End-of-Life Care Among Immigrants Disparities or Differences in Preferences?

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Although describing a "good death" is an existentially challenging exercise, most people, if asked to do so, would note the importance of the presence of friends and family, relief

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from distressing symptoms, time at home, completing life goals, and other values. Although these goals are

likely shared quite widely, how they are prioritized, and how they relate to other goals, may vary among individuals and across cultures.¹

Thus, in studies seeking to evaluate end-of-life care, it is essential to differentiate observed variation that results from differences in quality of care from variation that is attributable to differences in the underlying preferences of patients or families. For example, hospital-based deaths are often viewed as a marker of low-quality care based on evidence that most individuals from Western cultures prefer to die at home.² However, some patients may prefer death in hospitals under certain circumstances, perhaps owing to greater abilities to receive palliation for severe symptoms, such as refractory dyspnea, or so as not to burden loved ones with caring for them at home. If such nuanced preferences vary among cultures, then comparing care quality across cultures by this metric might yield erroneous conclusions.

These difficulties in evaluating the quality of end-of-life care challenge the interpretation of the elegant analyses of end-of-life care differences among immigrants to and native residents of Ontario, Canada, reported in this issue of JAMA.³ By leveraging several provincial and national data sets, Yarnell and colleagues³ provide an unparalleled, populationbased comparison of the final 6 months of life among 967 013 native-born and immigrant patients who died in Ontario between 2004 and 2015. With the ability to link immigration data that included variables such as education level and English fluency at the time of immigration, as well as country of birth, with claims data, the authors provide a lens into the end-of-life care patterns for nearly the entire population of Ontario. Such data also provide a unique opportunity to compare outcomes among patients who migrated between 1985 and 2015 (n = 47 514 [5%]) vs all others (ie, long-standing residents).

The authors found that recent immigrants, compared with long-standing Ontario residents, were more likely to die in an acute care hospital outside of an intensive care unit (ICU) (36.4% vs 34.6%) and were more likely to die in an ICU (15.6% vs 10.0%). Recent immigrants were also more commonly admitted to ICUs (24.9% vs 19.2%), spent more days on average in ICUs (2.72 days vs 1.64 days), and more commonly received several forms of life support including mechanical ventilation (21.5% vs 13.6%), dialysis (5.5% vs 3.4%), and surgical feeding tubes for artificial nutrition (5.5% vs 3.0%). Differences in the risks of dying in an ICU persisted after adjustment for demographic characteristics, comorbidities, and other potential confounders, and they appeared to be more strongly associated with country of birth than other variables documented at the time of immigration.

Confidence that the observed associations are real is supported by the additional finding that the increased risks of dying in the ICU were greatest among those who immigrated most recently (ie, 20% among those who immigrated 2 or fewer years prior to death compared with 14% among immigrants who immigrated 21-30 years before death). Thus, with greater time spent in the country, the end-of-life care received by immigrants progressively became more similar to the care received by long-standing residents. Such effects of the "dose of nativity" align with acculturation theory and considerable immigrant health research showing that differences in cultural values, preferences, health behaviors, and underlying risks for poor outcomes become progressively smaller with greater time spent living among a new population.⁴⁻⁶

Still, the mechanisms underlying these findings are difficult to disentangle and have different implications. Among many possible explanations, at least 4 merit consideration. First, there may be a true assimilation of values and preferences over time in a new country. If so, then the larger differences in care observed among more recent immigrants would not be problematic, but may instead reflect uniformly goalconcordant care for patients and families with different underlying objectives. Prior research on regional variation in the intensity of end-of-life care in the United States has suggested that most variation stems from unwarranted differences in clinician behavior rather than differences in patients' preferences.⁷⁻⁹ However, such studies have focused on care variation for well-characterized patients across regions, and thus yield findings that may not apply to the current comparison of within-region differences among immigrants vs longstanding residents.

Second, clinicians may approach goals-of-care discussions differently with patients and families from different cultures or backgrounds based on potentially inaccurate perceptions of differences among these cultures. The finding that the country of birth of patients was among the strongest factors associated with the intensity of care near the end of life is

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consistent with this explanation, which could reflect a care disparity. However, this finding is also consistent with the foregoing explanation of there being true differences in goals across cultures and the provision of care that meets these goals.

Third, with greater time in the country, immigrants may develop greater abilities to communicate their preferences, such that goal-discordant care is progressively reduced. Although the authors adjusted for whether immigrants were fluent in English at the time of immigration, this coarse dichotomization of linguistic ability is unlikely to capture the more nuanced aspects of communication required for highquality family meetings regarding goals of care. If true, this explanation would suggest a true disparity in care delivery for immigrants. Mitigating this disparity would require development and testing of an intervention, such as ensuring greater availability of translators or more routine involvement of translators earlier in the courses of care for immigrants.

Fourth, the narrowing of the differences in care received by long-standing residents and immigrants with greater time spent in the country is consistent with progressive abatement of underlying, but unmeasured, differences in health. Although decedent analyses, such as those presented by Yarnell and colleagues,³ tend to mitigate the possibility of incomplete risk adjustment (because all patients were at sufficiently high risk to have died), the fact that all reported risk ratios moved closer to the null with adjustment suggests the possibility of unmeasured confounding. In addition, if these findings are attributable to incomplete risk adjustment, they cannot be used to support changes in policy or practice.

These interpretive challenges do not diminish the importance of the work by Yarnell and colleagues.³ The first of 3 steps in health disparity research is to detect differences in care processes or health outcomes.^{10,11} Only then can research begin to explore whether the observed variation is attributable to true (ie, unwarranted) disparities in care and to eventually develop interventions to mitigate such disparities. Following this framework, the authors have helped to identify key needs for future research on intensive and palliative care. Future studies that are able to account for differences in patients' preferences, advance care planning, and other factors may help to identify which among several potential mechanisms explain the observed differences in care provided to immigrants and native residents near the end of life. Until such time, it is premature to suggest changes in policy or practice.

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Association Between Immigrant Status and End-of-Life Care in Ontario, Canada

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IMPORTANCE People who immigrate face unique health literacy, communication, and system navigation challenges, and they may have diverse preferences that influence end-of-life care.

OBJECTIVE To examine end-of-life care provided to immigrants to Canada in the last 6 months of their life.

DESIGN, SETTING, AND PARTICIPANTS This population-based cohort study (April 1, 2004, to March 31, 2015) included 967 013 decedents in Ontario, Canada, using validated linkages between health and immigration databases to identify immigrant (since 1985) and long-standing resident cohorts.

