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The Impact of COVID-19 on Calls made to Canadian Poison Centres Regarding Cleaning Products and Disinfectants: A Population Based Retrospective Interrupted Time-Series Study One Year before and after the WHO's Pandemic Declaration

Abdool S Yasseen[1*], Nina Dobbin[1,2], Deborah Weiss[1], Chunli Gu[1,3], Sara Khan[1,4], Ashley Rowe[1,5], Victoria Wan[2], Bojana Bogeljic[1], Dennis Leong[2], Laurie Mosher[5], Guillaume Belair[6], Brooke Button[3], James Hardy[7], Shahid Perwaiz[8], Alysyn Smith[9], Shawn Lawless[10], Margaret Thompson[4] , Richard Wootton[1]

[1]Environmental Health Science and Research Bureau, Health Canada, Ottawa, Ontario, Canada; [2]British Columbia Centre for Disease Control, Drug and Poison Information Centre, Vancouver, British Columbia, Canada; [3]Poison and Drug Information Service, Calgary, Alberta, Canada; [4]Ontario Poison Centre, Toronto, Ontario, Canada; [5]Izaak Walton Killam Poison Centre, Halifax, Nova Scotia, Canada; [6]Centre Antipoison Du Québec, Québec City, Quebec, Canada; [7]Consumer and Hazardous Products Safety Directorate, Health Canada, Ottawa, Ontario, Canada; [8]Marketed Health Product Directorate, Health Canada, Ottawa, Ontario, Canada; [9]Natural and Non-prescription Health Products Directorate, Health Canada, Ottawa, Ontario, Canada; [10]Health Products Food Branch, Health Canada, Ottawa, Ontario, Canada

ABSTRACT

Objective: To determine the impact of the COVID-19 pandemic on the rates of exposure calls related to cleaning products and disinfectants made to Canadian poison centers, one year into the pandemic.

Methods: Using data obtained from Canadian poison centers between March 2019 and March 2021 regarding hand sanitizers, disinfectants, bleaches, chlorine gas, and chloramine gas, we applied an interrupted time series design to evaluate changes before and after the World Health Organization (WHO) declaration of COVID-19 as a pandemic. Call rates were estimated as the number of cleaning products and disinfectants calls divided by the total number of exposures at monthly time intervals, and changes were assessed at 6 and 12 months after the WHO's declaration. We additionally conducted a stratified analysis by patient age groups (≤ 19 years and >19 years).

Results: A total of 396,041 exposures were reported to the five Canadian poison centers, of which 5,669 (1.4%) were for hand sanitizers, 3375 (0.9%) for disinfectants, 7022 (1.8%) for bleaches, 2205 (0.6%) for chlorine gas, and 369 (0.1%) for chloramine gas exposures. Those most often exposed to hand sanitizers were ≤ 19 years of age, whereas those >19 years of age were more often exposed to bleaches, chlorine and chloramine gas. One year after the WHO declaration, exposures to hand sanitizers, chlorine gas, and chloramine gas have yet to return to pre-pandemic rates, showing an increase of 169% (95% Confidence Intervals (CI): 125, 214), 35% (95% Confidence Intervals (CI): 19, 51), and 108% (95% Confidence Intervals (CI): 26, 191) from pre-pandemic rates, respectively.

Conclusions: After an initial increase in calls related to cleaning products and disinfectants, calls related to the use of some products have returned to pre-pandemic levels, whereas others remain elevated. We identified a correlation between national public health response and reduction in calls made to poison centers, but further work is needed to determine why the numbers have not returned to baseline.

