Epidemiologic trends in substance and opioid misuse-related emergency department visits in Alberta: a cross-sectional time-series analysis

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Abstract

Objectives Substance and opioid misuse are growing public health concerns. This study's objectives were to evaluate trends in substance and opioid misuse-related emergency department (ED) visits in Alberta, Canada.

Methods This is a cross-sectional time-series analysis utilizing National Ambulatory Care Reporting System ED data from Alberta, Canada. All substance and opioid misuse-related visits made by adults (≥ 18 years) from 2010/11 to 2014/15 were analyzed. Acuity was measured by the Canadian Triage and Acuity Scale (CTAS). Relevant visits were identified by ICD-10 diagnostic coding. Substance and opioid visits over 60 months were compared to all ED visits per 100,000 adult population using regression analysis, while controlling for temporal and seasonal variation. Trends among age and sex subgroups were also evaluated.

Results From 2010/11 to 2014/15, substance and opioid misuse-related visits increased by 38.0% and 57.3% to 1119 and 118 visits per 100,000 population, respectively. Annual growth rates for substance and opioid visits were 4.4% higher (95% CI: 2.2, 6.7) and 10.6% higher (95% CI: 6.8, 14.6) than all ED visits. The 18–29 year-old category experienced the highest annual growth rate of all age groups, and the annual opioid visit growth rate was 5.6% higher among males than females. Compared to all visits, substance misuse-related visits arrived more frequently by ambulance, were higher acuity, and were hospitalized more often.

Conclusion Substance and opioid misuse-related ED visits increased significantly from 2010 to 2015, especially among younger patients. Future research should elaborate causes and evaluate interventions to curb the growth of this issue.

Résumé

Objectifs Le mésusage des substances et des opioïdes est un problème de santé publique croissant. Nous avons voulu évaluer les tendances des visites aux services d'urgence (SU) liées au mésusage des substances et des opioïdes en Alberta, au Canada.

Méthode Nous avons procédé par analyse transversale des séries chronologiques en utilisant les données des SU du Système national d'information sur les soins ambulatoires de l'Alberta, au Canada. Nous avons analysé toutes les visites d'adultes (≥ 18 ans) aux SU liées au mésusage de substances et d'opioïdes entre 2010–2011 et 2014–2015. Nous avons mesuré la gravité des cas selon l'Échelle de triage et de gravité (ÉTG). Les visites pertinentes ont été recensées à l'aide des codes de diagnostic de la CIM-10. Par analyse de régression, nous avons comparé les visites liées aux substances et aux opioïdes sur cette période de 60 mois à l'ensemble des visites aux SU pour 100,000 adultes, après avoir apporté des ajustements pour tenir compte des effets des écarts temporels et saisonniers. Nous avons aussi évalué les tendances dans les sous-groupes d'âge et de sexe.

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Résultats De 2010–2011 à 2014–2015, les visites liées au mésusage des substances et des opioïdes ont augmenté de 38% et de 57,3%, soit à 1119 et à 118 visites pour 100,000 adultes, respectivement. Les taux de croissance annuels des visites liées aux substances et aux opioïdes ont été supérieurs de 4,4% (IC de 95% : 2,2, 6,7) et supérieurs de 10,6% (IC de 95% : 6,8, 14,6) au taux de croissance annuel de l'ensemble des visites aux SU. Le groupe d'âge où le taux de croissance annuel a été le plus élevé est celui des 18–29 ans, et le taux de croissance annuel des visites liées aux opioïdes a été 5,6% plus élevé chez les hommes que chez les femmes. Par rapport à l'ensemble des visites, les personnes ayant visité les SU pour des raisons de mésusage de substances sont plus souvent arrivées par ambulance, ont reçu des diagnostics plus graves et ont été plus souvent hospitalisées.

Conclusion Les visites aux SU liées au mésusage de substances et d'opioïdes ont considérablement augmenté entre 2010 et 2015, surtout chez les jeunes patients. Les futures études devraient préciser les causes du problème et évaluer les interventions pour en freiner la croissance.

