

# Subgroups of people who make frequent emergency department visits in Ontario and Alberta: a retrospective cohort study

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## Abstract

**Background:** The population that visits emergency departments frequently is heterogeneous and at high risk for mortality. This study aimed to characterize these patients in Ontario and Alberta, compare them with controls who do not visit emergency departments frequently, and identify subgroups.

**Methods:** This was a retrospective cohort study that captured patients in Ontario or Alberta from fiscal years 2011/12 to 2015/16 in the Dynamic Cohort from the Canadian Institute for Health Information, which defined people with frequent visits to the emergency department in the top 10% of annual visits and randomly selected controls from the bottom 90%. We included patients 18 years of age or older and linked to emergency department, hospitalization, continuing care, home care and mental health–related hospitalization data. We characterized people who made frequent visits to the emergency department over time, compared them with controls and identified subgroups using cluster analysis. We examined emergency department visit acuity using the Canadian Triage and Acuity Scale.

**Results:** The number of patients who made frequent visits to the emergency department ranged from 435 334 to 477 647 each year in Ontario ( $\geq 4$  visits per year), and from 98 840 to 105 047 in Alberta ( $\geq 5$  visits per year). The acuity of these visits increased over time. Those who made frequent visits to the emergency department were older and used more health care services than controls. We identified 4 subgroups of those who made frequent visits: “short duration” (frequent, regularly spaced visits), “older patients” (median ages 69 and 64 years in Ontario and Alberta, respectively; more comorbidities; and more admissions), “young mental health” (median ages 45 and 40 years in Ontario and Alberta, respectively; and common mental health–related and alcohol-related visits) and “injury” (increased prevalence of injury-related visits).

**Interpretation:** From 2011/12 to 2015/16, people who visited emergency departments frequently had increasing visit acuity, had higher health care use than controls, and comprised distinct subgroups. Emergency departments should codevelop interventions with the identified subgroups to address patient needs.

People who present frequently to emergency departments are a minority that account for disproportionate health care spending:<sup>1</sup> the highest 3% of this group comprise 30% of charges.<sup>2,3</sup> They are also high users of other health care<sup>3–6</sup> and are hospitalized and die more often than nonfrequent visitors to the emergency department,<sup>7,8</sup> suggesting a need for interventions that optimize patient outcomes and service allocation.<sup>9</sup> Effective interventions must recognize these patients' clinical and demographic heterogeneity. Our previous work identified 4 subgroups among patients who presented frequently to emergency departments in British Columbia,

including an older subgroup with prevalent cardiac-related conditions and a younger subgroup with mental health comorbidities,<sup>10</sup> corroborating other studies.<sup>11</sup>

**Competing interests:** See the end of the article.

This article has been peer reviewed.

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**CMAJ Open 2022 March 15. DOI:10.9778/cmajo.20210132**

There is an urgent need across Canada to identify subgroups among those who use emergency departments frequently, so that we can inform patient-focused, regionally specific interventions that could be nationally scalable where commonalities exist. We sought to test the generalizability of our BC-based findings and hypothesized that similar subgroups exist in other provinces. We aimed to characterize people who made frequent visits to the emergency department, compared to those who visited nonfrequently, and to identify subgroups in Ontario and Alberta.

## Methods

### Study design and setting

This was a retrospective administrative database study that captured patients who visited an emergency department in Ontario or Alberta between Apr. 1, 2011, and Mar. 31, 2016. Data were split into 5 fiscal years. For this study, we analyzed a combined data set from Ontario and Alberta, and we disaggregated data by province before analysis to facilitate inter-provincial comparisons. We report study findings in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline.<sup>12</sup>

### Participants

We analyzed annual subsets of patients aged 18 years or older who visited emergency departments most frequently (top 10%) and compared them to nonfrequent controls (remaining 90%) in Ontario and Alberta. We used the Canadian Institute for Health Information (CIHI) Dynamic Cohort of Complex, High System Users.

### Data sources

CIHI created the Dynamic Cohort using in-house data sets to identify patients in the top 10% of acute care costs, lengths of stay, number of hospitalizations and number of emergency department visits each year.<sup>13</sup>

CIHI identified patients in the top 10% of emergency department visits using records submitted by Ontario and Alberta in the National Ambulatory Care Reporting System (NACRS).<sup>14</sup> CIHI first stratified emergency department visit data by fiscal year, province and age (< 18 and ≥ 18 years). Within each stratum, CIHI identified the top 10% based on annual visit counts. CIHI also generated a control group by randomly selecting patients from the remaining 90%, using a 4:1 ratio.<sup>13</sup> CIHI repeated the cohort selection process each fiscal year, adding new patients and updating information from previously included patients.

We used the “ED Visit Indicator” variable to differentiate emergency department visits from scheduled revisits. All emergency departments in Ontario and Alberta comply with level 3 NACRS reporting, which mandates that diagnoses are completed and reported using the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision*, Canadian version (ICD-10-CA).<sup>15</sup>

CIHI performed all data linkages using personal health number. We linked NACRS records to the Discharge Abstract Database (DAD) for hospitalizations, and to the Continuing Care Reporting System, the Home Care Reporting System and

the Hospital Mental Health Database (HMHDB).<sup>16–19</sup> The HMHDB collates information on mental health-related admissions from 4 sources, depending on their availability in each jurisdiction: DAD, the Hospital Morbidity Database, the Hospital Mental Health Survey and the Ontario Mental Health Reporting System.<sup>18,20</sup>

### Study variables and definitions

All study variables and their data sources are described in Appendix 1, Table S1, available at [www.cmajopen.ca/content/10/1/E232/suppl/DC1](http://www.cmajopen.ca/content/10/1/E232/suppl/DC1).

### Demographic characteristics

We examined sex, age, province and rural or urban residence using NACRS. A “0” in the second character of a postal code denoted a rural address.<sup>21,22</sup>

### Emergency department visits

We summarized the characteristics of emergency department visits (ambulance arrival, triage level, diagnoses and disposition) in NACRS. Triage level was classified using the Canadian Triage and Acuity Scale (CTAS), a validated national tool with good inter-rater reliability; it specifies 5 acuity levels to assist emergency departments in prioritizing patient care.<sup>23–26</sup>

### Diagnostic categories

Diagnoses in NACRS and DAD were classified using ICD-10-CA, which groups diagnoses into 22 chapters.<sup>27</sup>

The HMHDB reports diagnoses within mental health categories based on the ICD-10-CA for DAD, and the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) for the Ontario Mental Health Reporting System (DSM-5) and the Hospital Mental Health Survey (DSM-III or DSM-IV-TR).<sup>19</sup>

We used a CIHI standard to quantify harms related to substance use in Canada,<sup>28</sup> which we cross-referenced against published expert analyses<sup>29</sup> to generate a list of ICD-10-CA codes that defined alcohol-related emergency department presentations pertaining to intoxication, withdrawal and complications (Appendix 1, Table S2).

### Charlson Comorbidity Index

We calculated patients’ Charlson Comorbidity Index using primary emergency department diagnoses from NACRS. This index assesses 17 medical comorbidities and has predictive validity for mortality.<sup>30</sup> Although it is usually based on hospitalization diagnoses, it has been validated using emergency department data.<sup>31–34</sup>

### Statistical analysis

#### Index year and index visit for cluster analysis

We defined Apr. 1, 2013, to Mar. 31, 2014, as the index year for our cluster analysis, and the index visit as each patient’s last visit in that year. We used a 365-day period before the index visit to examine baseline characteristics. We chose our index year for consistency with our previous cluster analysis using BC data, and to facilitate comparison.<sup>10</sup>

### Regularity index

We calculated regularity index for emergency department visits, to characterize the spacing between patients' visits over the 365-day period before the index visit using the following equation:  $1 \div (1 + \text{variance of visits})$ . Variance was based on the number of days between visits. This index ranged from 0 to 1 (closer to 1 indicated greater regularity).

To illustrate, a person who made 12 annual visits, 1 per month, would have an index close to 1; their index would be

closer to 0 if they visited 12 times at more random intervals. The regularity index has been used in large cohort studies that examined temporal visit dispersion.<sup>10,35–38</sup>

### Cluster analysis

We used cluster analysis to identify subgroups among people who visited emergency departments frequently.<sup>39</sup> This well-described method organizes data into clusters by optimizing within-subgroup similarities and between-subgroup differences.<sup>10,40</sup>