Keywords: Poison centers; Poison control centers; Cleaning products and disinfectants; COVID-19; Hand sanitizers; Disinfectants; Bleaches; Chlorine gas; Chloramine gas

Correspondence to: Abdool S Yasseen, Environmental Health Science and Research Bureau, Health Canada, Ottawa, Ontario, Canada, E-mail: abdool.yasseen@canada.ca

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INTRODUCTION

At the onset of the COVID-19 pandemic in March 2020, many government and public health agencies globally recommended intensified hand hygiene practices and rigorous disinfection and cleaning of surfaces to mitigate the spread of the SARS-CoV-2 virus [1,2]. Subsequently, a number of jurisdictions noted an increase in exposures associated with household cleaners, disinfectants, and hand sanitizers, partly due to the diligent monitoring of secondarily collected data from poison centers and other health administrative data sources [3]. Cases exposed to cleaners and disinfectants typically report mild or no symptoms and the majority of cases resolve without seeking additional medical attention. The exception is exposures in children, where symptoms can be more severe and treatment is often required [4-7]. Reasons for the observed increase are likely multifaceted, but have been attributed to increased product availability in the home [8,9] retail shortages leading to off-label use of chemical products, and the improper packaging of products with non-standard containers (e.g., food and beverage containers) [10,11]. The increased presence of children at home due to daycare and school closures may have also contributed to increased exposures among this age group [9,12]. In Canada, soon after WHO declared COVID-19 a global pandemic, public health messaging was released in an attempt to improve awareness of the safe use of household cleaners and disinfectants [13]. In addition, regulatory action was taken to remove dangerous or unregulated hand sanitizer products from the market [14]. To date, the long-term impact of the COVID-19 pandemic on consumer use of cleaning products and disinfectants and the effects of potential interventions to mitigate the risk of exposures is unclear. In this report, we compare exposure rates at Canadian poison centers before and after March 2020 to examine the impact of COVID-19 as a global pandemic and evaluate these changes up to one year post-declaration.

MATERIALS AND METHODS

Across Canada, a total of five poison centers provide treatment advice and guidance solicited from the general public and medical professionals through a telephone consultation service. Data collected from incoming calls are recorded in case management systems for treatment follow-up and administrative purposes by clinically trained Specialists in Poison Information (SPIs). Agreements between Health Canada and each of the five Canadian poison centers facilitated access to these data through the Canadian Surveillance System for Poison Information (CSSPI) program, for the purpose of surveillance and monitoring. Through CSSPI, we obtained de-identified case records from each of the five Canadian poison centres between March 2019 and March 2021. When SPIs capture call information in the poison centre's case management system, toxic exposures are categorized using the American Association of Poison Control Centres (AAPCC©) generic codes [15]. Using the appropriate AAPCC codes, exposures were then categorized as hand sanitizers, disinfectants, bleaches, chlorine gas, and chloramine gas (Supplementary Table S1). For the remainder of this paper, we use cases (i.e., individuals) and calls interchangeably, however one case could have multiple exposures (i.e., substances), and in circumstances where exposure to multiple cleaning products correspond to a single case, it is counted once.

We used a piecewise linear regression to apply an interrupted time series design [16] and evaluate call rates before and after the WHO declared COVID-19 a global pandemic (i.e., the primary intervention point across the study period, which occurred on March 11, 2020). Call rates were estimated as the number of cleaning products and disinfectants cases per 1,000 exposures and reported monthly. We used the absolute differences in the number of calls and percentage change to quantify the impact of COVID-19 at six and twelve months after March 2020 and reported the estimated 95% Confidence Intervals (CI) based on the line of best fit. As a secondary analysis, we stratified the primary analysis by patient age (≤ 19 and >19 years of age) and explored the use of a second intervention point on November 2020 for hand sanitizer exposures. This second intervention point was chosen a priori, through consultation with Health Canada's program representatives. The specific month of November 2020 was identified as the time point where the majority of Health Canada's public health response to chemical exposures (i.e., regulatory actions and public health messaging) was in full effect [17]. We contacted the Health Canada Research Ethics Board (REB) to discuss the CSSPI initiative, and determined that a REB review was not required for this study, given the mandatory suppression of small cell sizes and national aggregation, which collectively ensures a minimal risk of re-identification.