Keywords Substance-related disorders · Opioid-related disorders · Drug misuse · Public health · Epidemiology

Mots-clés Troubles liés à une substance · Troubles liés aux opiacés · Dose excessive · Santé publique · Épidémiologie

Introduction

Substance misuse is an important presenting concern in North American Emergency Departments (EDs), with mounting evidence of its growing public health impact. The 2012 Canadian Community Health Survey found that 21.6% of the Canadians met criteria for a substance use disorder during their lifetime (Pearson et al. 2013). In 2011, substance use disorders accounted for 2.1% of the hospitalizations and \$267 million in Canadian healthcare costs (Young and Jessemann 2014). In Alberta, substance misuse-related ED visits increased by 6% per quarter from 2014 to 2016 (Alberta Health 2017a), and in Ontario, ED visits related to narcotic-related diagnoses increased by 250% from 2005/06 to 2010/11 (Expert Working Group on Narcotic Addiction 2012). In the United States, visits due to illicit drug use increased by 25% from 2009 to 2011 (US Centers for Disease Control and Prevention 2011), and overdose has become the leading cause of injury-related mortality among young adults (Clark et al. 2014; Walley et al. 2013).

Opioid misuse as a subset of substance misuse has been described as a major public health crisis in North America. Globally, Canada ranks second in per capita narcotics consumption (International Narcotics Control Board 2016); approximately 2000 Canadians died from opioid toxicity in 2015 (Canadian Centre on Substance Abuse 2016). In British Columbia, 1100 people died from suspected drug overdose in the first 9 months of 2017, and fentanyl was implicated in 83% of these deaths (Fletcher 2017). In 2016 in Alberta, fentanyl-related overdose deaths increased from 70 to 119 from the first to fourth quarter and 196 deaths were attributable to non-fentanyl opioids (Alberta Health 2017a). Furthermore, recent Canadian data showed that ED visits due to opioid poisoning rose by 53% from 2010 to 2015, accounting for an average of three ED visits

per day in 2014/15 (Canadian Centre on Substance Abuse 2016). Similarly, from 1993 to 2010 in the US, ED visits for opioid overdose increased by 307% (Hasegawa et al. 2014a); 15% of the overdose visits were made by repeat presenters (Hasegawa et al. 2014b).

Despite the rapid growth of these issues, standardized surveillance in Canada is lacking (Fischer et al. 2016, 2014). Since most substance misuse-related toxicity and adverse events present to the healthcare system via emergency medical services (EMS) and/or the ED, an analysis of system-wide ED visit data may provide an important perspective of this public health issue. The objective of this time-series study is to evaluate trends in substance and opioid misuse-related ED visits in Alberta from 2010 to 2015 using administrative ED visit data obtained from the National Ambulatory Care Reporting System (NACRS). Complete ED visit data is not available from all Canadian provinces and territories, as reporting to NACRS is only fully mandatory in three Canadian jurisdictions (Alberta, Ontario, and the Yukon) (Canadian Institute for Health Information 2017). During the years of interest in this study, the NACRS database is largely represented by data submissions from Alberta and Ontario, with Alberta data consistently representing more than 40% of the available NACRS data (Canadian Institute for Health Information 2015). Therefore, an examination of substance misuse ED visit data in Alberta provides important information not only about the provincial context of this public health concern, but additionally, given the current lack of complete national ED data, provides a crucial picture of trends that may be representative of trends at a national level. We hypothesized that both substance and opioid misuse-related ED visits increased significantly in Alberta over the 5-year period.

Methods

Design, setting, and population

This is a time-series analysis utilizing system-level administrative ED visit data. The study setting is the Western Canadian province of Alberta, with a population of approximately 4.3 million served by over 100 EDs (13 urban and 5 regional and more than 80 small hospitals). Alberta maintains a publicly funded healthcare system that guarantees universal access to medically necessary hospital and physician services. No direct patient payment is required, and health access is transferrable among provinces. One unique provincial healthcare feature is a restricted triplicate prescription program for controlled substances monitored by the Royal Canadian Mounted Police and the regulatory body for physicians (College of Physicians and Surgeons of Alberta).