EXPOSURES All decedents who immigrated to Canada between 1985 and 2015 were classified as recent immigrants, with subgroup analyses assessing the association of time since immigration, and region of birth, with end-of-life care.

MAIN OUTCOMES AND MEASURES Location of death and intensity of care received in the last 6 months of life. Analysis included modified Poisson regression with generalized estimating equations, adjusting for age, sex, socioeconomic position, causes of death, urban and rural residence, and preexisting comorbidities.

RESULTS Among 967 013 decedents of whom 47 514 (5%) immigrated since 1985, sex, socioeconomic status, urban (vs rural) residence, and causes of death were similar, while long-standing residents were older than immigrant decedents (median [interquartile range] age, 75 [58-84] vs 80 [68-87] years). Recent immigrant decedents were overall more likely to die in intensive care (15.6% vs 10.0%; difference, 5.6%; 95% CI, 5.2%-5.9%) after adjusting for differences in age, sex, income, geography, and cause of death (relative risk, 1.30; 95% CI, 1.27-1.32). In their last 6 months of life, recent immigrant decedents experienced more intensive care admissions (24.9% vs 19.2%; difference, 5.7%; 95% CI, 5.3%-6.1%), hospital admissions (72.1% vs 68.2%; difference, 3.9%; 95% CI, 3.5%-4.3%), mechanical ventilation (21.5% vs 13.6%; difference, 7.9%; 95% CI, 7.5%-8.3%), dialysis (5.5% vs 3.4%; difference, 2.1%; 95% CI, 1.9%-2.3%), percutaneous feeding tube placement (5.5% vs 3.0%; difference, 2.5%; 95% CI, 2.3%-2.8%), and tracheostomy (2.3% vs 1.1%; difference, 1.2%; 95% CI, 1.1%-1.4%). Relative risk of dying in intensive care for recent immigrants compared with long-standing residents varied according to recent immigrant region of birth from 0.84 (95% Cl, 0.74-0.95) among those born in Northern and Western Europe to 1.96 (95% Cl, 1.89-2.05) among those born in South Asia.

CONCLUSIONS AND RELEVANCE Among decedents in Ontario, Canada, recent immigrants were significantly more likely to receive aggressive care and to die in an intensive care unit compared with other residents. Further research is needed to understand the mechanisms behind this association.

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Section Editor: Derek C. Angus, MD, MPH, Associate Editor, *JAMA* (angusdc@upmc.edu). ptimal end-of-life care combines best medical therapy and symptom control in accordance with patient wishes.¹ Many patients receive aggressive inhospital end-of-life care despite a preference for dying in a familiar setting, free from invasive technology.² This discrepancy has many contributors, including inadequate advance care planning, suboptimal communication between health care professionals and patients or their families, poor health literacy, uncertainty about imminence of death, and unavailability of nonintensive end-of-life or palliative care resources.^{3,4}

Canada has high rates of immigration relative to many high-income nations, which in turn leads to a diversity of geographic, cultural, and racial/ethnic backgrounds among its residents.⁵ In 2011 (midway through this study), Ontario, Canada, had a population of 12 851 821, of whom 3 611 365 (29%) were born in other countries and 501 060 (4%) arrived in Canada between 2006 and 2011.⁶ Immigrants often face challenges in communication, health literacy, and navigation of the health care system.⁷⁻⁹ Although immigrants are on average healthier than age-matched Canadians when they arrive in Canada, they subsequently experience excess morbidity and mortality from chronic medical and psychiatric conditions.⁷

Preliminary evidence suggests that some immigrants may face cultural and logistical challenges in end-of-life care due to decreased health literacy or language ability, different modes of family-based decision-making and filial responsibility, and decreased access to care due to insufficient financial and social resources.¹⁰⁻¹⁵ Some immigrants may have different endof-life care preferences than many long-standing residents.¹⁵ To our knowledge, there are no comprehensive large-scale quantitative studies of end-of-life care in recent immigrant populations. This population-based analysis was conducted to describe end-of-life care delivered to recently immigrated compared with long-standing resident decedents, including magnitude of and factors associated with differences in endof-life care.

Methods

Study Setting and Oversight

The study was approved by the research ethics board of Sunnybrook Health Sciences Centre including a waiver for individual patient consent because the data sets were linked using unique encoded identifiers and analyzed at the Institute for Clinical Evaluative Sciences.

Identification of Decedents (Study Participants)

All individuals (recent immigrants and long-standing residents) who died in Ontario between April 1, 2004, and March 31, 2015, were identified. Individuals with fewer than 6 months of enrollment in the provincial health care plan were excluded. Data on individuals who received care in Ontario but died in another country or province were not available. Patients with some missing baseline data were included in unadjusted analyses but not in adjusted analyses requiring a missing variable.

Key Points

Question Do recent immigrant patients experience different end-of-life care than long-standing resident patients?

Findings In this cohort study that included 967 013 patients, recent immigrant patients were more likely to be in the intensive care unit when they died and were more likely to receive invasive procedures in the last 6 months of life including hospital admission, intensive care unit admission, mechanical ventilation, tracheostomy, dialysis, or percutaneous feeding tube placement. These outcomes varied most significantly according to region of origin rather than socioeconomic position, language ability on arrival, or education level on arrival.

Meaning Among decedents in Ontario, Canada, recent immigrants were significantly more likely to receive aggressive care and to die in an intensive care unit compared with other residents. Further research is needed to understand the mechanisms behind this association.

Recent immigrants were identified within the data set through previously validated combined probabilistic and deterministic linkage of the list of deceased individuals to the registry of landed immigrants maintained by Immigration, Refugees and Citizenship Canada.¹⁶ Deterministic linkage occurs when 1 or more identifiers (eg, health card number and name) are identical, while probabilistic linkage uses probability scores to identify linkages among records where deterministic linkages were not possible. Recent immigrants were defined as those granted permanent residency or citizenship status in Canada between 1985 and 2015 (the years available in the Immigration, Refugees and Citizenship Canada data) and created subgroups according to duration since immigration. All other residents were defined as longstanding residents. Other research has reserved the term recent for immigrants arriving within shorter timeframes, but this broader definition sought to include all available data and acknowledge that some members of the long-standing resident cohort may also be immigrants but have lived in Canada for more than 30 years. Immigration, Refugees and Citizenship Canada data also included information obtained at the time of immigration application on immigration class (economic, family, refugee, and other), education level, language ability, and country of birth. Information on the level of health literacy, religion, and specific cultural practices was not available.