RESULTS

Across the two year study period, a total of 396,041 exposures were reported to the five Canadian poison centers with 5,669 (1.4%) related to hand sanitizer exposures, 3,375 (0.9%) related to disinfectant exposures, 7,022 (1.8%) related to bleach exposures, 2,205 (0.6%) related to chlorine gas exposures, and 369 (0.1%) related to chloramine gas exposures. The overall percentage point difference between the periods before and after March 2020 were 1.44, 0.42, 0.44, 0.14, and 0.09 for each of these substances, respectively. One year after the WHO declared COVID-19 a pandemic, rates of exposures for hand sanitizers and chloramine gas have not yet returned to pre-pandemic levels, whereas disinfectants, bleaches, and chlorine gas have decreased to baseline levels after an initial increase (Figure 1). In total, hand sanitizers, disinfectants, bleaches, chlorine gas, and chloramine gas accounted for 2,526 (95% Confidence Interval (CI): 2,022, 3,025), 1,024 (95% (CI): 636, 1,416), 1,372 (95% (CI): 821, 1,925), 423 (95% (CI): 114, 729), and 153 (95% (CI): 23, 285) excess calls made to Canadian poison centres compared to expected pre-pandemic rates, respectively (Table 1). Those most often exposed to hand sanitizers were ≤ 19 years of age whereas those >19 years of age were more often exposed to bleaches, chlorine and chloramine gas (Figure 2). A decreasing trend (-2.2 (95% Confidence Interval (CI): -3.4, -1.1) in the rate of hand sanitizer calls per 1000 exposures was observed when a second intervention was added at the November 2020 time point (Figure 3).