All visits made by adult patients (≥ 18 years old) to any of more than 100 Albertan EDs for a substance misuse-related presentation between 2010/11 and 2014/15 were analyzed, and the patients who made these visits were also examined. The adult age cutoff was chosen, because adolescents and children presenting with substance misuse were postulated to represent a distinct patient subset. Total Albertan ED visits made by adult patients (≥ 18 years old) were also analyzed during the same timeframe.

Data sources

The database for this study was obtained from the Alberta Health Services Data Integration Management and Reporting service (Alberta Health Services 2017). The study received ethics approval from the University of Alberta Human Research Ethics Board (PRO00058053_AME3). Visits and patients of interest were identified from the NACRS administrative ED visit database, which records all ED visits made in Alberta. All data were de-identified prior to being obtained and analyzed by study investigators. Scrambled patient identifiers were maintained and attached to each visit, enabling patient-level analysis. Visit acuity indicates the severity of a patient's illness or the urgency with which they require medical attention when presenting to the ED. Visit acuity was measured using the Canadian Triage and Acuity Scale (CTAS), a five-level triage tool allowing EDs to prioritize care requirements by categorizing patients by the nature and severity of their presenting symptoms and signs (Canadian Association of Emergency Physicians 2017). Rural status was determined by the presence of zero in the second position of the postal code, in accordance with a standardized algorithm (Statistics Canada 2015).

The NACRS database contains basic ED visit information (i.e., visit date, visit time, arrival mode, CTAS level), patient demographic information (i.e., personal health number, age, sex, postal code), in-ED care (i.e., provider details, procedures [10 fields]), and outcome (International Classification of Diseases and Related Health Problems [ICD]-10 diagnostic codes [10 fields], disposition date, time, and destination).

Substance misuse definition

Visits were classified as being related to substance misuse if the primary and/or secondary visit diagnoses were among an *a priori* determined group of ICD-10 diagnostic codes, consistent with previous work that has used ICD coding to identify aspects of substance misuse (Hasegawa et al. 2014a, b). The primary definition of substance misuse consisted of ICD-10 codes within the category “Mental and behavioural disorders due to psychoactive substance use” (F10-F19). This definition has been previously utilized by the Ministry of Health and Long-Term Care in Ontario (Repeat emergency visits for substance abuse 2015). Two additional sensitivity analyses of substance misuse definitions were conducted. First, selected codes within the category “Poisoning by drugs, medications and biological substances” (T36-T50) were additionally included. Second, F10-F19 codes were utilized except for codes pertaining to tobacco use (F17).

A subgroup analysis of opioid misuse-related visits was conducted by isolating ICD-10 diagnostic codes related to opioid use disorders. The primary definition consisted of ICD-10 codes within the category “Mental and behavioural disorders due to use of opioids” (F11) or relevant codes within the category “Poisoning by narcotics and psychodysleptics” (T40). A second definition including only the F11 codes was tested in a sensitivity analysis. The primary definition is consistent with the Alberta Health Services' quarterly report on opioid dependence, which defines narcotic misuse based on F11 and T40 ICD-10 diagnostic codes (Alberta Health 2017b).

Statistical analysis

Substance misuse-related visits were isolated for each fiscal year (April 1 to March 31) from 2010 to 2015. Overall numbers of ED visits were examined annually for trends. Annual substance misuse-related visits were compared as visits per 100,000 adult population in Alberta (≥ 18 years) to standardize for population growth. Adjusted Government of Alberta population estimates were obtained (Government of Alberta 2017). Additionally, annual substance misuse-related visits were reported as percentages of total annual ED visits.

Numbers of unique patients and visits per patient for substance misuse were also analyzed. Visit and patient trends were also reported by rural and non-rural status.