Identification of Health Care Use Prior to Death

A combination of health administrative databases linked at the individual level were used to describe health care service use at the population level in Ontario. These included the Registered Persons Database containing vital statistics on all persons issued a Provincial Health Card, the Ontario Health Insurance Plan containing data on all professional services and procedures resulting in charges to the health care system, the Office of the Registrar General for Deaths, the Discharge Abstract Database containing detailed patient-level information including resources used and procedures performed for all inpatients, and the National Ambulatory Care Reporting System for similar data among ambulatory hospital admissions and emergency department presentations.^{17,18} Although these databases do not include care provided at community health centers (frequented by some recent immigrants, but overall reaching less than 1% of the population), the databases contain comprehensive coverage of care provided in hospitals.¹⁹

Characteristics of Patients

Patient characteristics and demographics are reported including age, sex, socioeconomic position based on postal code census data, and place of residence at time of death. Data are reported on intensive care admissions, chronic conditions including the Charlson Comorbidity Index (Deyo modification), hospitalizations, procedures, and emergency department visits during the final 24 months of life, with emphasis on the final 6 months. The database does not contain specific information on do-not-resuscitate orders, advanced care planning, or overall goals of care but captures the consequences of these decisions with respect to health care delivery.

Outcomes

The primary outcome described end-of-life care according to location of death: intensive care unit, acute care hospital, longterm care facility (or nursing home), and other (including hospice or home). The results are described in terms of relative risk (RR), which in this case refers to the ratio of proportions of recent immigrant compared with long-standing resident decedents that experienced a given outcome. Secondary outcomes assessed whether a patient experienced intensive or invasive interventions in the last 6 months of life including hospital admission, intensive care admission, mechanical ventilation, dialysis, percutaneous gastric/gastrojejunal tube, or tracheostomy. Other secondary outcomes included emergency department, hospital, and intensive care use in the last 6 months of life.

Subgroup Analyses

Prespecified subgroup analyses were performed according to patient demographics (age, sex, urban or rural place of residence, and socioeconomic position), comorbidity (specific diagnostic categories and Charlson Comorbidity Index), and recent immigrant characteristics (immigration class, language ability on arrival, education level on arrival, time since immigration, and region of birth) (eTable 1 and eTable 2 in the Supplement).

Statistical Analysis

Recent immigrant and long-standing resident end-of-life care was compared using χ^2 testing for categorical outcomes (location of death and proportion receiving invasive interventions) and rates (emergency department presentation, hospital admission, and intensive care admission), Mann-Whitney tests for comparisons of median duration of stay (hospital and intensive care admissions) and number of episodes (hospital and intensive care admissions and emergency department visits), and *t* tests for comparisons of mean duration (hospital and intensive care unit admissions).

Separate modified Poisson regression analyses of location of death (intensive care unit, acute care hospital, long-term care facility, or other including home) were conducted among recent immigrants compared with longstanding resident decedents to estimate RRs.²⁰ We also performed separate modified Poisson regression analyses of type of invasive care received in the last 6 months including hospital admission, intensive care unit admission, mechanical ventilation, dialysis, percutaneous feeding tube placement, and tracheostomy. All analyses adjusted for potential confounders of age, sex, income quintile, urban-rural residence, and cause of death. To account for the correlation of outcomes among patients residing within the same geographic area, the analysis implemented generalized estimating equations using an exchangeable correlation structure, clustering by postal code.²⁰ Recent immigrants were separately analyzed according to region of birth, years in Ontario, language ability on arrival, education level on arrival, and immigration class while adjusting for the same covariates as above. Two-sided P values less than .05 were considered significant but were not adjusted for multiple comparisons. Analyses were performed with SAS Enterprise Guide 6.1 (SAS Institute) and R 3.2.2 software (R Foundation). Details of the analysis protocol, regional definitions, causes of death, and further analyses assessing robustness across multiple fixed intervals preceding death can be found in eAppendix 1 in the Supplement.

Results

Demographic and Clinical Characteristics

A total of 967 013 decedents were analyzed, of whom 47 514 (5%) immigrated since 1985. Recent immigrant decedents originated from diverse global regions (eTable 3 in the **Supplement**). The median age at death was 79 years, with ischemic heart disease, lung cancer, and dementia being the most common causes of death. Compared with long-standing resident decedents, recent immigrant decedents tended to be younger and more likely to live in an urban area and of lower socioeconomic position (**Table 1**). The median duration in Canada for recent immigrants was 16 years.

End-of-Life Care

Of the 967 013 decedents, 434 783 (45%) died in the hospital including 99 680 (10%) who died in intensive care. Compared with long-standing resident decedents, a higher proportion of recent immigrant decedents died in intensive care (15.6% vs 10.0%; difference, 5.6%; 95% CI, 5.2%-5.9%) (Table 2). This increase persisted after adjusting for differences in age, sex, income, geography, and cause of death (Table 3) (adjusted RR of dying in intensive care comparing recent immigrant with long-standing resident decedents: 1.30; 95% CI, 1.27-1.32; Table 2).

In their last 6 months of life, recent immigrant decedents experienced more intensive care admissions (24.9% vs 19.2%; difference, 5.7%; 95% CI, 5.3%-6.1%), hospital admissions (72.1% vs 68.2%; difference, 3.9%; 95% CI, 3.5%-4.3%),