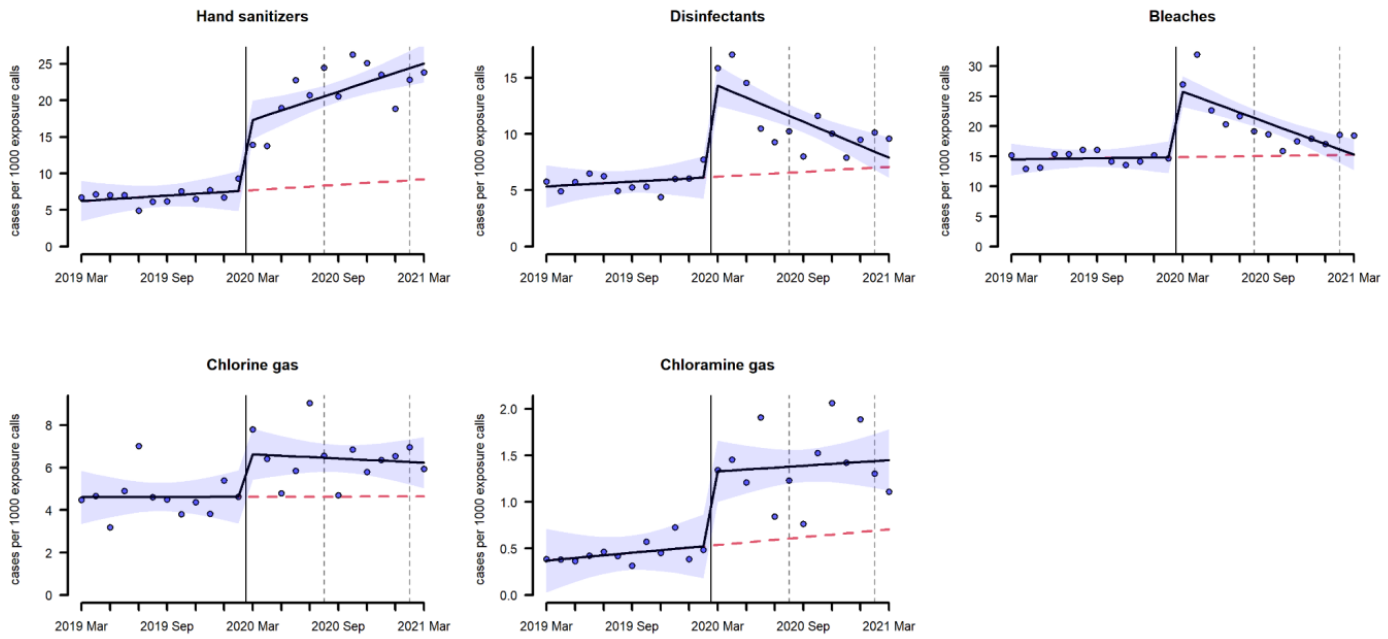

Figure 1: Interrupted time series models of the effect of COVID-19 on the rate of calls made to Canadian poison centres regarding select cleaning products and disinfectants. The solid black vertical line in each plot represents the date the WHO declared COVID-19 a global pandemic, and the subsequent vertical dotted lines represent time points six and twelve months after the WHO's declaration. The solid black line fitted to the data points represents the interrupted time series model, the dashed red line represents the counterfactual line of best fit extrapolated from pre-pandemic data points, and shaded area around fitted line represents the 95% confidence limits.

Table 1: Effect measures from the interrupted time series models by age groups.

Cleaning products and disinfectants	Age groups	Effect measures	Point estimate at September 2020 (i.e., 6 months after the intervention) (95% CI)	Point estimate at March 2021 (i.e., 12 months after the intervention) (95% CI)	Cumulative excess calls between calls between March 2020 and March 2021 (95% CI)
Hand sanitizers	All ages*	Extra calls**	208 (166, 249)	238 (194, 281)	2526 (2022, 3025)
		Percentage change	147 (101, 193)	169 (125, 214)	
	≤ 19 years	Extra calls**	138 (105, 171)	167 (132, 202)	1686 (1285, 2087)
		Percentage change	158 (78, 238)	199 (105, 294)	
	>19 years	Extra calls**	72 (47, 97)	71 (45, 98)	866 (562, 1166)
		Percentage change	137 (65, 209)	126 (78, 174)	
Disinfectants	All ages*	Extra calls**	91 (58, 124)	27 (-2, 57)	1024 (636, 1416)
		Percentage change	77 (54, 100)	20 (6, 35)	
	≤ 19 years	Extra calls**	35 (13, 58)	17 (-4, 38)	402 (136, 676)
		Percentage change	56 (43, 69)	26 (16, 36)	
	>19 years	Extra calls**	52 (28, 75)	6 (-15, 26)	574 (296, 854)
		Percentage change	95 (52, 139)	6 (-14, 26)	

Bleaches	All ages*	Extra calls**	122 (76, 169)	27 (-15, 68)	1372 (821, 1925)
		Percentage change	42 (35, 49)	6 (0, 12)	
	≤ 19 years	Extra calls**	41 (17, 64)	26 (6, 47)	475 (195, 756)
		Percentage change	59 (49, 68)	42 (31, 53)	
	>19 years	Extra calls**	77 (38, 117)	-5 (-40, 31)	845 (378, 1313)
		Percentage change	38 (29, 46)	-7 (-13, -1)	
Chlorine gas	All ages*	Extra calls**	36 (10, 61)	29 (4, 53)	423 (114, 729)
		Percentage change	40 (23, 56)	35 (19, 51)	
	≤ 19 years	Extra calls**	4 (-4, 11)	5 (-2, 12)	48 (-42, 137)
		Percentage change	61 (-103, 226)	96 (-164, 356)	
	>19 years	Extra calls**	31 (6, 55)	21 (-3, 44)	358 (62, 650)
		Percentage change	37 (25, 49)	25 (14, 36)	
Chloramine gas	All ages*	Extra calls**	13 (2, 24)	11 (0, 22)	153 (23, 285)
		Percentage change	127 (7, 247)	108 (26, 191)	
	≤ 19 years	Extra calls**	2 (-2, 5)	1 (-2, 4)	18 (-24, 55)
		Percentage change	225 (-3167, 3616)	197 (-3683, 4077)	
	>19 years	Extra calls**	11 (1, 22)	11 (0, 21)	137 (12, 260)
		Percentage change	126 (43, 210)	109 (52, 166)	

Note: *Includes records with and without missing information on age. **The number of excess calls above what was expected from baseline levels one year prior.