**Table 1 (part 1 of 2): Demographic and health care utilization characteristics of people who made frequent visits to the emergency department in Ontario**

| Characteristic  | Apr. 1, 2011–<br>Mar. 31, 2012                  | Apr. 1, 2012–<br>Mar. 31, 2013                  | Apr. 1, 2013–<br>Mar. 31, 2014                  | Apr. 1, 2014–<br>Mar. 31, 2015                  | Apr. 1, 2015–<br>Mar. 31, 2016                  |
|---|---|---|---|---|---|
| Emergency department visit characteristics (NACRS metadata) |   |   |   |   |   |
| No. of patients   | 435 334   | 446 954   | 451 568   | 465 949   | 477 647   |
| No. of visits per patient, median (IQR)                     | 4 (3–5)   | 4 (3–5)   | 4 (3–5)   | 4 (3–5)   | 4 (3–5)   |
| No. of emergency department visits                          | 2 004 975                                       | 2 053 609                                       | 2 079 281                                       | 2 149 965                                       | 2 213 161                                       |
| Arrival by ambulance, <i>n</i> (%)                          |   |   |   |   |   |
| Air ambulance   | 486 (0)   | 422 (0)   | 369 (0)   | 459 (0)   | 411 (0)   |
| Air and ground ambulance                                    | 978 (0)   | 1119 (0.1)                                      | 1054 (0.1)                                      | 1283 (0.1)                                      | 1315 (0.1)                                      |
| Ground ambulance  | 352 171 (17.6)                                  | 376 214 (18.3)                                  | 397 811 (19.1)                                  | 428 368 (19.9)                                  | 446 762 (20.2)                                  |
| No ambulance  | 1 651 340 (82.4)                                | 1 675 854 (81.6)                                | 1 680 047 (80.8)                                | 1 719 855 (80.0)                                | 1 764 673 (79.7)                                |
| Triage level (CTAS), <i>n</i> (%)                           |   |   |   |   |   |
| 1 (resuscitation)   | 13 123 (0.7)                                    | 14 229 (0.7)                                    | 16 599 (0.8)                                    | 18 759 (0.9)                                    | 20 796 (0.9)                                    |
| 2 (emergent)  | 332 219 (16.6)                                  | 361 122 (17.6)                                  | 402 949 (19.4)                                  | 435 122 (20.2)                                  | 458 014 (20.7)                                  |
| 3 (urgent)  | 849 844 (42.4)                                  | 896 673 (43.7)                                  | 931 616 (44.8)                                  | 975 875 (45.4)                                  | 1 012 638 (45.8)                                |
| 4 (less urgent)   | 648 833 (32.4)                                  | 634 937 (30.9)                                  | 597 374 (28.7)                                  | 588 964 (27.4)                                  | 593 436 (26.8)                                  |
| 5 (nonurgent)   | 151 140 (7.5)                                   | 137 432 (6.7)                                   | 121 391 (5.8)                                   | 114 988 (5.3)                                   | 113 565 (5.1)                                   |
| Unknown   | 8040 (0.4)                                      | 7607 (0.4)                                      | 7615 (0.4)                                      | 14 344 (0.7)                                    | 12 344 (0.6)                                    |
| Not available   | 1776 (0.1)                                      | 1609 (0.1)                                      | 1737 (0.1)                                      | 1913 (0.1)                                      | 2368 (0.1)                                      |
| Top 5 ICD-10-CA primary diagnosis chapters, <i>n</i> (%)    |   |   |   |   |   |
| 1   | Respiratory<br>162 000 (8.1)                    | Respiratory<br>170 897 (8.3)                    | Respiratory<br>160 762 (7.7)                    | Respiratory<br>180 688 (8.4)                    | Respiratory<br>178 433 (8.1)                    |
| 2   | Musculoskeletal<br>136 297 (6.8)                | Musculoskeletal<br>137 722 (6.7)                | Musculoskeletal<br>140 076 (6.7)                | Musculoskeletal<br>146 490 (6.8)                | Musculoskeletal<br>154 688 (7.0)                |
| 3   | Abnormal clinical<br>findings<br>412 928 (20.6) | Abnormal clinical<br>findings<br>427 536 (20.8) | Abnormal clinical<br>findings<br>442 744 (21.3) | Abnormal clinical<br>findings<br>458 415 (21.3) | Abnormal clinical<br>findings<br>473 430 (21.4) |
| 4   | Injury and<br>poisoning<br>285 123 (14.2)       | Injury and<br>poisoning<br>294 076 (14.3)       | Injury and<br>poisoning<br>300 560 (14.5)       | Injury and<br>poisoning<br>305 651 (14.2)       | Injury and<br>poisoning<br>320 186 (14.5)       |
| 5   | General health<br>status<br>215 204 (10.7)      | General health<br>status<br>212 930 (10.4)      | General health<br>status<br>210 348 (10.1)      | General health<br>status<br>205 890 (9.6)       | General health<br>status<br>202 791 (9.2)       |
| Visit disposition, <i>n</i> (%)                             |   |   |   |   |   |
| Discharged  | 1 620 491 (80.8)                                | 1 658 247 (80.7)                                | 1 679 353 (80.8)                                | 1 732 802 (80.6)                                | 1 778 194 (80.4)                                |
| Transferred or admitted                                     | 290 321 (14.5)                                  | 306 710 (14.8)                                  | 315 618 (15.2)                                  | 326 049 (15.2)                                  | 337 594 (15.2)                                  |
| Left against medical advice                                 | 93 003 (4.6)                                    | 87 501 (4.3)                                    | 83 169 (4)                                      | 89 909 (4.2)                                    | 96 255 (4.3)                                    |
| Died  | 1160 (0.1)                                      | 1151 (0.1)                                      | 1141 (0.1)                                      | 1205 (0.1)                                      | 1118 (0)  |

**Table 1 (part 2 of 2): Demographic and health care utilization characteristics of people who made frequent visits to the emergency department in Ontario**

| Characteristic  | Apr. 1, 2011–<br>Mar. 31, 2012                 | Apr. 1, 2012–<br>Mar. 31, 2013                 | Apr. 1, 2013–<br>Mar. 31, 2014                 | Apr. 1, 2014–<br>Mar. 31, 2015                | Apr. 1, 2015–<br>Mar. 31, 2016                |
|---|--|--|--|---|---|
| Hospitalization characteristics (DAD metadata)  |  |  |  |   |   |
| No. of admissions   | 255 202  | 268 573  | 276 307  | 284 787                                       | 292 411                                       |
| No. of admissions per patient, median (IQR)   | 1 (1–2)  | 1 (1–2)  | 1 (1–2)  | 1 (1–2)                                       | 1 (1–2)                                       |
| Top 5 ICD-10 primary diagnosis chapters simplified, <i>n</i> (%)  |  |  |  |   |   |
| 1   | Circulatory<br>45 573 (17.9)                   | Circulatory<br>46 974 (17.5)                   | Circulatory<br>48 260 (17.5)                   | Circulatory<br>49 267 (17.3)                  | Circulatory<br>50 029 (17.1)                  |
| 2   | Respiratory<br>9 491 (11.6)                    | Respiratory<br>32 452 (12.1)                   | Respiratory<br>32 177 (11.6)                   | Respiratory<br>36 479 (12.8)                  | Respiratory<br>35 749 (12.2)                  |
| 3   | Digestive<br>36 263 (14.2)                     | Digestive<br>37 876 (14.1)                     | Digestive<br>39 235 (14.2)                     | Digestive<br>38 983 (13.7)                    | Digestive<br>41 150 (14.1)                    |
| 4   | Abnormal clinical<br>findings<br>26 679 (10.5) | Abnormal clinical<br>findings<br>27 441 (10.2) | Abnormal clinical<br>findings<br>27 767 (10.0) | Abnormal clinical<br>findings<br>27 771 (9.8) | Abnormal clinical<br>findings<br>27 636 (9.5) |
| 5   | Injury and<br>poisoning<br>24 054 (9.4)        | Injury and<br>poisoning<br>25 134 (9.4)        | Injury and<br>poisoning<br>26 302 (9.5)        | Injury and<br>poisoning<br>26 175 (9.2)       | Injury and<br>poisoning<br>27 506 (9.4)       |
| Mental health hospitalization–related characteristics (HMHDB metadata)  |  |  |  |   |   |
| No. of mental health–related admissions   | 37 100   | 38 282   | 39 030   | 39 913  | 42 708  |
| No. of mental health–related admissions per patient, median (IQR)   | 1 (1–2)  | 1 (1–2)  | 1 (1–2)  | 1 (1–2)                                       | 1 (1–2)                                       |
| Diagnosis category, <i>n</i> (%)  |  |  |  |   |   |
| Mood disorder   | 11 513 (31.0)                                  | 11 563 (30.2)                                  | 11 148 (28.6)                                  | 11 565 (29.0)                                 | 12 038 (28.2)                                 |
| Schizophrenic and psychotic disorder  | 9 355 (25.2)                                   | 9 362 (24.5)                                   | 9 797 (25.1)                                   | 9 008 (22.6)                                  | 9 192 (21.5)                                  |
| Substance-related disorder  | 7 097 (19.1)                                   | 7 200 (18.8)                                   | 7 484 (19.2)                                   | 7 849 (19.7)                                  | 8 758 (20.5)                                  |
| Organic disorder  | 3 628 (9.8)                                    | 4 275 (11.2)                                   | 4 615 (11.8)                                   | 4 974 (12.5)                                  | 5 721 (13.4)                                  |
| Other mental health disorder  | 2 679 (7.2)                                    | 2 863 (7.5)                                    | 2 898 (7.4)                                    | 2 988 (7.5)                                   | 3 187 (7.5)                                   |
| Anxiety disorder  | 1 412 (3.8)                                    | 1 480 (3.9)                                    | 1 467 (3.8)                                    | 1 647 (4.1)                                   | 1 661 (3.9)                                   |
| Personality disorder  | 1 245 (3.4)                                    | 1 353 (3.5)                                    | 1 388 (3.6)                                    | 1 672 (4.2)                                   | 1 918 (4.5)                                   |
| Non–mental health disorder  | 125 (0.3)                                      | 133 (0.3)                                      | 175 (0.4)                                      | 175 (0.4)                                     | 183 (0.4)                                     |
| Unknown disorder (not available)  | 46 (0.1)                                       | 53 (0.1)                                       | 58 (0.1)                                       | 35 (0.1)                                      | 50 (0.1)                                      |
| Note: CTAS = Canadian Triage and Acuity Scale, DAD = Discharge Abstract Database, HMHDB = Hospital Mental Health Database, ICD-10-CA = <i>International Statistical Classification of Diseases and Related Health Problems, 10th revision, Canadian version</i> , IQR = interquartile range, NACRS = National Ambulatory Care Reporting System. |  |  |  |   |   |

For our clustering algorithm, we included variables pertaining to emergency department visit patterns and characteristics in NACRS. As is commonly done,<sup>41</sup> we used our previous analyses<sup>5,10</sup> and clinical experience to inform the inclusion of variables that would be clinically useful for emergency physicians.<sup>10,40</sup> We excluded patients with missing information. We included 10 variables: (1) number of emergency department visits; (2) number of months that the patient visited an emergency department; ICD-10-CA emergency department diagnoses pertaining to (3) mental health, (4) circulatory, (5) respiratory or (6) digestive issues; (7) number of ICD-10-CA diagnostic chapters; (8) regularity index; (9) Charlson Comorbidity Index; and (10) age.