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| | No. (%) | | Standardized | |
|---|--|--|------------------------|--|
| Characteristic | Long-standing Residents (n = 919 499) | Recent <mark>Immigrants</mark> (n = 47 514) | Difference of Means | |
| Age at death, y | | | | |
| Median (IQR) | 80 (68-87) | 75 (58-84) | 0.33 | |
| ≤40 | 25 731 (3) | 3250 (7) | 0.19 | |
| 41-60 | 109 851 (12) | 10169 (21) | 0.26 | |
| 61-80 | 346 016 (38) | 17 267 (36) | 0.03 | |
| ≥81 | 437 901 (48) | 16828 (35) | 0.25 | |
| Sex | | | | |
| Female | 461 318 (50) | 23 217 (49) | 0.03 | |
| Male | 458 181 (50) | 24297 (51) | 0.03 | |
| <mark>Income</mark> quintile ^b | | | | |
| First (lowest) | 212 052 (<mark>23</mark>) | 14 373 (<mark>30</mark>) | 0.16 | |
| Second | 191 583 (21) | 10878 (23) | 0.05 | |
| Third | 174 606 (19) | 9029 (19) | < 0.01 | |
| Fourth | 170 366 (19) | 7692 (16) | 0.06 | |
| Fifth (highest) | 165 708 (<mark>18</mark>) | 5435 (<mark>12</mark>) | 0.19 | |
| Metropolitan influence zone ^c | | | | |
| None (least urban) | 116 641 (13) | 742 (2) | 0.44 | |
| Weak | 290 846 (32) | 5148 (11) | 0.53 | |
| Moderate | 179 758 (20) | 4151 (9) | 0.31 | |
| Strong (most urban) | 332 142 (36) | 37 462 (79) | 0.96 | |
| Cause of death ^d | | | | |
| Ischemic heart disease | 124 796 (14) | 5089 (11) | 0.09 | |
| Cancer of lung and bronchus | 58 043 (6) | 2314 (5) | 0.06 | |
| Dementia and Alzheimer disease | 53 053 (6) | 1628 (3) | 0.11 | |
| Cerebrovascular diseases | 47 599 (5) | 2596 (6) | 0.01 | |
| Chronic lower respiratory diseases | 31 778 (4) | 730 (2) | 0.12 | |
| Cancer of colon, rectum, or anus | 27 878 (3) | 1323 (3) | 0.01 | |
| Diabetes | 24516 (3) | 1245 (3) | < 0.01 | |
| Influenza and pneumonia | 22 737 (3) | 1061 (2) | 0.02 | |
| Cancer of lymph, blood and related | 21853 (2) | 1333 (3) | 0.03 | |
| Cancer of breast | 16886 (2) | 1171 (3) | 0.04 | |
| Others | 490 360 (53) | 29 024 (61) | 0.16 | |
| Charlson Comorbidity Index score | | | | |
| ≤2 | 383 790 (42) | 17 773 (37) | 0.1 | |
| 3-4 | 170 153 (19) | 8623 (18) | 0.01 | |
| ≥5 | 270 605 (<mark>29</mark>) | 16 477 (<mark>35</mark>) | 0.12 | |
| Missinge | 94 951 (10) | 4641 (10) | | |

Abbreviation: IQR, interquartile range.

^a This Table shows the baseline characteristics for each cohort in absolute number and percentage form. As a consequence of large sample sizes, all differences are significant by χ^2 testing. The standardized difference of means is included as a more appropriate test of difference between subgroups with large sample sizes. Standardized differences show the ratio of the difference in means and SDs. Values less than 0.1 are generally considered to reflect negligible differences between subgroups.

^b Defined by postal code average income.

- ^c Describes the extent to which an area is urbanized, with "strong" being the most urbanized.
- ^d Selected from most common; additional information available in eTable 11 in the Supplement, which includes 67 categories of causes of death ordered by prevalence.
 ^e No admissions in final 24 months of life.

mechanical ventilation (21.5% vs 13.6%; difference, 7.9%; 95% CI, 7.5%-8.3%), dialysis (5.5% vs 3.4%; difference, 2.1%; 95% CI, 1.9%-2.3%), percutaneous feeding tube placement (5.5% vs 3.0%; difference, 2.5%; 95% CI, 2.3%-2.8%), and tracheostomy (2.3% vs 1.1%; difference, 1.2%; 95% CI, 1.1%-1.4%), even after adjusting for potential confounders (Table 2 and eTable 4 and eTable 5 in the Supplement). These increases persisted across various fixed intervals preceding death (1 month, 6 months, 12 months, and 24 months) (eFigure 1 in the Supplement).

Subgroup Analyses

Our finding that recent immigrant decedents were more likely to die in intensive care was consistent across diverse subgroups including older age at death, sex, socioeconomic status, place of residence, and Charlson Comorbidity Index score (**Figure 1**). The association persisted across different conditions including colorectal cancer (RR, 1.26; 95% CI, 1.02-1.57), diabetes (RR, 1.99; 95% CI, 1.74-2.28), cerebrovascular disease (RR, 2.12; 95% CI, 1.98-2.28), and dementia (RR, 3.69; 95% CI, 2.66-5.13).

The RR of death in intensive care comparing recent immigrant and long-standing resident decedents was highest among patients older than 80 years, female patients, and patients with a lower comorbidity index (Figure 1). There was substantial variation in end-of-life care according to region of birth and time since immigration (**Figure 2**). The RR of dying in intensive care (using the overall long-standing resident risk

| Variable | Long-standing Residents (n = 919 499) | Recent Immigrants (n = 47 514) | Absolute Difference in Percentage Points (95% CI) | Unadjusted Relative Risk (95% CI) | Adjusted Relative Risk (95% CI) |
|--|---|--------------------------------------|---|---|---------------------------------------|
| Location of <mark>death</mark> , No. (%) | | | | | |
| ICU | 92 270 (<mark>10</mark>) | 7410 (<mark>16</mark>) | 5.6 (5.2 to 5.9) | 1.55 (1.52 to 1.59) | 1.30 (1.27 to 1.32) |
| Acute care hospital (not ICU) | 317 830 (35) | 17 273 (36) | 1.8 (1.4 to 2.2) | 1.05 (1.04 to 1.06) | 1.06 (1.05 to 1.09) |
| Long-term care facility | 73 628 (8) | 3608 (8) | -0.4 (-0.2 to -0.6) | 0.95 (0.92 to 0.98) | 0.92 (0.88 to 0.95) |
| Other (including home) | 435 771 (47) | 19 223 (41) | -6.9 (-6.5 to -7.4) | 0.85 (0.84 to 0.86) | 0.89 (0.88 to 0.90) |
| Care received in final 6 mo, No. (%) | | | | | |
| Hospital admission | 626 739 (<mark>68</mark>) | 34 261 (<mark>72</mark>) | 3.9 (3.5 to 4.3) | 1.06 (1.05 to 1.06) | 1.04 (1.04 to 1.06) |
| ICU admission | 176 417 (<mark>19</mark>) | 11 840 (<mark>25</mark>) | 5.7 (5.3 to 6.1) | 1.30 (1.28 to 1.32) | 1.16 (1.15 to 1.19) |
| Mechanical ventilation | 125 246 (<mark>14</mark>) | 10 227 (<mark>22</mark>) | 7.9 (7.5 to 8.3) | 1.60 (1.54 to 1.66) | 1.28 (1.25 to 1.30) |
| Dialysis | 31 639 (<mark>3</mark>) | 2615 (<mark>6</mark>) | 2.1 (1.9 to 2.3) | 1.58 (1.55 to 1.61) | 1.39 (1.33 to 1.45) |
| Percutaneous feeding tube | 27 438 (3) | 2627 (6) | 2.5 (2.3 to 2.8) | 1.85 (1.78 to 1.93) | 1.51 (1.45 to 1.59) |
| Tracheostomy | 9978 (1) | 1091 (2) | 1.2 (1.1 to 1.4) | 2.12 (1.99 to 2.25) | 1.61 (1.51 to 1.72) |
| Care episodes in final 6 mo, median (IQR) ^b | | | | | |
| Hospital admission length, d ^c | 6 (0-19) | 7 (0-22) | | | |
| Hospital admissions, No. ^c | 1 (0-2) | 1 (0-2) | | | |
| ICU admission length, d ^c | 0 (0-0) | 0 (0-0) | | | |
| ICU admissions, No. ^c | 0 (0-0) | 0 (0-0) | | | |
| Emergency department visits, No. ^d | 1 (1-2) | 1 (1-2) | | | |

Abbreviation: ICU, intensive care unit; IQR, interquartile range.