A cross-sectional time-series design was employed to evaluate temporal trends in ED visits for substance and opioid misuse compared to all ED visits. Visits were aggregated by month over the 60-month study timeframe and converted to rates per 100,000 Alberta residents ≥ 18 years of age. Annual populations were interpolated between years using a cubic smoothing spline to obtain monthly population estimates. Visit rates were log-transformed and analyzed using linear regression models. The primary regression models included terms for visit type (either substance or opioid misuse versus all ED visits), annual trend, season (winter, spring, summer and fall), lag 1 autocorrelation (log-transformed rate 1 month prior), and lag 12 autocorrelation (log-transformed rate 12 months prior). The models also included interactions with visit type and all other covariates to allow comparison of temporal and seasonal trends by visit type. Since only two time-series were included in these models (substance or opioid misuse and all ED visits), we opted for fixed effects, rather than random effects. Diagnostic plots of the residuals did not indicate any signs of autocorrelation. Secondary regression models were fit to evaluate whether ED visit trends for substance and opioid misuse differed among age and sex subgroups. Separate models were fit for each visit type. As before, the models included covariates for annual trend, season, lag 1 autocorrelation, and lag 12 autocorrelation. These models also included sex and age group (18–29, 30–39, 40–49, 50–59, and ≥ 60 years), with the 40- to 49-year-old age group chosen as the reference category. Interaction terms for each temporal and seasonal covariate with age group and sex were included to allow comparison of trends by the demographic subgroup.

Selected visit characteristics (e.g., arrival by ambulance, CTAS score, rural visits, and hospitalizations) were reported as proportions of total visits. Visit length of stay and patient age were presented as means and patient sex distribution was presented as a proportion. Visit and patient characteristics for substance-misuse-related and opioid misuse-related visits were reported for the baseline year (2010/11) and final year (2014/15) of the study to assess whether population-level changes occurred over time. Pairwise tests for significant differences between visit and patient characteristics for substance misuse-related versus all ED visits in Alberta and for opioid misuse-related versus all ED visits in Alberta were conducted. Differences in means were evaluated for continuous variables and differences in proportions were evaluated for categorical variables. Normal distributions were utilized given the large numbers of visits and patients in this study. A threshold of $p < 0.05$ was considered statistically significant. All statistical analyses were performed using R 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria) and SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

Epidemiological trends in substance misuse-related visits

Over the study period, 149,719 substance misuse-related visits were made by 65,089 unique patients. In comparison, 7,774,424 total ED visits were made by 1,923,702 unique patients in Alberta. Annual numbers of visits and unique patients related to substance and opioid misuse are displayed in Table 1. From 2010/11 to 2014/15, an increasing trend was observed in substance and opioid misuse-related visits when measured absolutely, standardized by 100,000 population in Alberta, and as a percentage of total ED visits. An increase was also seen in the number of unique patients making substance and opioid misuse-related visits. These changes remained consistent for sensitivity analyses based on different substance and opioid misuse definitions (Supplementary Table 1). Compared to a 2010/11 baseline of 811 visits per 100,000 population, substance misuse-related ED visits in Alberta increased by 38.0% to 1119 per 100,000 population by 2014/15. For opioid misuse-related ED visits in Alberta, there was a 57.3% increase from the 2010/11 baseline of 75 per 100,000 population to 118 per 100,000 population by 2014/15. Interaction effects for annual trends represent the percentage point difference in annual growth rates of substance and opioid misuse visits compared to all ED visits. In the cross-sectional time-series regression analysis controlling for seasonal and temporal trends, the annual growth in the substance misuse-related visit rate was 4.4% (95% CI 2.2, 6.7) higher than that of all ED visits and annual growth in the opioid misuse-related visit rate was 10.6% (95% CI 6.8, 14.6) higher than that of all ED visits. The rate of all ED visits in Alberta declined by 1.4% annually (95% CI –3.3, 0.4), though the change was not statistically significant; whereas the annual substance and opioid misuse-related visit rates increased significantly by 2.9% (95% CI 0.6, 5.3) and 9.0% (95% CI 5.1, 13.1), respectively.

In cross-sectional time-series analyses evaluating subgroups defined by age and sex, no significant difference was seen between annual growth rates of substance misuse-related visits between sexes. However, the annual growth rate for opioid misuse-related visits among males was 5.6% higher than that of females (95% CI 1.6, 9.7). There were significant differences in the annual growth rate for substance and opioid misuse-related visits between age groups. The most pronounced increases in annual visit rates were seen in the 18- to 29-year-old age groups, where annual growth rate of substance misuse visits was 11.6% (95% CI 8.1, 15.3) and of opioid misuse visits was 16.6% (95% CI 8.0, 25.8) higher than the 40- to 49-year-old reference category. Additionally, annual growth in substance and opioid misuse-related ED visits was significantly higher in the 30- to 39-year-old age category compared to the reference group.