We employed a *k*-means algorithm and used the elbow plot and pseudo-*F* test as a guide to the appropriate cluster number.<sup>42,43</sup> As is accepted in cluster analysis, we applied clinical experience to determine meaningful groupings.<sup>42,44</sup> Four clusters optimally described our data with respect to statistical optimization and generating clinically meaningful subgroups (Appendix 1, Tables S3 and S4 and Figures S1 to S6).

We named each subgroup for ease of reference, based on observed patterns in demographics and emergency department use. We defined “short duration” as making emergency department visits over a median of 2 months or less, informed by previous related analyses.<sup>10</sup>

We described demographic characteristics and health care utilization using all available data sources from Apr. 1, 2011, to Mar. 31, 2016. We compared people who used emergency departments frequently to controls for the fiscal year from Apr. 1, 2015, to Mar. 31, 2016. We chose this year because it had the most recent data available, as well as for consistency (and to facilitate comparison) with our characterization of data in BC using the same fiscal year.<sup>5</sup> As described above, we carried out

cluster analysis to identify subgroups using the index year Apr. 1, 2013, to Mar. 31, 2014.

We performed all analyses using R (R Development Core Team, 2011).

### Ethics approval

The University of British Columbia Clinical Research Ethics Board approved this study.

**Table 2 (part 1 of 2): Demographic and health care utilization characteristics of people who made frequent visits to the emergency department in Alberta**

| Characteristic  | Apr. 1, 2011–<br>Mar. 31, 2012              | Apr. 1, 2012–<br>Mar. 31, 2013               | Apr. 1, 2013–<br>Mar. 31, 2014               | Apr. 1, 2014–<br>Mar. 31, 2015               | Apr. 1, 2015–<br>Mar. 31, 2016               |
|---|---|--|--|--|--|
| Emergency department visit characteristics (NACRS metadata) |   |  |  |  |  |
| No. of patients   | 98 840                                      | 102 781                                      | 103 711                                      | 105 047                                      | 102 027                                      |
| No. of visits per patient, median (IQR)                     | 5 (4–7)                                     | 5 (4–7)                                      | 5 (4–7)                                      | 5 (4–7)                                      | 5 (4–7)                                      |
| No. of emergency department visits                          | 680 740                                     | 699 962                                      | 700 347                                      | 704 256                                      | 690 330                                      |
| Arrival by ambulance, <i>n</i> (%)                          |   |  |  |  |  |
| Air ambulance   | 433 (0.1)                                   | 398 (0.1)                                    | 403 (0.1)                                    | 501 (0.1)                                    | 443 (0.1)                                    |
| Air and ground ambulance                                    | 767 (0.1)                                   | 766 (0.1)                                    | 649 (0.1)                                    | 650 (0.1)                                    | 470 (0.1)                                    |
| Ground ambulance  | 79 141 (11.6)                               | 85 515 (12.2)                                | 89 108 (12.7)                                | 94 726 (13.5)                                | 97 925 (14.2)                                |
| No ambulance  | 600 399 (88.2)                              | 613 283 (87.6)                               | 610 187 (87.1)                               | 608 379 (86.4)                               | 591 492 (85.7)                               |
| Triage level (CTAS), <i>n</i> (%)                           |   |  |  |  |  |
| 1 (resuscitation)   | 1649 (0.2)                                  | 2195 (0.3)                                   | 2570 (0.4)                                   | 3153 (0.4)                                   | 3109 (0.5)                                   |
| 2 (emergent)  | 50 532 (7.4)                                | 57 895 (8.3)                                 | 63 947 (9.1)                                 | 70 898 (10.1)                                | 77 985 (11.3)                                |
| 3 (urgent)  | 177 861 (26.1)                              | 190 429 (27.2)                               | 193 700 (27.7)                               | 209 718 (29.8)                               | 221 905 (32.1)                               |
| 4 (less urgent)   | 240 461 (35.3)                              | 242 305 (34.6)                               | 248 299 (35.5)                               | 249 633 (35.4)                               | 239 741 (34.7)                               |
| 5 (nonurgent)   | 159 539 (23.4)                              | 159 704 (22.8)                               | 153 945 (22.0)                               | 134 544 (19.1)                               | 116 670 (16.9)                               |
| Unknown   | 48 740 (7.2)                                | 45 577 (6.5)                                 | 35 774 (5.1)                                 | 34 405 (4.9)                                 | 29 364 (4.3)                                 |
| Not available   | 1958 (0.3)                                  | 1857 (0.3)                                   | 2112 (0.3)                                   | 1905 (0.3)                                   | 1556 (0.2)                                   |
| Top 5 ICD-10-CA primary diagnosis chapters, <i>n</i> (%)    |   |  |  |  |  |
| 1   | General health status<br>176 635 (25.9)     | General health status<br>174 778 (25.0)      | General health status<br>170 621 (24.4)      | General health status<br>162 792 (23.1)      | General health status<br>155 595 (22.5)      |
| 2   | Abnormal clinical findings<br>97 120 (14.3) | Abnormal clinical findings<br>100 856 (14.4) | Abnormal clinical findings<br>104 234 (14.9) | Abnormal clinical findings<br>108 528 (15.4) | Abnormal clinical findings<br>109 645 (15.9) |
| 3   | Injury and poisoning<br>83 836 (12.3)       | Injury and poisoning<br>88 125 (12.6)        | Injury and poisoning<br>89 318 (12.8)        | Injury and poisoning<br>90 696 (12.9)        | Injury and poisoning<br>88 772 (12.9)        |
| 4   | Respiratory<br>52 425 (7.7)                 | Respiratory<br>55 897 (8.0)                  | Respiratory<br>53 191 (7.6)                  | Respiratory<br>54 796 (7.8)                  | Respiratory<br>50 195 (7.3)                  |
| 5   | Musculoskeletal<br>39 632 (5.8)             | Musculoskeletal<br>40 971 (5.9)              | Musculoskeletal<br>41 019 (5.9)              | Digestive<br>40 888 (5.8)                    | Mental and behavioural<br>40 297 (5.8)       |
| Visit disposition, <i>n</i> (%)                             |   |  |  |  |  |
| Discharged  | 584 541 (85.9)                              | 597 069 (85.3)                               | 593 365 (84.7)                               | 590 099 (83.8)                               | 577 751 (83.7)                               |
| Transferred or admitted                                     | 71 150 (10.4)                               | 75 501 (10.8)                                | 77 497 (11.0)                                | 80 386 (11.5)                                | 82 193 (11.9)                                |
| Left against medical advice                                 | 24 857 (3.7)                                | 27 208 (3.9)                                 | 29 274 (4.2)                                 | 33 524 (4.8)                                 | 30 174 (4.4)                                 |
| Died  | 192 (0.0)                                   | 184 (0.0)                                    | 211 (0.0)                                    | 247 (0.0)                                    | 212 (0.0)                                    |