^a Each relative risk calculated in binary fashion, eg, death in ICU compared with death in all other locations. Exposure variables in modified Poisson regression analyses: age, sex, income quintile, urbanization of place of living, date of death, and cause of death (categories: cancer, cardiovascular, sepsis, and other). This table shows the outcome data in absolute and percentage form, with unadjusted relative risk and adjusted relative risk based on modified Poisson regression showing the magnitude and significance of any differences. Positive absolute percentage differences indicate increased percentage of recent immigrants as compared with long-standing residents.

^b Care episode data show the median and interquartile range for the number of emergency department visits, hospital admissions, and ICU admissions per decedent, as well as the median and interquartile range of the duration of hospital and ICU admission per decedent.

^c Between-group comparison, *P* < .001.

^d Between-group comparison, *P* = .15.

of dying in intensive care as baseline) ranged from 0.84 (95% CI, 0.74-0.95) among decedents born in northern and western Europe to 1.78 (95% CI, 1.66-1.92) among decedents born in western and central Asia, 1.84 (95% CI, 1.70-2.00) among decedents born in Africa, and 1.96 (95% CI, 1.89-2.05) among decedents born in South Asia (eFigure 2 in Supplement). After adjustment for age and other covariates in the recent immigrant population, the increased **RR** of dying in intensive care persisted among recent immigrant decedents from East Asia, Central America and Mexico, South America, Africa, western and central Asia, Southeast Asia, and South Asia. All other regions, including Northern and Western Europe, did not show statistically significant differences from Northern America (eTable 6 in Supplement). Differences were associated with time in Canada, with an <u>RR</u> of dying in intensive care of 1.42 (95% CI, 1.36-1.48) among those who immigrated 21 to 30 years before death and an RR of 2.03 (95% CI, 1.80-2.29) seen in those who immigrated

fewer than 2 years before death. In adjusted analyses, the increased RR of dying in intensive care seen among recent immigrant decedents who immigrated 2 or fewer years before death remained statistically significant relative to recent immigrant decedents who immigrated more than 10 years before death, but the differences between those who immigrated between 3 and 10 years before death were no longer statistically significant (eTable 6 in the Supplement). There were no significant differences in the adjusted analysis according to immigration class, language ability on arrival, socioeconomic position, or education level on arrival.

Sensitivity Analyses

The primary analysis does not include recent immigrant decedents who left Ontario before death. However, for the 95% CI of our estimate for proportion of recent immigrant decedents dying in intensive care to overlap with the

| | Intensive Care (n = 99 680) | | Hospital (Non-I (n = 335 103) | CU) | Long-term Care (77 236) | 2 | Other (454 994) | |
|---|--------------------------------|-------------------------|----------------------------------|-------------------------|----------------------------|-------------------------|-------------------------|------------------------|
| Variable | No. of Decedents (%) | Adjusted RR (95% CI) | No. of Decedents (%) | Adjusted RR (95% CI) | No. of Decedents (%) | Adjusted RR (95% CI) | No. of Decedents (%) | Adjusted RR (95%) |
| Age, y | | | | | | | | |
| ≤40 | 4977 (5) | 1 [Reference] | 4049 (1) | 1 [Reference] | 584 (1) | 1 [Reference] | 19 371 (4) | 1 [Reference] |
| 41-60 | 18 487 (19) | 1.03 (1.00-1.06) | 33 995 (10) | 1.95 (1.90-2.02) | 7789 (10) | 2.69 (2.48-2.93) | 59749 (13) | 0.76 (0.75-0.77) |
| 61-80 | 49 283 (49) | 0.90 (0.87-0.92) | 135 734 (41) | 2.61 (2.54-2.69) | 32 532 (42) | 3.83 (3.53-4.16) | 145 734 (32) | 0.60 (0.60-0.61) |
| ≥81 | 26 933 (27) | 0.34 (0.33-0.35) | 161 325 (48) | 2.67 (2.59-2.76) | 36 331 (47) | 4.22 (3.87-4.60) | 230 140 (51) | 0.72 (0.71-0.73) |
| Sex | | | | | | | | |
| Female | 56 243 (56) | 1 [Reference] | 165 059 (49) | 1 [Reference] | 39039 (51) | 1 [Reference] | 237 000 (52) | 1 [Reference] |
| Male | 43 437 (44) | 1.10 (1.08-1.11) | 170 044 (51) | 1.06 (1.05-1.06) | 38 197 (49) | 0.99 (0.97-1.00) | 217 994 (48) | 0.93 (0.93-0.94) |
| Income quintile | | | | | | | | |
| First (lowest) | 24 250 (24) | 1 [Reference] | 78 807 (24) | 1 [Reference] | 17 997 (23) | 1 [Reference] | 105 371 (23) | 1 [Reference] |
| Second | 21722 (22) | 1.03 (1.00-1.06) | 72911 (22) | 1.02 (1.00-1.04) | 17 019 (22) | 1.02 (0.95-1.08) | 90 809 (20) | 0.98 (0.95-1.00) |
| Third | 18723 (19) | 1.00 (0.97-1.03) | 64277 (19) | 0.99 (0.97-1.01) | 14 481 (19) | 0.95 (0.90-1.00) | 86 154 (19) | 1.02 (0.99-1.04) |
| Fourth | 17 820 (18) | 0.99 (0.96-1.03) | 60914 (18) | 0.96 (0.94-0.99) | 13 858 (18) | 0.93 (0.88-0.98) | 85 466 (19) | 1.04 (1.02-1.07) |
| Fifth (highest) | 16 647 (17) | 1.00 (0.96-1.03) | 56619(17) | 0.93 (0.90-0.95) | 13 391 (17) | 0.92 (0.87-0.97) | 84 486 (19) | 1.08 (1.05-1.11) |
| Metropolitan influence zone ^b | | | | | | | | |
| None (least urban) | 10 222 (10) | 1 [Reference] | 42 582 (13) | 1 [Reference] | 7550 (10) | 1 [Reference] | 57 029 (13) | 1 [Reference] |
| Weak | 28 675 (29) | 1.11 (1.06-1.16) | 99 393 (30) | 0.92 (0.90-0.95) | 26 521 (34) | 1.39 (1.31-1.48) | 141 405 (31) | 0.99 (0.95-1.02) |
| Moderate | 17 967 (18) | 1.13 (1.08-1.19) | 58 512 (17) | 0.87 (0.84-0.90) | 10 256 (13) | 0.86 (0.79-0.92) | 97 174 (21) | 1.10 (1.06-1.13) |
| Strong (most urban) | 42 806 (43) | 1.30 (1.25-1.35) | 134 580 (40) | 0.99 (0.97-0.78) | 32 901 (43) | 1.38 (1.30-1.46) | 159 317 (35) | 0.90 (0.88-0.93) |
| Cause of death ^c | | | | | | | | |
| Other | 52 341 (53) | 1 [Reference] | 149791 (45) | 1 [Reference] | 31 053 (40) | 1 [Reference] | 228 138 (50) | 1 [Reference] |
| Cancer | 10833 (11) | 0.36 (0.35-0.37) | 97 956 (29) | 1.32 (1.30-1.33) | 33 481 (43) | 2.31 (2.26-2.36) | 81 148 (18) | 0.77 (0.77-0.78) |
| Cardiovascular | 28 453 (29) | 1.13 (1.11-1.14) | 68 602 (20) | 0.82 (0.81-0.83) | 11 109 (14) | 0.66 (0.65-0.68) | 134 205 (29) | 1.15 (1.14-1.16) |
| Sepsis | 8053 (8) | 2.06 (2.02-2.10) | 18754 (6) | 1.38 (1.36-1.39) | 1593 (2) | 0.56 (0.53-0.59) | 11 503 (3) | 0.59 (0.58-0.60) |
| Date of death (per year between 2004 and 2015) | | 1.001 (0.999-1.003) | | 0.988 (0.988-0.989) | | 1.01 (1.01-1.02) | | 1.001 (1.006-1.007) |