Table 1 Substance misuse, opioid misuse, and total Alberta ED visit and patient trends

	All years	2010/11	2011/12	2012/13	2013/14	2014/15
Substance misuse visits and patients						
Substance misuse visit number	149,719	23,549	26,999	29,828	33,336	36,007
Substance misuse visits/100,000 population ≥ 18 years	4654*	811	915	986	1067	1119
Substance misuse visits/total ED visits (%)	1.93	1.63	1.78	1.89	2.08	2.21
Substance misuse patient number	65,089**	14,936	16,589	17,632	19,344	20,700
Substance misuse visits/patient	2.30	1.58	1.63	1.69	1.72	1.74
Opioid misuse visits and patients						
Opioid misuse visit number	14,275	2164	2481	2761	3065	3804
Opioid misuse visits/100,000 population ≥ 18 years	444*	75	84	91	98	118
Opioid misuse visits/total ED visits (%)	0.18	0.15	0.16	0.17	0.19	0.23
Opioid patient number	9811**	1773	2039	2184	2457	3029
Opioid misuse visits/patient	1.45	1.22	1.22	1.26	1.25	1.26
Total Alberta ED visits and patients						
Total ED visits	7,774,424	1,444,090	1,515,012	1,579,486	1,606,384	1,629,452
Total ED patients	1,923,702**	672,743	704,320	741,238	763,581	779,944
Total Alberta population ≥ 18 years	N/A	2,902,901	2,949,781	3,026,267	3,123,831	3,270,722
Total ED visits/100,000 population ≥ 18 years	241,671 *	49,746	51,360	52,193	51,424	50,652
Total ED visits/patient	2.47	2.15	2.15	2.13	2.10	2.09

*N.B. Visits/100,000 population for the entire study period were calculated using the most recent annual population estimate (2014/15)

**N.B. The patient totals for all years for substance misuse, opioid misuse, and all ED visits are fewer than the sum of all patients from the individual years, because some unique patients have presented in multiple years and have only been counted once

Graphically, the annual changes in substance misuse-related visits, opioid misuse-related visits, and all ED visits standardized by population in Alberta are shown in Fig. 1. Figures 2 and 3 demonstrate annual visit trends in substance and opioid misuse-related ED visits by age and sex categories. Notably, the growth in opioid misuse-related ED visits in the 18- to 29-year-old age category appears to be exponential.

The substance and opioid misuse-related visit increases from 2010/11 to 2014/15 were more pronounced in non-rural than in rural settings (Supplementary Table 2). The subset of non-rural substance misuse-related ED visits increased by 38.9% from 529 to 735 visits per 100,000 population whereas those made in rural settings increased by 20.9% from 215 to 260 visits per 100,000 population. Similarly, the subset of non-

Fig. 1 Trends in substance misuse, opioid misuse, and total ED visits in Alberta*. *To allow comparable scales, substance misuse-related, opioid misuse-related, and total ED visits are expressed per 100,000 population ≥ 18 years, per 1000 population ≥ 18 years, and per 100 population ≥ 18 years, respectively

Fig. 2 Substance misuse-related ED visit trends by age and sex categories

rural opioid misuse-related ED visits increased by 61.3% from 31 to 50 ED visits per 100,000 population compared to those made in rural settings, which increased by 33.3% from 12 to 16 ED visits per 100,000 population. Notably, 10% of the substance misuse-related visits and 6% of the opioid misuse-related visits (compared to 1% of the visits for overall Alberta ED data) did not have a coded rural status due to missing postal code information (Table 2).