**Table 2 (part 2 of 2): Demographic and health care utilization characteristics of people who made frequent visits to the emergency department in Alberta**

| Characteristic  | Apr. 1, 2011–<br>Mar. 31, 2012        | Apr. 1, 2012–<br>Mar. 31, 2013        | Apr. 1, 2013–<br>Mar. 31, 2014        | Apr. 1, 2014–<br>Mar. 31, 2015        | Apr. 1, 2015–<br>Mar. 31, 2016        |
|---|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| Hospitalization characteristics (DAD metadata)  |                                       |                                       |                                       |                                       |                                       |
| No. of admissions   | 66 843                                | 70 069                                | 72 127                                | 73 466                                | 75 014                                |
| No. of admissions per patient, median (IQR)   | 1 (1–2)                               | 1 (1–2)                               | 1 (1–2)                               | 1 (1–2)                               | 1 (1–2)                               |
| Top 5 ICD-10 primary diagnosis chapters simplified, n (%)   |                                       |                                       |                                       |                                       |                                       |
| 1   | Mental and behavioural<br>6736 (10.1) | Mental and behavioural<br>7244 (10.3) | Mental and behavioural<br>7824 (10.8) | Mental and behavioural<br>8143 (11.1) | Mental and behavioural<br>8608 (11.5) |
| 2   | Circulatory<br>8328 (12.5)            | Circulatory<br>8734 (12.5)            | Circulatory<br>8865 (12.3)            | Circulatory<br>9319 (12.7)            | Circulatory<br>9415 (12.6)            |
| 3   | Respiratory<br>7196 (10.8)            | Respiratory<br>7906 (11.3)            | Respiratory<br>7957 (11.0)            | Respiratory<br>8778 (11.9)            | Respiratory<br>8679 (11.6)            |
| 4   | Digestive<br>8945 (13.4)              | Digestive<br>9186 (13.1)              | Digestive<br>9534 (13.2)              | Digestive<br>9828 (13.4)              | Digestive<br>9910 (13.2)              |
| 5   | Injury and poisoning<br>6966 (10.4)   | Injury and poisoning<br>7310 (10.4)   | Injury and poisoning<br>7556 (10.5)   | Injury and poisoning<br>7823 (10.6)   | Injury and poisoning<br>7904 (10.5)   |
| Mental health hospitalization–related characteristics (HMHDB metadata)  |                                       |                                       |                                       |                                       |                                       |
| No. of mental health–related admissions   | 7835                                  | 8393                                  | 9103                                  | 9292                                  | 9798                                  |
| No. of mental health–related admissions per patient, median (IQR)   | 1 (1–2)                               | 1 (1–2)                               | 1 (1–2)                               | 1 (1–2)                               | 1 (1–2)                               |
| Diagnosis category, n (%)   |                                       |                                       |                                       |                                       |                                       |
| Mood disorder   | 1806 (23.1)                           | 1751 (20.9)                           | 1823 (20)                             | 1789 (19.3)                           | 1854 (18.9)                           |
| Schizophrenic and psychotic disorder  | 1335 (17.0)                           | 1434 (17.1)                           | 1512 (16.6)                           | 1294 (13.9)                           | 1297 (13.2)                           |
| Substance-related disorder  | 2268 (28.9)                           | 2691 (32.1)                           | 3095 (34)                             | 3351 (36.1)                           | 3570 (36.4)                           |
| Organic disorder  | 860 (11.0)                            | 875 (10.4)                            | 906 (10.0)                            | 919 (9.9)                             | 986 (10.1)                            |
| Other mental health disorder  | 855 (10.9)                            | 909 (10.8)                            | 971 (10.7)                            | 1 122 (12.1)                          | 1142 (11.7)                           |
| Anxiety disorder  | 353 (4.5)                             | 403 (4.8)                             | 427 (4.7)                             | 415 (4.5)                             | 459 (4.7)                             |
| Personality disorder  | 337 (4.3)                             | 310 (3.7)                             | 342 (3.8)                             | 358 (3.9)                             | 446 (4.6)                             |
| Non–mental health disorder  | 21 (0.3)                              | 20 (0.2)                              | 27 (0.3)                              | 44 (0.5)                              | 44 (0.4)                              |
| Note: CTAS = Canadian Triage and Acuity Scale, DAD = Discharge Abstract Database, HMHDB = Hospital Mental Health Database, ICD-10-CA = <i>International Statistical Classification of Diseases and Related Health Problems, 10th revision, Canadian version</i> , IQR = interquartile range, NACRS = National Ambulatory Care Reporting System. |                                       |                                       |                                       |                                       |                                       |

## Results

From 2011/12 to 2015/16, the annual cohort of people who made frequent visits to the emergency department ranged from 435 334 to 477 647 in Ontario (median  $\geq 4$  visits per year), and 98 840 to 105 047 in Alberta (median  $\geq 5$  visits per year; Tables 1 and 2; Appendix 1, Tables S5 and S6). We observed increases from 2011/12 to 2015/16 in the proportion of visits that were triaged as resuscitation, emergent or urgent (CTAS 1–3; Ontario: 59.7% v. 67.4%; Alberta: 33.7% v. 43.9%); visits that involved arrival by ambulance (Ontario: 17.6% v. 20.3%; Alberta: 11.8% v. 14.3%); and visits that

involved admission to hospital (Ontario: 14.5% v. 15.2%; Alberta: 10.4% v. 11.9%). Mental health–related hospitalizations related to substance use (including alcohol use) also increased from 2011/12 to 2015/16 (Ontario: 19.1% v. 20.5%; Alberta: 28.9% v. 36.4%).

### Frequent emergency department visitors versus controls

The group that made frequent emergency department visits (compared to nonfrequent controls) was older (Ontario: median age 52 yr v. 49 yr; Alberta: median age 46 yr v. 43 yr); had a higher proportion of females (Ontario: 55.4% v. 52.4%;

Alberta: 55.3% v. 50.7%); more commonly lived in a rural location (Ontario: 20.5% v. 16.0%; Alberta: 34.5% v. 17.7%); arrived more commonly by ambulance (Ontario: 20.3% v. 14.8%; Alberta: 14.3% v. 11.9%); and were admitted to hospital more often (Ontario: 15.3% v. 10.5%; Alberta: 11.9% v. 11.0%; Table 3 and Appendix 1, Table S7).

The proportion of people who made frequent emergency department visits that were triaged as resuscitation, emergent or urgent (CTAS 1–3) was higher in Ontario (67.4%

v. 66.6%), but lower in Alberta (43.9% v. 53.2%) compared to nonfrequent controls. Those who made frequent emergency department visits had more episodes of continuing care (Ontario: 4.1% v. 1.2%; Alberta: 1.1% v. 0.4%), home care (Ontario: 19.2% v. 6.5%; Alberta: 15.6% v. 5.1%) and mental health admission (Ontario: 5.4% v. 0.9%; Alberta: 5.8% v. 1.2%) compared to controls; a high proportion of these were related to substance use (Ontario: 20.5% v. 14.3%; Alberta: 36.4% v. 19.2%).

**Table 3 (part 1 of 3): Patient and health care utilization characteristics of people who make frequent emergency department visits and controls (Apr. 1, 2015, to Mar. 31, 2016), by province**

| Characteristic   | Ontario                              |                  | Alberta                              |                |
|--|--------------------------------------|------------------|--------------------------------------|----------------|
|  | Frequent emergency department visits | Controls         | Frequent emergency department visits | Controls       |
| <b>Patient characteristics (NACRS metadata)</b>                    |                                      |                  |                                      |                |
| No. of patients  | 477 647                              | 1 711 848        | 102 027                              | 404 111        |
| <b>Gender, n (%)</b>   |                                      |                  |                                      |                |
| Female   | 264 731 (55.4)                       | 896 281 (52.4)   | 56 417 (55.3)                        | 204 986 (50.7) |
| Male   | 212 908 (44.6)                       | 815 550 (47.6)   | 45 610 (44.7)                        | 199 125 (49.3) |
| Other  | 6 (0.0)                              | 9 (0.0)          | 0 (0.0)                              | 0 (0.0)        |
| Undifferentiated   | 2 (0.0)                              | 8 (0.0)          | 0 (0.0)                              | 0 (0.0)        |
| Age, yr, median (IQR)  | 52 (33–70)                           | 49 (33–64)       | 46 (30–64)                           | 43 (30–59)     |
| <b>Rural or urban, n (%)</b>                                       |                                      |                  |                                      |                |
| Rural  | 98 098 (20.5)                        | 273 212 (16.0)   | 35 178 (34.5)                        | 71 432 (17.7)  |
| Urban  | 377 318 (79.0)                       | 1 435 081 (83.8) | 65 429 (64.1)                        | 330 834 (81.9) |
| Not available  | 2231 (0.5)                           | 3555 (0.2)       | 1420 (1.4)                           | 1845 (0.4)     |
| No. of visits per patient, median (IQR)                            | 4 (3–5)                              | 1 (1–1)          | 5 (4–7)                              | 1 (1–2)        |
| <b>Emergency department visit characteristics (NACRS metadata)</b> |                                      |                  |                                      |                |
| Total number of emergency department visits                        | 2 213 161                            | 2 106 899        | 690 330                              | 562 922        |
| <b>Arrival by ambulance, n (%)</b>                                 |                                      |                  |                                      |                |
| Air ambulance  | 411 (0.0)                            | 236 (0.0)        | 443 (0.1)                            | 349 (0.1)      |
| Air and ground ambulance   | 1315 (0.1)                           | 591 (0.0)        | 470 (0.1)                            | 165 (0.0)      |
| Ground ambulance   | 446 762 (20.2)                       | 310 071 (14.7)   | 97 925 (14.2)                        | 66 255 (11.8)  |
| No ambulance   | 1 764 673 (79.7)                     | 1 796 001 (85.2) | 591 492 (85.7)                       | 496 153 (88.1) |
| <b>Triage level (CTAS), n (%)</b>                                  |                                      |                  |                                      |                |
| 1 (resuscitation)  | 20 796 (0.9)                         | 19 316 (0.9)     | 3 109 (0.5)                          | 3 192 (0.6)    |
| 2 (emergent)   | 458 014 (20.7)                       | 418 003 (19.8)   | 77 985 (11.3)                        | 81 244 (14.4)  |
| 3 (urgent)   | 1 012 638 (45.8)                     | 967 356 (45.9)   | 221 905 (32.1)                       | 215 251 (38.2) |
| 4 (less urgent)  | 593 436 (26.8)                       | 638 023 (30.3)   | 239 741 (34.7)                       | 206 498 (36.7) |
| 5 (nonurgent)  | 113 565 (5.1)                        | 60 197 (2.9)     | 116 670 (16.9)                       | 46 307 (8.2)   |
| Unknown  | 12 344 (0.6)                         | 2 695 (0.1)      | 29 364 (4.3)                         | 9 957 (1.8)    |
| Not available  | 2 368 (0.1)                          | 1 309 (0.1)      | 1 556 (0.2)                          | 473 (0.1)      |
| <b>Visit disposition, n (%)</b>                                    |                                      |                  |                                      |                |
| Discharged   | 1 778 194 (80.3)                     | 1 818 664 (86.3) | 577 751 (83.7)                       | 479 990 (85.3) |
| Transferred or admitted  | 337 594 (15.3)                       | 221 797 (10.5)   | 82 193 (11.9)                        | 61 864 (11.0)  |
| Left against medical advice  | 96 255 (4.3)                         | 63 833 (3.0)     | 30 174 (4.4)                         | 20 513 (3.6)   |
| Died   | 1 118 (0.1)                          | 2 605 (0.1)      | 212 (0.0)                            | 555 (0.1)      |

