,693	$8,286	$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

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