Visit and patient characteristics

Visit and patient characteristics of substance misuse-related visits and all provincial ED visits are displayed in Table 2. Patient and visit characteristics for substance-related visits and for opioid-related visits did not appear to differ at a population level between the baseline 2010/11 year and the most recent year of data, 2014/15. Overall, both substance misuse-related and opioid-misuse related visits arrived more often by

Fig. 3 Opioid misuse-related ED visit trends by age and sex categories

Table 2 ED visit and patient characteristics, 2010–2015

	Substance misuse-related ED visits and patients, all years	Substance misuse-related ED visits and patients, 2010/11	Substance misuse-related ED visits and patients, 2014/15	Opioid misuse-related ED visits and patients, all years	Opioid misuse-related ED visits and patients, 2010/11	Opioid misuse-related ED visits and patients, 2014/15	Total ED visits and patients
Total visit number	149,719	23,549	36,007	8786	1277	2301	7,774,424
Arrival by ambulance, <i>n</i> (%)	70,576 (47%)*	11,034 (47%)	16,670 (46%)	2229 (25%)*	328 (26%)	599 (26%)	1,001,078 (13%)
Acuity, <i>n</i> (%)							
CTAS 1 and 2	41,098 (27%)*	5731 (24%)	10,615 (29%)	1594 (18%)*	182 (14%)	461 (20%)	855,755 (11%)
CTAS 3	67,284 (45%)	10,556 (45%)	16,410 (46%)	3871 (44%)	519 (41%)	1087 (47%)	2,481,682 (32%)
CTAS 4/5	38,053 (25%)	6559 (28%)	8322 (23%)	3045 (35%)	522 (41%)	691 (30%)	4,069,729 (52%)
Unknown or missing	3284 (2%)	703 (3%)	660 (2%)	258 (3%)	54 (4%)	62 (3%)	367,258 (5%)
Length of stay, hours (mean, SD)	7.7 (12.9)*	7.9 (25.4)	8.5 (11.1)	5.9 (8.0)*	5.6 (8.5)	6.5 (9.6)	3.9 (9.5)
Rural visits, <i>n</i> (%)	36,216 (24%)*	6249 (27%)	8372 (23%)	2047 (23%)*	344 (27%)	522 (23%)	2,446,344 (31%)
	Missing: 15,638 (10%)	Missing: 1943 (8%)	Missing: 4003 (11%)	Missing: 511 (6%)	Missing: 41 (3%)	Missing: 175 (8%)	Missing: 57,879 (1%)
Hospitalization <i>n</i> (%)	22,645 (15%)*	3715 (16%)	5487 (15%)	1010 (12%)*	149 (12%)	252 (11%)	755,953 (10%)
Total patient number	65,089	14,936	20,700	5743	1002	1762	1,923,702
Age (mean, SD)	38 (15)*	39 (15)	38 (15)	39 (14)*	40 (14)	37 (14)	44 (19)
Male <i>n</i> (%)	41,531 (64%)*	9603 (64%)	13,390 (65%)	3201 (56%)*	550 (55%)	1017 (58%)	967,206 (50%)

*Significant compared to all ED visits and patients in Alberta at $p < 0.05$

ambulance, were of higher acuity based on CTAS score, had longer ED lengths of stay, were made more often in non-rural locations, and more frequently led to hospitalization compared to all ED visits in Alberta. These differences were all significant on pairwise testing.

Patients presenting with substance misuse-related and opioid misuse-related concerns were younger and more often male than the total population of patients presenting to Albertan EDs. These differences were significant on pairwise testing.

Discussion

This study examined all substance misuse-related ED visits in Alberta from 2010 to 2015 and therefore provides a comprehensive understanding of provincial trends that may be extrapolated nationally, given a current lack of comprehensive national ED data. Our cross-sectional time-series analysis demonstrated that the annual growth in both substance and opioid misuse-related visit rates was significantly greater than that of all ED visits in Alberta, when controlling for temporal and seasonal trends. A 38.0% increase in substance misuse-related visits and a 57.3% increase in opioid misuse-related visits were observed, while the overall provincial ED visits per 100,000 population declined. Our analysis also demonstrated that the highest rate of growth was concentrated in the 18- to 29-year-old category for both substance and opioid misuse, and the growth appeared exponential for 18- to 29-year-old males with opioid misuse. Additionally, our study showed that substance misuse-related visits compared to total ED visits were of higher acuity and were hospitalized more often.