**Table 3 (part 2 of 3): Patient and health care utilization characteristics of people who make frequent emergency department visits and controls (Apr. 1, 2015, to Mar. 31, 2016), by province**

| Characteristic  | Ontario                              |                | Alberta                              |               |
|---|--------------------------------------|----------------|--------------------------------------|---------------|
|   | Frequent emergency department visits | Controls       | Frequent emergency department visits | Controls      |
| Hospitalization characteristics (DAD metadata)                |                                      |                |                                      |               |
| No. of patients with at least 1 admission, (%)                | 157 965 (33.1)                       | 186 498 (10.9) | 38 464 (37.7)                        | 50 348 (12.5) |
| No. of admissions   | 292 411                              | 211 916        | 75 014                               | 59 728        |
| ICD-10 primary problem chapter among admissions, <i>n</i> (%) |                                      |                |                                      |               |
| Infectious diseases (I)                                       | 13 966 (4.8)                         | 8 194 (3.9)    | 2 624 (3.5)                          | 1 738 (2.9)   |
| Neoplasms (II and III)  | 18 315 (6.3)                         | 11 092 (5.2)   | 3 439 (4.6)                          | 2 778 (4.7)   |
| Endocrine (IV)  | 12 236 (4.2)                         | 5 688 (2.7)    | 3 028 (4.0)                          | 1 543 (2.6)   |
| Mental and behavioural (V)                                    | 10 187 (3.5)                         | 4 202 (2.0)    | 8 608 (11.5)                         | 4 754 (8.0)   |
| Neurologic (VI)   | 6 983 (2.4)                          | 4 583 (2.2)    | 1 655 (2.2)                          | 1 264 (2.1)   |
| Eye and ear (VII and VIII)                                    | 836 (0.3)                            | 1 114 (0.5)    | 242 (0.3)                            | 385 (0.6)     |
| Circulatory (IX)  | 50 029 (17.1)                        | 45 727 (21.6)  | 9 415 (12.6)                         | 9 660 (16.2)  |
| Respiratory (X)   | 35 749 (12.2)                        | 20 607 (9.7)   | 8 679 (11.6)                         | 5 353 (9.0)   |
| Digestive (XI)  | 41 150 (14.1)                        | 34 488 (16.3)  | 9 910 (13.2)                         | 8 722 (14.6)  |
| Skin (XII)  | 5 120 (1.8)                          | 2 015 (1.0)    | 1 653 (2.2)                          | 645 (1.1)     |
| Musculoskeletal (XIII)  | 8 113 (2.8)                          | 4 757 (2.2)    | 1 975 (2.6)                          | 1 352 (2.3)   |
| Genitourinary (XIV)   | 19 100 (6.5)                         | 10 740 (5.1)   | 4 695 (6.3)                          | 3 563 (6.0)   |
| Pregnancy (XV)  | 5 417 (1.9)                          | 6 688 (3.2)    | 2 848 (3.8)                          | 2 853 (4.8)   |
| Perinatal (XVI)   | 0 (0.0)                              | 1 (0.0)        | 2 (0.0)                              | 0 (0.0)       |
| Congenital (XVII)   | 124 (0.0)                            | 110 (0.1)      | 44 (0.1)                             | 47 (0.1)      |
| Abnormal clinical findings (XVIII)                            | 27 636 (9.5)                         | 15 969 (7.5)   | 5 523 (7.4)                          | 3 374 (5.6)   |
| Injury and poisoning (XIX)                                    | 27 506 (9.4)                         | 27 818 (13.1)  | 7 904 (10.5)                         | 9 135 (15.3)  |
| General health status (XXI)                                   | 9 944 (3.4)                          | 8 122 (3.8)    | 2 770 (3.7)                          | 2 560 (4.3)   |
| Not available   | 0 (0.0)                              | 1 (0.0)        | 0 (0.0)                              | 2 (0.0)       |
| Alcohol-related diagnoses among admissions, <i>n</i> (%)      |                                      |                |                                      |               |
| Yes   | 4 000 (1.4)                          | 1 402 (0.7)    | 2 482 (3.3)                          | 771 (1.3)     |
| No  | 288 411 (98.6)                       | 210 514 (99.3) | 72 532 (96.7)                        | 58 957 (98.7) |
| Continuing care (CCRS metadata)                               |                                      |                |                                      |               |
| Number of patients with continuing care use, <i>n</i> (%)     | 19 512 (4.1)                         | 20 307 (1.2)   | 1 140 (1.1)                          | 1 730 (0.4)   |
| Home care (HCRS metadata)                                     |                                      |                |                                      |               |
| Number of patients with home care use, <i>n</i> (%)           | 91 582 (19.2)                        | 111 368 (6.5)  | 15 901 (15.6)                        | 20 439 (5.1)  |

### Subgroups of frequent emergency department visitors

Our cluster analysis identified 4 subgroups that were similar in Ontario and Alberta (Tables 4 and 5; Appendix 1, Tables S8 and S9).

The “short duration” subgroup (Ontario: *n* = 34 116 [7.6%]; Alberta: *n* = 4 301 [4.2%]) had median ages of 49 and 44 years, respectively; made a median number of 2 and 3 visits per year; and had regularly spaced visits. They commonly visited emergency departments for intravenous therapy (which could

include antibiotics), dressings and cellulitis. Fewer patients were hospitalized in the index year for general hospitalizations (Ontario: 20.0%; Alberta: 14.0%) and mental health–related (Ontario: 3.2%; Alberta: 1.3%) than other subgroups.

The “older patients” subgroup (Ontario: *n* = 74 995 [16.6%]; Alberta: *n* = 8 776 [18.1%]) had median ages of 69 and 64 years, respectively; made a median number of 3 visits per year; and had higher Charlson Comorbidity Index scores than the other subgroups. More were hospitalized at least once in the index year (Ontario: 60.6%; Alberta: 58.2%) than in the other subgroups,



**Table 3 (part 3 of 3): Patient and health care utilization characteristics of people who make frequent emergency department visits and controls (Apr. 1, 2015, to Mar. 31, 2016), by province**

| Characteristic   | Ontario                              |              | Alberta                              |             |
|--|--------------------------------------|--------------|--------------------------------------|-------------|
|  | Frequent emergency department visits | Controls     | Frequent emergency department visits | Controls    |
| Mental health hospitalization–related characteristics (HMHDB metadata)                           |                                      |              |                                      |             |
| No. of patients with at least 1 mental health–related admission (%)                              | 25 555 (5.4)                         | 16 048 (0.9) | 5913 (5.8)                           | 4677 (1.2)  |
| Homelessness status among patients with at least 1 mental health–related admission, <i>n</i> (%) |                                      |              |                                      |             |
| Home   | 1246 (4.9)                           | 247 (1.5)    | 338 (5.7)                            | 80 (1.7)    |
| No. of mental health–related admissions  | 42 708                               | 18 243       | 9798                                 | 5653        |
| Diagnosis category among mental health–related admissions <i>n</i> (%)                           |                                      |              |                                      |             |
| Mood disorder  | 12 038 (28.2)                        | 5654 (31.0)  | 1854 (18.9)                          | 1379 (24.4) |
| Substance-related disorder   | 8758 (20.5)                          | 2600 (14.3)  | 3570 (36.4)                          | 1086 (19.2) |
| Schizophrenic and psychotic disorder   | 9192 (21.5)                          | 3973 (21.8)  | 1297 (13.2)                          | 1118 (19.8) |
| Organic disorder   | 5721 (13.4)                          | 3518 (19.3)  | 986 (10.1)                           | 1063 (18.8) |
| Other mental health disorder   | 3187 (7.5)                           | 1533 (8.4)   | 1142 (11.7)                          | 658 (11.6)  |
| Anxiety disorder   | 1661 (3.9)                           | 618 (3.4)    | 459 (4.7)                            | 217 (3.8)   |
| Personality disorder   | 1918 (4.5)                           | 234 (1.3)    | 446 (4.6)                            | 88 (1.6)    |
| Non–mental health disorder   | 183 (0.4)                            | 86 (0.5)     | 44 (0.4)                             | 44 (0.8)    |
| Unknown disorder or not available  | 50 (0.1)                             | 27 (0.1)     | 0 (0.0)                              | 0 (0.0)     |

Note: CCRS = Continuing Care Reporting System, CTAS = Canadian Triage and Acuity Scale, DAD = Discharge Abstract Database, HCRS = Home Care Reporting System, HMHDB = Hospital Mental Health Database, IQR = interquartile range, ICD-10-CA = *International Statistical Classification of Diseases and Related Health Problems, 10th revision, Canadian version*, NACRS = National Ambulatory Care Reporting System.

commonly for circulatory (Ontario: 29.7%; Alberta: 23.4%) and respiratory issues (Ontario: 20.3%; Alberta: 21.7%).