Table 3. Modified Poisson Regression for Relative Risk of Each Location of Death (N = 967 013)^a

Abbreviations: ICU, intensive care unit; RR, relative risk.

^a This Table shows the adjusted relative risks of dying in intensive care

^b Describes the extent to which an area is urbanized, with "strong" being the most urbanized.

associated with each row variable estimated by modified Poisson regression with generalized estimating equations incorporating postal code geographic data as well as immigration status (see Table 2) and each variable in the rows of the table

^c Diagnostic categories defined in eTable 11 in the Supplement, according to clinically relevant subsets of causes of death.

corresponding quantity among long-standing residents, 26 329 recent immigrants (36%) would have had to leave Ontario and then die outside of an intensive care unit (eAppendix 2 in the Supplement).

A total of 14 758 decedents were excluded owing to fewer than 6 months of health care enrollment, of whom 458 (3%) were recent immigrants. The prevalence of missing data was highest in the Charlson Comorbidity Index score data because of a subset of patients who were never hospitalized, but otherwise the proportion of missing data was small (eTable 7 in Supplement).

Other sensitivity analyses assessed the difference between recent immigrants identified through deterministic as opposed to probabilistic matching. Of the 47514 recent immigrant decedents identified, 37 046 (78%) were identified with deterministic linking and 10468 (22%) were identified with probabilistic linking (eTable 8 in the Supplement). The 2 cohorts of recent immigrants were similar with respect to baseline characteristics, unadjusted primary analysis, and adjusted secondary analyses (eTables 3, 9, 10, and 11 in the Supplement).

Discussion

Among decedents in Ontario, recent immigrants were significantly more likely to receive aggressive care and to die in an intensive care unit than long-standing residents. In the last 6 months of life, recent immigrant decedents were more likely to experience intensive care unit admission, hospital admission, mechanical ventilation, dialysis, percutaneous feeding tube placement, and tracheostomy. These increased rates of aggressive care varied substantially according to region of birth, attenuated with time in Canada, and were

Figure 1. Proportion of Decedents Dying in Intensive Care^a

| | No. (%) Dying in Intensive Care | | Unadiusted | |
|--|---------------------------------|-----------|------------------|------------|
| | Long-standing | Recent | Relative Risk | |
| | Resident | Immigrant | (95% CI) | |
| Age, y | | | | |
| ≤40 | 4372 (17) | 605 (19) | 1.10 (1.01-1.18) | |
| 41-60 | 16624 (15) | 1863 (18) | 1.21 (1.16-1.26) | - |
| 61-80 | 18839 (15) | 1292 (20) | 1.43 (1.38-1.47) | - |
| ≥81 | 46006 (13) | 3277 (19) | 1.71 (1.64-1.80) | - |
| Sex | | | | |
| Male | 52115 (11) | 4128 (17) | 1.49 (1.45-1.54) | |
| Female | 40155 (9) | 3282 (14) | 1.62 (1.57-1.68) | - |
| Income Quintile | | | | |
| Fifth (highest) | 15921 (10) | 726 (13) | 1.39 (1.30-1.49) | |
| Fourth | 16765 (10) | 1055 (14) | 1.39 (1.32-1.48) | - |
| Second | 20032 (11) | 1690 (16) | 1.49 (1.42-1.56) | - |
| Third | 17259 (10) | 1464 (16) | 1.64 (1.56-1.72) | - |
| First (lowest) | 21788 (10) | 2462 (17) | 1.67 (1.60-1.73) | - |
| Metropolitan Influence Zone ^b | | | | |
| None (least urban) | 10161(9) | 61 (8) | 0.94 (0.74-1.20) | |
| Weak | 28021 (10) | 654 (13) | 1.32 (1.23-1.42) | |
| Moderate | 17351(10) | 616 (15) | 1.54 (1.43-1.66) | |
| Strong (most urban) | 36727 (11) | 6079 (16) | 1.47 (1.43-1.50) | |
| Cause of Death | | | | |
| Colorectal cancer | 1368 (5) | 82 (6) | 1.26 (1.02-1.57) | _ |
| Other | 57047(12) | 4649 (16) | 1.38 (1.34-1.42) | = |
| Lung cancer | 2555 (4) | 150 (6) | 1.47 (1.26-1.73) | _ _ |
| Influenza and pneumonia | 3245 (14) | 247 (23) | 1.63 (1.46-1.83) | |
| Ischemic heart disease | 13162(11) | 882 (17) | 1.64 (1.54-1.75) | |
| Hematologic malignancy | 2553 (12) | 276 (21) | 1.77 (1.59-1.98) | |
| Chronic lower respiratory disease | 3817 (12) | 158 (22) | 1.80 (1.56-2.08) | |
| Breast cancer | 493 (3) | 66 (6) | 1.93 (1.50-2.48) | |
| Diabetes | 1955 (8) | 198 (16) | 1.99 (1.74-2.28) | _ _ |
| Cerebrovascular disease | 5731 (12) | 663 (26) | 2.12 (1.98-2.28) | -=- |
| Dementia | 344 (1) | 39 (3) | 3.69 (2.66-5.13) | |
| Charlson Comorbidity Index Score | | | | |
| ≥5 | 25165(9) | 2132 (13) | 1.39 (1.34-1.45) | = |
| 3-4 | 25925 (15) | 2025 (24) | 1.54 (1.48-1.60) | - |
| ≤2 | 41180 (11) | 3253 (18) | 1.71 (1.65-1.76) | • |
| | | | 0 | 7 10 |