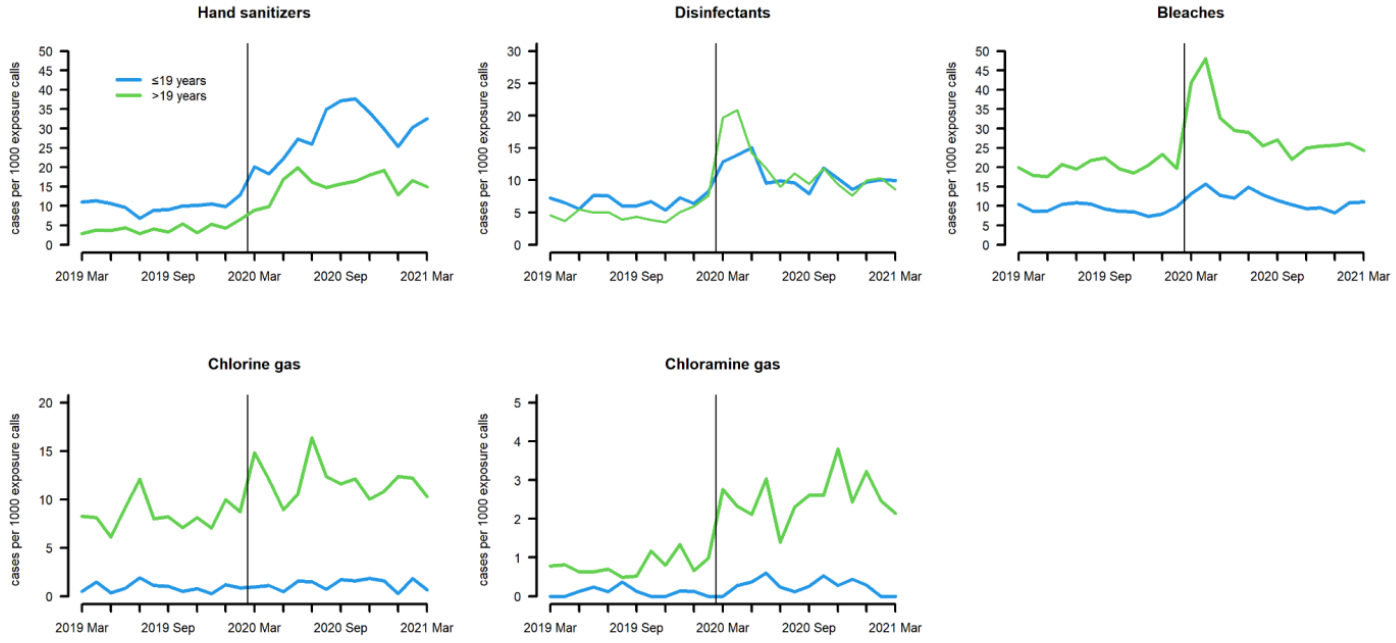

Figure 2: Line plots of the changing rates of calls regarding cleaning products and disinfectants exposures across the study period, stratified by age groups.

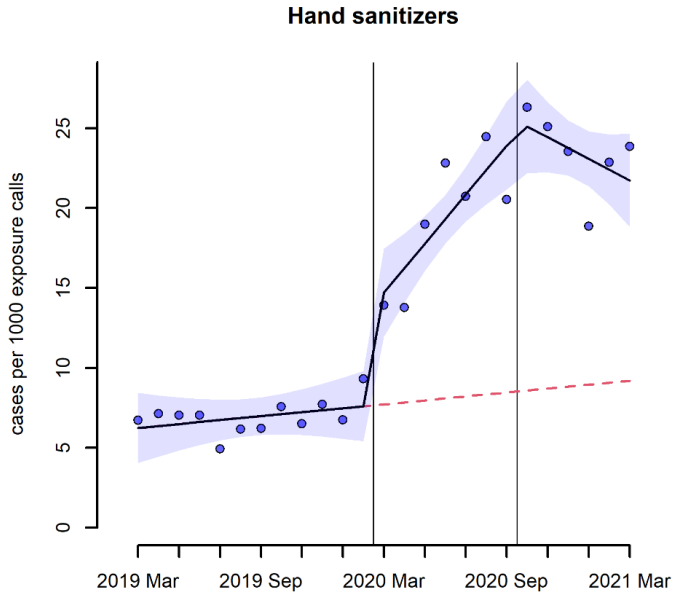

Figure 3: A multiple intervention interrupted time series analysis of the rate of poison centre calls related to hand sanitizers and the health promotion interventions introduced by regulatory agencies. The first vertical line (i.e., March 2020) represents the date the WHO declared COVID-19 a global pandemic, and the second vertical line (i.e., November 2020) represents the date when public advisories and notifications were in full effect.