The “young mental health” subgroup (Ontario: *n* = 49 167 [10.9%]; Alberta: *n* = 12 827 [12.4%]) had median ages of 45 and 40 years, respectively; made a median number of 6 and 7 visits per year; were more commonly female (Ontario: 59.3%; Alberta: 60.5%); made more mental health–related visits (Ontario: 11.6%; Alberta: 10.0%); made more alcohol-related visits (Ontario: 3.5%; Alberta: 9.1%); and more commonly left the emergency department against medical advice (Ontario: 5.8%; Alberta: 5.2%) compared to other subgroups. This group had more mental health–related hospitalizations (Ontario: 20.4%; Alberta: 22.2%), among which diagnoses related to substance use were prevalent (Ontario: 26.4%; Alberta: 45.5%).

The “injury” subgroup (Ontario: *n* = 292 704 [64.9%]; Alberta: *n* = 67 722 [65.4%]) had median ages of 47 and 40 years, respectively; made a median number of 2 and 3 visits per year; and made more injury-related visits than the other subgroups (Ontario: 17.7%; Alberta: 15.9%).

### Interpretation

Our study characterized those who made frequent visits to the emergency department in Ontario and Alberta using linked population-level administrative data and cluster analysis to identify clinically important subgroups. Our results indicated

that visit acuity among these patients increased over time, and that they made high use of health care services compared to nonfrequent controls. We identified 4 subgroups with distinct demographic, clinical and visit patterns.

Our results denote important patterns that require further exploration. Increasing visit acuity suggests that people who use the emergency department frequently may be at growing risk for poor outcomes. These patients were more commonly admitted to hospital; however, although emergency department visits were of higher acuity in Ontario compared to non-frequent controls, they were of lower acuity in Alberta, similar to previous analyses.<sup>45</sup> This finding may indicate that social complexities (e.g., unstable housing or older patients failing to thrive in unsupported home environments) or lack of community follow-up to enable safe discharge may influence admission decisions.

Increases in substance use are likely to be multifactorial and may suggest improved identification, growing prevalence or increasing illicit substance toxicity, particularly in the early years of the opioid epidemic, which were captured by our data. Our findings were in alignment with existing literature that shows an increasing burden of frequent emergency department use over time, including rising clinical severity, substance use and poor outcomes.<sup>5,46,47</sup>

Repeated presentations from the subgroups we identified suggest that system-level gaps led to a failure to meet patients’

**Table 4 (part 1 of 2): Cluster analysis and subgroup characterization among people who made frequent emergency department visits from Apr. 1, 2013, to Mar. 31, 2014 — Ontario**

| Characteristic   | Subgroup 1<br>("Short duration")            | Subgroup 2<br>("Older patients")   | Subgroup 3<br>("Young mental health")                                    | Subgroup 4<br>("Injury")   |
|--|---|--|--|--|
| Subgroup characteristics (clustering variables)  |   |  |  |  |
| No. of patients  | 34 116                                      | 74 995   | 49 167   | 292 704  |
| Age, yr, median (IQR)  | 49 (32–64)                                  | 69 (54–80)   | 45 (29–63)   | 47 (30–65)   |
| No. of visits to the emergency department, median (IQR)                                | 2 (1–3)                                     | 3 (2–4)  | 6 (4–8)  | 2 (1–3)  |
| Charlson Comorbidity Index, median (IQR)   | 0 (0–0)                                     | 1 (1–1)  | 0 (0–0)  | 0 (0–0)  |
| No. of different discharge diagnosis chapters, median (IQR)                            | 2 (2–2)                                     | 3 (2–4)  | 5 (4–6)  | 3 (2–3)  |
| No. of months in the year that patients visited the emergency department, median (IQR) | 1 (1–2)                                     | 3 (3–4)  | 6 (5–7)  | 3 (2–3)  |
| Regularity index, median (IQR)   | 1 (0.8–1)                                   | $0.9 \times 10^{-7}$<br>( $0.6 \times 10^{-7}$ to $6.8 \times 10^{-5}$ ) | $1.3 \times 10^{-7}$<br>( $0.9 \times 10^{-7}$ to $2.2 \times 10^{-7}$ ) | $0.9 \times 10^{-7}$<br>( $0.5 \times 10^{-7}$ to $1.2 \times 10^{-4}$ ) |
| Patient characteristics (NACRS metadata)   |   |  |  |  |
| Gender, <i>n</i> (%)   |   |  |  |  |
| Female   | 16 875 (49.5)                               | 39 575 (52.8)  | 29 136 (59.3)  | 166 034 (56.7)   |
| Male   | 17 241 (50.5)                               | 35 420 (47.2)  | 20 030 (40.7)  | 126 667 (43.3)   |
| Other  | 0 (0.0)                                     | 0 (0.0)  | 0 (0.0)  | 1 (0.0)  |
| Undifferentiated   | 0 (0.0)                                     | 0 (0.0)  | 1 (0.0)  | 1 (0.0)  |
| Not available  | 0 (0.0)                                     | 0 (0.0)  | 0 (0.0)  | 1 (0.0)  |
| Rural or urban, <i>n</i> (%)   |   |  |  |  |
| Rural  | 7 361 (21.6)                                | 15 945 (21.3)  | 10 957 (22.3)  | 58 949 (20.1)  |
| Urban  | 26 669 (78.2)                               | 58 923 (78.6)  | 37 485 (76.2)  | 232 647 (79.5)   |
| Emergency department visit characteristics (NACRS metadata)                            |   |  |  |  |
| No. of emergency department visits   | 113 990                                     | 386 011  | 563 397  | 1 187 131  |
| Top 5 ICD-10 emergency department primary diagnoses, <i>n</i> (%)                      |   |  |  |  |
| 1  | Drug therapies<br>13 082 (11.5)             | COPD<br>23 782 (4.2)   | Abdominal pain<br>23 782 (4.2)   | Abdominal pain<br>46 055 (3.9)   |
| 2  | Abdominal pain<br>3 944 (3.5)               | Asthma<br>15 192 (2.7)   | Drug therapies<br>15 192 (2.7)   | UTI<br>37 335 (3.1)  |
| 3  | Dressings<br>3 151 (2.8)                    | Pneumonia<br>15 025 (2.7)  | UTI<br>15 025 (2.7)  | Chest pain<br>31 801 (2.7)   |
| 4  | Cellulitis of the lower limb<br>3 107 (2.7) | Bronchitis<br>12 552 (2.2)   | Chest pain<br>12 552 (2.2)   | Drug therapies<br>26 497 (2.2)   |
| 5  | Cellulitis of the upper limb<br>2 021 (1.8) | CHF<br>10 268 (1.8)  | Alcohol intoxication<br>10 268 (1.8)                                     | Cellulitis of the lower limb<br>16 941 (1.4)                             |
| Visit disposition, <i>n</i> (%)  |   |  |  |  |
| Discharged   | 92 928 (81.5)                               | 266 750 (69.1)   | 455 419 (80.8)   | 1 003 316 (84.5)   |
| Left against medical advice  | 4 525 (4.0)                                 | 8 323 (2.2)  | 32 546 (5.8)   | 43 506 (3.7)   |
| Admitted   | 9 544 (8.4)                                 | 101 667 (26.3)   | 64 298 (11.4)  | 121 653 (10.2)   |
| Transferred to another facility  | 6 952 (6.1)                                 | 8 706 (2.3)  | 10 989 (2.0)   | 18 268 (1.5)   |
| Died   | 41 (0.0)                                    | 565 (0.1)  | 145 (0.0)  | 388 (0.0)  |