Forest plot depicting the ratio of the proportions of decedents dying in intensive care units comparing recent immigrant with long-standing resident cohorts (relative risk). Relative risks greater than 1 correspond to an increased relative risk of recent immigrant compared with long-standing resident decedents being in the intensive care unit at death. The size of each square is proportional to the precision of the relative risk estimate.

^a The denominator for each row is the total number of decedents in each cohort in each subgroup by row, ie, the denominator for each cell in the corresponding cell in Table 1.

Unadjusted Relative Risk (95% CI)

^b Denotes the extent to which an area is urbanized, with "strong" being the most urbanized.

not explained by differences in <mark>age</mark>, sex, <mark>cause</mark> of <mark>death, comorbidity,</mark> or socioeconomic position.

This study is a large-scale population-level quantitative analysis of end-of-life care provided to patients who have recently immigrated, using comprehensive data on hospital care as a consequence of universal health insurance. The data show extensive global region variation, with recent immigrants from Northern and Western Europe experiencing less-aggressive end-of-life care than long-standing residents, while those from Africa, South Asia, or Southeast Asia experienced the most-aggressive end-of-life care relative to long-standing residents. Qualitative research conducted in multiple cultural settings corroborates the finding that differences in end-of-life care provided to recent immigrants may be associated with region of origin.²¹⁻²⁵ Within Europe and Asia, variations in the rate of organ-supporting care at the end of life are significantly associated with both region and the culture or religion of patients and physicians.^{26,27} The results agree with quantitative research conducted in racial/ethnic minority groups in the United States.^{21,22,24,25,28,29} The differences in end-of-life care delivery may also attenuate with time since immigration, consistent with other research describing acculturation and end-of-life care.³⁰

The variation in end-of-life care based on region of birth has multiple potential explanations, including patient preferences, cultural differences, clinician behavior, endof-life care decision processes, or differences in service accessibility.^{10,31} If recent immigrants live in social and geographic communities relating to their region of birth, this could lead to differential palliative care service availability for certain groups.³² Clinicians may conduct end-of-life care discussions in different ways, or less commonly, based on

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Figure 2. Proportion of Decedents Dying in Intensive Care: Recent Immigrant Characteristics^a

| Ν | No. (%) Dying in Intensive Care | | Unadiusted | | |
|--|---------------------------------|---------------------|--|--|-----|
| L | ong-standing esident | Recent Immigrant | Relative Risk ^a (95% CI) | | |
| Region of Birth | | | . , | : | — |
| Northern and Western Europe | | 221 (8) | 0.84 (0.74-0.95) |) —— | |
| Northern America | | 121 (11) | 1.11 (0.94-1.31) |) | |
| Southern Europe | | 225 (11) | 1.11 (0.98-1.26) |) | |
| Eastern Europe | | 873 (13) | 1.26 (1.19-1.35) |) — | |
| East Asia | | 1118 (14) | 1.38 (1.31-1.46) |) | |
| Oceania | | 59 (15) | 1.46 (1.15-1.85) |) | |
| Central America, Caribbean, and Mexico | | 611 (16) | 1.59 (1.48-1.71) |) — | |
| South America | | 431 (17) | 1.67 (1.53-1.82) |) | |
| Southeast Asia | | 776 (17) | 1.74 (1.63-1.85) |) | |
| Western and Central Asia | | 597 (18) | 1.78 (1.66-1.92) |) — | |
| Africa | | 482 (18) | 1.84 (1.70-2.00) |) — | |
| South Asia | | 1893 (20) | 1.96 (1.89-2.05) |) = | |
| Time in Ontario, y | | | | | |
| 21-30 | | 1826 (14) | 1.42 (1.36-1.48) |) - | |
| 16-20 | | 2039 (15) | 1.52 (1.46-1.58) |) = | |
| 11-15 | | 1631 (16) | 1.56 (1.49-1.63) |) - | |
| 6-10 | | 1152 (17) | 1.72 (1.63-1.81) |) | |
| 3-5 | | 545 (18) | 1.75 (1.62-1.89) |) | |
| ≤2 | | 217 (20) | 2.03 (1.80-2.29) |) — | |
| Language Ability on Arrival | | | | | |
| Not fluent in English | | 3478 (15) | 1.49 (1.44-1.54) |) 🗕 | |
| Fluent in English | | 3931 (16) | 1.62 (1.57-1.66) |) = | |
| Education Level on Arrival, y | | | | | |
| ≤9 | | 3179 (15) | 1.48 (1.43-1.53) |) = | |
| ≥10 | | 4231 (16) | 1.62 (1.57-1.66) |) = | |
| Immigration Type | | | | | |
| Family | | 4377 (14) | 1.44 (1.40-1.48) |) = | |
| Other | | 297 (15) | 1.49 (1.34-1.66) |) — | |
| Economic | | 1608 (18) | 1.79 (1.71-1.87) |) - | |
| Refugee | | 1128 (18) | 1.81 (1.72-1.91) |) | |
| Entire Cohort ^b 9 | 2 270 (10) | 7410 (16) | 1.55 (1.52-1.59) |) | |
| | | | | 0.7 1.0 Unadiusted Relative Risk (95% CI) | 4.0 |

Forest plot analogous to Figure 1 depicting the ratio of the proportions of decedents dying in intensive care units comparing recent immigrant with long-standing resident cohorts (relative risk). In contrast to Figure 1, this figure focuses on subgroups defined only among the recent immigrant cohort including region of origin, language ability on arrival, education level on arrival, immigration class, and time since immigration. The proportion of recent immigrant decedents dying in intensive care within each subgroup is compared with the proportion of long-standing resident decedents dying in intensive care (92 270 of 919 499 [10%]), and so a relative risk greater than 1 corresponds to

an increased relative risk of recent immigrant compared with long-standing resident decedents being in the intensive care unit at death. Note that percentages are based on the size of each subgroup by row, not based on the overall analytic sample size for recent immigrant decedents of 47 514. The size of each square is proportional to the precision of the relative risk estimate.