DISCUSSION

After an initial increase in calls received by Canadian poison centers related to disinfectants and bleaches, we show that calls related to these substances receded to baseline levels approximately one year after the WHO declared COVID-19 a pandemic. These results are encouraging and may represent a normalization of the use of these products, leading to safer use and storage practices. Our results also indicate an ongoing opportunity for improvement as exposures to chlorine gas, chloramine gas, and hand sanitizer remain elevated compared to pre-pandemic baseline levels. Exposure to hand sanitizers shows some indications of trending downwards, but this assertion needs to be interpreted with caution and further monitoring is still required.

Early in the pandemic (i.e., the first quarter of 2020), Chang, et al. [7], examined data from the National Poison Data System in the U.S. and showed an overall increase of 20.4 and 16.4 percentage points in calls concerning cleaners and disinfectants, respectively [7]. These percentage changes are lower than our observations at six months after the WHO declaration (i.e., September 2020), inferring that consumer behaviour regarding these products was still on the rise at the time of their report. This difference could also be an artifact of their observation period, which included months prior to the WHO declaration, since we noted that January and February 2020 were relatively consistent compared to the previous year. Data from Chary, et al. [3], and Rosenman, et al. [18], in Boston and Michigan, respectively, for approximately the same time period (i.e., within the first half of 2020) showed that there were substantial regional differences, whereas our records from the five Canadian poison centers were relatively homogenous (Supplementary Figure S1). Other international studies in Italy, France, and Croatia that examined calls related to household cleaning products and hand sanitizer exposures early on in the pandemic and showed similar results to our observations, [5,6,19,20] indicating that calls to US poison centers regarding these substances was less frequent, compared to other countries. However, there were fundamental differences in the case definitions defining cleaning products and disinfectants and other demographic variabilities across these studies, making comparison difficult.

One year after COVID-19 was declared a global pandemic, consumer demand for hand sanitizers in Canada is still 3.0 to 4.5 times greater than pre-pandemic levels [11], which correlates well with the observed increase in calls made to Canadian poison centers. We speculate that a combination of the increased frequency of interaction with cleaning products and disinfectants, unconventional or non-compliant product packaging, and lack of consumer awareness of safe handling practices may have contributed to the observed increase in calls. While we show that calls regarding hand sanitizers have yet to subside to pre-pandemic levels in our primary analysis, once a second intervention point was added at November 2020, we showed a statistically significant downward trend (β=-2.21; $p<0.001$). From the onset of the pandemic and in the months leading up to November 2020, Health Canada conducted various activities specifically related to hand sanitizers. These included ongoing industry/public consultation, stop-sales/recalls, publication of a policy outlining additional package/labeling requirements, and warning consumers of the potential risks of unintentional ingestion [11,14]. The Government of Canada, through various modalities (e.g., TV, web, and print advertisement) also provided awareness of this issue to the general public.

Calls regarding exposures to chlorine and chloramine gases do not appear to have returned to pre-pandemic levels, and were predominantly reported among adults, i.e., those more likely to be responsible for cleaning in the household. Given that these gases are generated through the inappropriate mixing of bleach with acid or ammonia containing products [21], including drain cleaners, glass cleaners, or other miscellaneous swimming pool treatments, it is unexpected that these exposures remain elevated while exposures to bleach have returned to its baseline. Perhaps consumer behaviour,

e.g., heightened attention to cleaning of household surfaces with bleaches, may have decreased when it was understood publically that the SARS-CoV-2 virus is not transmitted *via* fomites [22]. Greater time spent at home might lead to increased cleaning of swimming pools and other areas within the household, where there is a higher chance of producing these noxious gases. It is possible that consumers may have a propensity to use bleach products and are more confident in mixing these substances, but it is difficult to speculate as to the reason(s) why without knowing the specific nature of these exposures. Continued targeted public health messaging [23], as was implemented for hand sanitizers, might help reduce the inappropriate mixing of cleaners, and additional public health messaging to increase awareness of safe handling of bleach products may be warranted.