**Table 4 (part 2 of 2): Cluster analysis and subgroup characterization among people who made frequent emergency department visits from Apr. 1, 2013, to Mar. 31, 2014 — Ontario**

| Characteristic  | Subgroup 1<br>("Short duration")        | Subgroup 2<br>("Older patients")         | Subgroup 3<br>("Young mental health")     | Subgroup 4<br>("Injury")                    |
|---|---|--|---|---|
| Hospitalization characteristics (DAD metadata)                          |   |  |   |   |
| No. of patients with at least 1 admission (%)                           | 6825 (20.0)                             | 45 430 (60.6)                            | 21 745 (44.2)                             | 72 084 (24.6)                               |
| No. of admissions   | 8078                                    | 100 924                                  | 57 359                                    | 110 157                                     |
| Top 5 ICD-10-CA primary diagnosis chapters, <i>n</i> (%)                |   |  |   |   |
| 1   | Digestive<br>1574 (19.5)                | Circulatory<br>30 001 (29.7)             | Digestive<br>12 229 (21.3)                | Digestive<br>19 370 (17.6)                  |
| 2   | Injury and poisoning<br>1351 (16.7)     | Respiratory<br>20 441 (20.3)             | Abnormal clinical findings<br>6901 (12.0) | Injury and poisoning<br>14 330 (13.0)       |
| 3   | Circulatory<br>1286 (15.9)              | Abnormal clinical findings<br>7836 (7.8) | Injury and poisoning<br>5604 (9.8)        | Abnormal clinical findings<br>12 961 (11.8) |
| 4   | Abnormal clinical findings<br>599 (7.4) | Neoplasms and blood<br>7459 (7.4)        | Circulatory<br>4707 (8.2)                 | Circulatory<br>12 934 (11.7)                |
| 5   | Genitourinary<br>560 (6.9)              | Digestive<br>6693 (6.6)                  | Genitourinary<br>4615 (8.0)               | Genitourinary<br>9034 (8.2)                 |
| All alcohol-related diagnoses, <i>n</i> (%)                             |   |  |   |   |
| No  | 8027 (99.4)                             | 100 643 (99.7)                           | 55 351 (96.5)                             | 108 918 (98.9)                              |
| Yes   | 51 (0.6)                                | 281 (0.3)                                | 2008 (3.5)                                | 1239 (1.1)                                  |
| Mental health hospitalization–related characteristics (HMHDB metadata)  |   |  |   |   |
| No. of patients with at least 1 admission (%)                           | 1103 (3.2)                              | 4955 (6.6)                               | 10 048 (20.4)                             | 20 031 (6.8)                                |
| No. of mental health–related admissions                                 | 1926                                    | 8467                                     | 40 406                                    | 45 035                                      |
| Diagnosis category among mental health–related admissions, <i>n</i> (%) |   |  |   |   |
| Mood disorder   | 629 (32.7)                              | 1967 (23.2)                              | 10 473 (25.9)                             | 14 071 (31.2)                               |
| Schizophrenic and psychotic disorder                                    | 524 (27.2)                              | 1291 (15.2)                              | 9852 (24.4)                               | 11 582 (25.7)                               |
| Substance-related disorder  | 337 (17.5)                              | 1150 (13.6)                              | 10 686 (26.4)                             | 8766 (19.5)                                 |
| Organic disorder  | 177 (9.2)                               | 3097 (36.6)                              | 1379 (3.4)                                | 3606 (8.0)                                  |
| Other mental health disorder  | 137 (7.1)                               | 423 (5.0)                                | 3248 (8.0)                                | 3478 (7.7)                                  |
| Anxiety disorder  | 57 (3.0)                                | 344 (4.1)                                | 1582 (3.9)                                | 1772 (3.9)                                  |
| Personality disorder  | 51 (2.6)                                | 162 (1.9)                                | 2964 (7.3)                                | 1517 (3.4)                                  |
| Non–mental health disorder  | 11 (0.6)                                | 30 (0.4)                                 | 177 (0.4)                                 | 183 (0.4)                                   |
| Unknown disorder  | 3 (0.2)                                 | 3 (0.0)                                  | 45 (0.1)                                  | 60 (0.1)                                    |

Note: CHF = congestive heart failure, COPD = chronic obstructive pulmonary disease, DAD = Discharge Abstract Database, HMHDB = Hospital Mental Health Database, ICD-10-CA = *International Statistical Classification of Diseases and Related Health Problems, 10th revision, Canadian version*, IQR = Interquartile range, NACRS = National Ambulatory Care Reporting System, UTI = urinary tract infection.

needs. The “short duration” subgroup may represent patients with visits related to an acute event that required a period of medical care (e.g., infection, injury). Although we used the NACRS “ED Visit Indicator” to exclude scheduled visits, a portion of these visits could still have been scheduled — for intravenous antibiotics, anticoagulation or wound care, for instance.

Our “older patient” subgroup had prevalent medical comorbidity and admissions, suggesting that supports are

needed to avoid hospitalization (e.g., specialist clinics, home visits, improved primary care, chronic disease management and end-of-life care).

Similarly, our “young mental health” subgroup had very high numbers of emergency department visits, prevalent substance use and mental health–related hospitalizations, suggesting a need for immediate access to low-barrier treatment for substance use disorders, as well as psychosocial supports (e.g.,

**Table 5 (part 1 of 2): Cluster analysis and subgroup characterization among people who made frequent emergency department visits from Apr. 1, 2013, to Mar. 31, 2014 — Alberta**

| Characteristic   | Subgroup 1<br>("Short duration")      | Subgroup 2<br>("Older patients")                                       | Subgroup 3<br>("Young mental health")                                    | Subgroup 4<br>("Injury")   |
|--|---------------------------------------|--|--|--|
| Subgroup characteristics (clustering variables)  |                                       |  |  |  |
| No. of patients  | 4301                                  | 18 776   | 12 827   | 67 722   |
| Age, yr, median (IQR)  | 44 (31–58)                            | 64 (48–78)   | 40 (28–55)   | 40 (27–58)   |
| No. of visits to the emergency department, median (IQR)                                | 3 (2–4)                               | 3 (2–5)  | 7 (4–11)   | 3 (2–4)  |
| Charlson Comorbidity Index, median (IQR)   | 0 (0–0)                               | 1 (1–1)  | 0 (0–0)  | 0 (0–0)  |
| No. of different discharge diagnosis chapters, median (IQR)                            | 2 (2–2)                               | 4 (3–5)  | 5 (5–6)  | 3 (2–4)  |
| No. of months in the year that patients visited the emergency department, median (IQR) | 1 (1–1)                               | 4 (3–5)  | 7 (6–8)  | 3 (2–4)  |
| Regularity index, median (IQR)   | 1 (0.8–1)                             | $1 \times 10^{-7}$<br>( $0.7 \times 10^{-7}$ to $3.8 \times 10^{-5}$ ) | $1.6 \times 10^{-7}$<br>( $1.2 \times 10^{-7}$ to $2.6 \times 10^{-7}$ ) | $0.9 \times 10^{-7}$<br>( $0.6 \times 10^{-7}$ to $8.6 \times 10^{-5}$ ) |
| Patient characteristics (NACRS metadata)   |                                       |  |  |  |
| Gender, <i>n</i> (%)   |                                       |  |  |  |
| Female   | 1868 (43.4)                           | 9744 (51.9)  | 7766 (60.5)  | 37 888 (55.9)  |
| Male   | 17 241 (50.5)                         | 35 420 (47.2)  | 20 030 (40.7)  | 126 667 (43.3)   |
| Other  | 0 (0.0)                               | 0 (0.0)  | 0 (0.0)  | 1 (0.0)  |
| Undifferentiated   | 0 (0.0)                               | 0 (0.0)  | 1 (0.0)  | 1 (0.0)  |
| Not available  | 0 (0.0)                               | 0 (0.0)  | 0 (0.0)  | 1 (0.0)  |
| Rural or urban, <i>n</i> (%)   |                                       |  |  |  |
| Rural  | 1428 (33.2)                           | 6720 (35.8)  | 5526 (43.1)  | 22 378 (33.0)  |
| Urban  | 2850 (66.3)                           | 11 921 (63.5)  | 6846 (53.4)  | 44 610 (65.9)  |
| Emergency department visit characteristics (NACRS metadata)                            |                                       |  |  |  |
| No. of emergency department visits   | 499 395                               | 1 587 307  | 139 770  | 780 967  |
| Top 5 ICD-10 emergency department primary diagnoses, <i>n</i> (%)                      |                                       |  |  |  |
| 1  | Drug therapies<br>12 356 (48.0)       | Drug therapies<br>9492 (7.0)   | Drug therapies<br>31 466 (15.3)  | Drug therapies<br>38 202 (9.9)   |
| 2  | Dressings<br>1574 (6.1)               | COPD<br>4599 (3.4)   | Dressings<br>6016 (2.9)  | Dressings<br>12 771 (3.3)  |
| 3  | Other medical care<br>823 (3.2)       | Bronchitis<br>4241 (3.1)   | Abdominal pain<br>5650 (2.7)   | UTI<br>9159 (2.4)  |
| 4  | Cellulitis of lower limb<br>623 (2.4) | CHF<br>3919 (2.9)  | UTI<br>4044 (2.0)  | Abdominal pain<br>9075 (2.4)   |
| 5  | Periapical abscess<br>372 (1.4)       | Asthma<br>3025 (2.2)   | Alcohol intoxication<br>4329 (2.1)                                       | Orthopedic care<br>8380 (2.2)  |
| Visit disposition, <i>n</i> (%)  |                                       |  |  |  |
| Discharged   | 23 892 (92.9)                         | 102 510 (76.0)   | 177 626 (86.3)   | 334 800 (87.0)   |
| Left against medical advice  | 409 (1.6)                             | 3306 (2.5)   | 10 731 (5.2)   | 14 663 (3.8)   |
| Admitted   | 762 (3.0)                             | 24 873 (18.4)  | 14 082 (6.8)   | 27 476 (7.1)   |
| Transferred to another facility  | 654 (2.5)                             | 4090 (3.0)   | 3376 (1.6)   | 7861 (2.0)   |
| Died   | 2 (0.0)                               | 119 (0.1)  | 37 (0.0)   | 53 (0.0)   |