Our results align well with other emerging evidence on substance misuse in Canada and North America. Overall, observed Albertan rates of 811 ED visits/100,000 population for substance misuse-related concerns in 2011 were similar to the 790 ED visits/100,000 population observed in national ED data in the US (Substance Abuse and Mental Health Services Administration 2013). Our results showing 118 opioid misuse-related visits per 100,000 population are also consistent with previous findings of 27 ED visits per 100,000 population in 2014/15 for opioid toxicity in Alberta (Canadian Centre on Substance Abuse 2016); this latter number was calculated using a more restrictive ICD-10 definition limited to acute toxicity-related codes rather than our comprehensive algorithm including all opioid misuse-related presentations. The increases observed may be due to greater availability of illicit substances, or to increasing misuse of

prescription medications (Substance Abuse and Mental Health Services Administration 2013; Murphy et al. 2015; Alberta Health and Wellness 2011). Changes in physician prescribing practices may be another explanation; for instance, previous research has described correlations between increases in long-acting opioid prescriptions and opioid-related mortality (Dhalla et al. 2009). Another possibility is that popular drugs of abuse are becoming increasingly potent or dangerous, leading to more toxicity-related ED presentations. For instance, increasing numbers of hospitalizations and deaths due to fentanyl and synthetic opioid derivatives have been reported (Canadian Centre on Substance Abuse 2016). Among these, carfentanil was implicated in 29 overdose deaths in 2016 and 21 in the first quarter of 2017 in Alberta (Alberta Health 2017a). Finally, the mixture of opioids with other drugs has led to tragic outcomes for some users; among confirmed fentanyl overdoses in 2016 in Alberta, 65% had additional substances listed on the death certificate (Alberta Health 2017a).

The current results also align with data indicating increasing societal prevalence of opioid misuse (Inocencio et al. 2013). This is a proof of principle that analysis of ED trends may provide important surveillance for the scope and spread of public health issues and the effectiveness of interventions. The relative high acuity of substance misuse-related visits suggests that patients making these visits are at high risk for poor outcomes (Canadian Centre on Substance Abuse 2016; Substance Abuse and Mental Health Services Administration 2013). Primary and secondary prevention are therefore important priorities (Kolodny et al. 2015; National Advisory Council on Prescription Drug Misuse 2013; Weiner et al. 2016). Our demonstration of a concentration of growth of substance and opioid misuse in younger individuals has important implications for the effective targeting of preventive interventions.

Our study has several limitations inherent in administrative database research. First, secular changes in the study population cannot be excluded. The influence of Alberta's population growth was mitigated by presenting results as ED visits per 100,000 population. Second, identification of substance misuse-related visits was performed by isolating relevant ICD-10 diagnostic codes. The ICD-10 based definition employed is not validated and therefore may have either over- or underestimated the ED visits of interest. To minimize this risk, a primary definition was utilized that has been recommended by authorities in this area of research and therefore remains consistent with existing standards (Repeat emergency visits for substance abuse 2015). Additionally, these results remained significant over multiple sensitivity tests and therefore are considered robust. Third, these numbers are likely an

underestimate of the true frequency of opioid misuse events because (a) many mixed overdoses have no clear etiology and drug testing is often unavailable or unhelpful to clinicians; (b) some events are aborted in the pre-hospital setting, especially with the increasing use of naloxone; and (c) some patients die prior to being transported to the ED. For example, increasing access to bystander naloxone administration and treat-and-release programs for EMS may lead to aborted severe events remaining unreported, in the cases of bystander or EMS naloxone use, or unrecorded within an ED database, in the case of pre-hospital treat-and-release programs or death. Finally, although the results presented here are striking, they are observational in nature. The results demonstrate an increase in visit numbers but cannot elaborate cause or effect.

Conclusion

Both substance and opioid misuse-related ED visits increased significantly from 2010/11 to 2014/15 in Alberta, particularly in younger and male patients, and indicate an important and growing public health concern. Future research should replicate this analysis nationally, should focus on elaborating reasons underlying these observed trends, and should explore the actual human and societal impacts of growing levels of substance and opioid misuse. Furthermore, there is a need to develop and test interventions to curb the growth and impact of illicit and prescription drug misuse, especially targeting younger individuals aged 18–29 years, in Alberta and more broadly.

Compliance with ethical standards

The study received ethics approval from the University of Alberta Human Research Ethics Board (PRO00058053_AME3).

Conflict of interest The authors declare that they have no conflict of interest.

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