LIMITATIONS

Our findings should be tempered and interpreted in the context of a number of limitations and caveats that we would like to highlight. Firstly, the information aggregated for our study constitutes data collected by clinically trained SPIs at each of the five Canadian poison centers. These individuals strive to ensure the validity and completeness of the compiled data; however, we are unable to guarantee the accuracy of the information provided by the caller. Health Canada's agreements with the five Canadian poison centers only permit the public release of national aggregate data and we were unable to report on potential regional differences across these centres. However, we conducted local analyses (data not shown), which demonstrate that the national aggregate findings are relatively robust across the five Canadian poison centers. In addition, as there was limited data collected on the severity of these exposures and we are unable to fully report on the subsequent clinical outcomes of the cases. Overall, cases were generally minor or considered not of clinical significance sufficient to warrant medical follow-up (data not shown). Secondly, exposures reported to poison centers are known to underestimate true incidences occurring in the target population, as reports of exposures to poison centers are not mandated and represent voluntary calls for assistance or advice. Thus the numbers of cases in our analyses are likely underestimates of the extent of the problem. The value of poison center data is in documenting some exposures that would otherwise not have come to the attention of health care facilities and regulators as callers often do not seek higher levels of care. To minimize this potential bias we opted to report on call rates and compute percentage change from the previous year's baseline, as these estimates normalize for the number of cases seen at the poison centre level. Thirdly, regression models used in our analysis assume a linear response between the rate of exposures and time that might not accurately represent possible non-linear relationships. To provide a nuanced description of potential non-linear trends, we provide a smoothed cubic spline plot (Supplementary Figure S2), which does not assume linearity and may more accurately represent trends in exposures. Lastly, we identified one potential concomitant intervention with regards to hand sanitizers occurring on November 2020, but cannot guarantee the absence of others across the study period. There were numerous interventions and messaging on the safe use of cleaning products and disinfectants provided by federal, provincial, territorial, and international public health institutions at differing time points across our study. It is possible that these potential modalities might have influenced consumer behaviours at the time, independent of our examined interventions. While interrupted time series is a common study design for evaluating the impact of interventions, it only represents correlations and associations, and causality should not be inferred.

CONCLUSION

We show that after an initial increase, the rate of calls to Canadian poison centers relating to cleaning products and disinfectant exposures returned to their pre-pandemic baseline levels roughly one year after the WHO declared COVID-19 a pandemic. We highlight correlations that suggest the potential effectiveness of public health regulatory actions and show that based on current trends, calls related to hand sanitizer exposures may be expected to return to baseline levels within 2021. Chloramine gas related calls remain elevated and further work is required to monitor future changes and understand why rates have not subsided to pre-pandemic levels. Information collected from poison centers has facilitated the timely assessment, evaluation, and response to the COVID-19 pandemic and is poised to be an important avenue for future public health surveillance.

AUTHORS CONTRIBUTION

ASY conceived, designed, and conducted the analysis. ND, DW, CG, SK, and AR collected/compiled the data and provided critical review of the initial study design and reporting modalities. B Bogeljic, and RW provided logistical support and specialist review from an emergency management perspective, JH, SP, AS, and SL provided expert opinion from a regulatory and public health perspective, and VW, DL, LM, GB, B Button, and MT provided critical review of the study design from a clinical/poison center perspective. Some of this work is from regular surveillance activities conducted by the Surveillance and Coordination Unit of the Chemical Emergency Management and Toxic vigilance Division of Health Canada. A first draft of the manuscript was developed by ASY which was critically reviewed by all listed co-authors.

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