**Table 5 (part 2 of 2): Cluster analysis and subgroup characterization among people who made frequent emergency department visits from Apr. 1, 2013, to Mar. 31, 2014 — Alberta**

| Characteristic  | Subgroup 1<br>("Short duration")   | Subgroup 2<br>("Older patients")         | Subgroup 3<br>("Young mental health")    | Subgroup 4<br>("Injury")                 |
|---|------------------------------------|--|--|--|
| Hospitalization characteristics (DAD metadata)  |                                    |  |  |  |
| No. of patients with at least 1 admission (%)   | 603 (14.0)                         | 10 926 (58.2)                            | 6209 (48.4)                              | 18 857 (27.8)                            |
| No. of admissions   | 728                                | 26 281                                   | 15 937                                   | 29 826                                   |
| Top 5 ICD-10-CA primary diagnosis chapters, <i>n</i> (%)  |                                    |  |  |  |
| 1   | Digestive<br>125 (17.2)            | Circulatory<br>6145 (23.4)               | Mental and behavioural<br>3522 (22.1)    | Digestive<br>4581 (15.4)                 |
| 2   | Injury and poisoning<br>120 (16.5) | Respiratory<br>5693 (21.7)               | Digestive<br>2933 (18.4)                 | Injury and poisoning<br>4404 (14.8)      |
| 3   | Genitourinary<br>73 (10)           | Abnormal clinical findings<br>2175 (8.3) | Injury and poisoning<br>1655 (10.4)      | Mental and behavioural<br>3526 (11.8)    |
| 4   | Pregnancy<br>71 (9.8)              | Digestive<br>2033 (7.7)                  | Abnormal clinical findings<br>1347 (8.5) | Abnormal clinical findings<br>2647 (8.9) |
| 5   | Circulatory<br>57 (7.8)            | Endocrine<br>1558 (5.9)                  | Respiratory<br>906 (5.7)                 | Genitourinary<br>2405 (8.1)              |
| All alcohol-related diagnoses, <i>n</i> (%)   |                                    |  |  |  |
| No  | 726 (99.7)                         | 26 117 (99.4)                            | 14 479 (90.9)                            | 28 939 (97.0)                            |
| Yes   | 2 (0.3)                            | 164 (0.6)                                | 1458 (9.1)                               | 887 (3.0)                                |
| Mental health hospitalization-related characteristics (MHMD metadata)   |                                    |  |  |  |
| No. of patients with at least 1 admission (%)   | 58 (1.3)                           | 1399 (7.5)                               | 2842 (22.2)                              | 4522 (6.7)                               |
| No. of mental health-related admissions   | 85                                 | 2400                                     | 10 065                                   | 9439                                     |
| Diagnosis category among mental health-related admissions, <i>n</i> (%)   |                                    |  |  |  |
| Mood disorder   | 18 (21.2)                          | 433 (18)                                 | 1629 (16.2)                              | 2137 (22.6)                              |
| Schizophrenic and psychotic disorder  | 19 (22.4)                          | 288 (12)                                 | 1350 (13.4)                              | 1555 (16.5)                              |
| Substance-related disorder  | 20 (23.5)                          | 536 (22.3)                               | 4583 (45.5)                              | 3236 (34.3)                              |
| Organic disorder  | 9 (10.6)                           | 739 (30.8)                               | 252 (2.5)                                | 587 (6.2)                                |
| Other mental health disorder  | 12 (14.1)                          | 210 (8.8)                                | 1110 (11.0)                              | 1144 (12.1)                              |
| Anxiety disorder  | 4 (4.7)                            | 146 (6.1)                                | 407 (4.0)                                | 421 (4.5)                                |
| Personality disorder  | 1 (1.2)                            | 43 (1.8)                                 | 708 (7.0)                                | 322 (3.4)                                |
| Non-mental health disorder  | 2 (2.4)                            | 5 (0.2)                                  | 26 (0.3)                                 | 37 (0.4)                                 |
| <small>Note: CHF = congestive heart failure, COPD = chronic obstructive pulmonary disease, DAD = Discharge Abstract Database, MHMD = Hospital Mental Health Database, ICD-10-CA = International Statistical Classification of Diseases and Related Health Problems, 10th revision, Canadian version, IQR = Interquartile range, NACRS = National Ambulatory Care Reporting System, UTI = urinary tract infection.</small> |                                    |  |  |  |

outreach teams, peer-based violence prevention programs, supportive housing and managed care plans).<sup>48</sup> Finally, our "injury" subgroup pointed to a possible role for individual- and population-level public health injury-prevention messaging.

Our findings were in alignment with literature that demonstrated heterogeneity among people who made frequent visits to the emergency department,<sup>46,49</sup> and with our previous BC characterization, which identified nearly identical

subgroups: short-term, with regularly spaced visits over a short period; older patients with multiple comorbidities; middle-aged patients with visits for mental health issues and alcohol use; and younger patients visiting emergency departments for mental health concerns.<sup>10,46,49</sup>

The comparability of our results strongly suggests generalizability across Canada, indicating that effective interventions could be nationally scaled. However, we lacked the data to

determine whether the racial or ethnic composition of subgroups differed regionally. Barriers, stigma and discrimination affect health equity, access and the quality of care for many racialized groups,<sup>50</sup> and follow-up research and interventions must consider these factors critically.

The existing literature focuses mostly on case management and care plans, targeting people who make frequent visits to the emergency department in aggregate, and has shown moderate effectiveness at decreasing repeat visits and potentially saving costs.<sup>9,51</sup> Researchers, clinicians, emergency departments and policy-makers should undertake qualitative examination and collaborative engagement of subgroups of people who use emergency departments frequently so that they can better understand people's reasons for high use and unmet needs. They should also codesign and pilot patient-centred interventions and referral pathways.

### Limitations

Our analysis was limited by data availability. Variables such as employment and race or ethnicity were unavailable, and we could link only to CIHI's data holdings, which did not include provincial pharmacy records, physician billing records and vital statistics. This restricted our ability to assess health care utilization, family physician attachment and mortality fully. Nonetheless, CIHI's Dynamic Cohort is comprehensive, and it provided access to a built-in control cohort.

Our study was also limited by data quality (e.g., diagnostic coding), although this was mitigated by CIHI's routine quality assurance. Moreover, Ontario and Alberta submit level 3 NACRS data, increasing data completeness.

The accuracy and reliability of the NACRS "ED Visit Indicator" to differentiate emergency department visits from scheduled returns were uncertain. Our cohort likely included patients with scheduled visits, but we had no reliable way of verifying this hypothesis. Therefore, we could not confirm and exclude suspected scheduled visits based on the data available.

Finally, because of delays in acquisition and linkage, our data were not current; the most recent available year was 2015/16. Still, although interim change is possible, the trends we identified remain relevant; for instance, substance use visits have likely increased further in the ongoing opioid epidemic.

### Conclusion

People who use emergency departments frequently are making increasingly higher acuity visits and comprise distinct subgroups ("short duration," "older patients," "young mental health" and "injury"). Clinicians and policy-makers must engage with patients to codesign and advocate for effective interventions (both in the emergency department and outside of it) to address heterogeneous patient-specific needs.

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**Competing interests:** Jessica Moe has received grant funding from the Canadian Institutes of Health Research, Health Canada Substance Use and Addictions Program, Canadian Association of Emergency Physicians, Vancouver Coastal Health Research Institute, Vancouver Foundation, Vancouver Physician Staff Association, UBC Department of Family Practice, Vancouver General Hospital Complex Pain and Addictions Service, BC Centre for Disease Control Foundation for Public Health, and the UBC Faculty of Medicine. Margaret McGregor is a board member of the Vancouver Coastal Health Authority. Kathryn Dong has received grant funding from the Canadian Research Initiative in Substance Misuse, committee honoraria from the College of Physicians and Surgeons of Alberta and the Edmonton Zone Medical Staff Association, financial support from the Royal College of Physicians and Surgeons of Canada and the Canadian Association of Emergency Physicians, and a medical leadership salary from Alberta Health Services. No other competing interests were declared.

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**Contributors:** Jessica Moe conceived the study, designed the analysis, obtained research funding, analyzed the data, interpreted results, and provided overall study oversight. Elle (Yuequiao) Wang designed the analysis, analyzed the data, created tables, and interpreted results. Margaret McGregor, Michael Schull, Kathryn Dong, Brian Holroyd, Eric Grafstein, Corinne Hohl and Johanna Trimble provided feedback on study design, data analysis, and results interpretation. Fiona O'Sullivan assisted with data analysis and table creation. Kimberly McGrail served as a methodological expert, designed the analysis, analyzed the data, and provided feedback on results interpretation. Jessica Moe drafted the manuscript and all authors contributed substantially to its revision. All authors have reviewed the final version, have provided final approval for publication, and agree to be accountable for all aspects of the work.

**Funding:** This study received funding from the Canadian Institutes of Health Research and the Canadian Association of Emergency Physicians.

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**Data sharing:** We accessed our data through a data request to the Canadian Institute for Health Information (CIHI). Additional investigators can access the data analyzed in this study through an independent data request to CIHI.

**Supplemental information:** For reviewer comments and the original submission of this manuscript, please see [www.cmajopen.ca/content/10/1/E232/suppl/DC1](http://www.cmajopen.ca/content/10/1/E232/suppl/DC1).