^a The denominator data for the percentages are the total numbers of recent immigrant decedents in each subgroup, ie, the corresponding cells in eTable 3 in the Supplement.

conscious or subconscious cultural, geographic, or religious perceptions of end-of-life care practices.³³ Variation seen across diagnostic categories suggests the possibility of residual confounding due to clustering of disease processes and immigration status, although the associations with more-aggressive care persist after adjustment for category of cause of death. Many recent immigrant patients and families may be more familiar with clinician-directed or family and community-based models of medical decision-making, leading to different outcomes in an environment where patient preferences or shared patient-clinician decision-making guide end-of-life care decisions.^{15,21,33} The findings in this study might also be explained by differences in health literacy or language ability that could promote more aggressive end-of-life care through delayed clinical presentations, incomplete understanding of

medical situations, or even decreased trust of health care professionals.^{31,34,35} However, the findings did not appear to be explained by English proficiency, level of education, socio-economic position, nor place of residence at time of death.

Limitations

This study has several limitations. The most important limitation is that the recent immigrant and long-standing resident cohorts differed significantly in terms of age, socioeconomic status, and geography, which leaves the possibility of residual confounding.³⁶ However, comprehensive coverage of all hospital care for every Canadian resident reduces confounding due to economic barriers that may exist to a greater extent in some other jurisdictions and with adjustment of these and other baseline characteristics, the potential for residual confounding should be greatly reduced. Another limitation is that different diseases have different terminal time courses, while the design analyzed fixed intervals preceding death; therefore, some aspects of end-of-life care may have been missed or some care prior to end of life may have been included.³⁷ Health administrative databases are also limited in terms of risk adjustment by disease severity; however, decedent analyses involve inherent severity adjustment through selection of patients who have died. Although data were captured on all decedents in Ontario, no data were available about recent immigrants who returned to their country of origin to die; however, these populations are likely very small (eAppendix 2 in the Supplement). There were no analyses of hospital length of stay prior to intensive care unit admission. There were no data on or analyses of marital status, language ability for long-standing residents (or language ability more recently than arrival for recent immigrants), education level for long-standing residents, or goals of care and preferences for any patients or families.

Conclusions

Among decedents in Ontario, recent immigrants were significantly more likely to receive aggressive care and to die in an intensive care unit compared with other residents. Further research is needed to understand the mechanisms behind this association.

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Author Contributions: Dr Fowler had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Supplementary Online Content

Yarnell CJ, Fu L, Manuel D, et al. Association between immigrant status and end-of-life care in Ontario, Canada. *JAMA*. Published online October 2, 2017. doi:10.1001/JAMA.2017.14418

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This supplementary material has been provided by the authors to give readers additional information about their work.

eAppendix 1. eMethods

Basic Definitions

Study inclusion - all individuals who died in Ontario between April 1 2004 and March 31 2015, excluding individuals with less than 6 months of enrolment in the provincial health care plan.

Recent immigrant – an individual in the study population granted permanent residency status in Canada between 1985 and 2015 according to the IRCC data.

Long-standing resident – an individual included in the study who is not a recent immigrant.

Analysis Plan / Protocol

1) Primary analysis. Compare location of death for recent immigrant and long-standing resident cohorts in binary outcome (intensive care versus all other) and multiple outcome (ICU, hospital-non-ICU, long-term care, other) analyses.

2) Primary subgroup analysis. Repeat the primary analysis on location of death (intensive care versus all other) stratified by age brackets (5-10 years each according to sample size), gender (male or female), socioeconomic position (quintiles), urbanization of place of living (metropolitan influence zone), and primary diagnoses (cardiovascular, neurologic, oncologic, psychiatric, other top 20 diagnoses). Results displayed by forest plot.

3) Primary adjusted analysis. Analyze location of death (ICU, hospital-non-ICU, long-term care, other) across the whole cohort using modified Poisson regression to assess for the influence of immigration status, age, gender, SES by postal code, date of death and primary causes of death (using broad diagnostic categories). We included all of the Table 1 variables (age, sex, income quintile, metropolitan influence zone, cause of death) as potential predictors in the model.

4) Primary analysis reported by recent immigrant subgroup. Repeat the primary analysis on location of death (intensive care versus all other) comparing the whole long-standing resident cohort to subgroups of the recent immigrant cohort according to language ability on arrival (English-speaking or not), level of education on arrival (at least 10 or less than 10 years of education), immigration class (economic, family, refugee), and region of origin (as defined in appendix).

3) Primary adjusted analysis within recent immigrant cohort. Analyze location of death (intensive care versus all other) within only the recent immigrant cohort using modified Poisson regression to assess the influence of language ability on arrival, level of education on arrival, immigration class and region of origin as well as age, gender, SES by postal code, date of death and primary causes of death (using broad diagnostic categories). We also included all of the Table 1 variables (age, sex, income quintile, metropolitan influence zone, cause of death) as potential predictors in the model.

5) Secondary analysis. Compare recent immigrant and long-standing resident cohorts with respect to proportion receiving different invasive interventions in the last 6 months of life (hospital admission, intensive care admission, mechanical ventilation, dialysis, percutaneous feeding tube, and tracheostomy). We repeated the analyses using different intervals preceding death (1 month, 12 months, 24 months).

6) Secondary adjusted analysis. Analyze the proportion receiving different invasive interventions in the last 6 months of life using modified Poisson regression to assess the influence of immigration status, age, gender, SES by postal code, date of death and primary causes of death (using broad diagnostic categories). We will conduct a

separate modified Poisson regression for each of the following six outcomes: proportion experiencing hospital admission, intensive care admission, mechanical ventilation, dialysis, percutaneous feeding tube, and tracheostomy. We will include all of the Table 1 variables as potential predictors in the model.

7) Utilization data. Compare duration and number of hospital admissions and ICU admissions (days in ICU and days in hospital, number of hospital and ICU episodes) as well as emergency department visits during final 6 months of life for recent immigrant and long-standing resident cohorts.

Regional Definitions

Drawn from the United Nations at https://unstats.un.org/unsd/methods/m49/m49regin.htm

Northern Europe and Western Europe: Åland Islands, Channel Islands, Denmark, Estonia, Faeroe Islands, Finland, Guernsey, Iceland, Ireland, Isle of Man, Jersey, Latvia, Lithuania, Norway, Sark, Svalbard and Jan Mayen Islands, Sweden, United Kingdom of Great Britain and Northern Ireland, Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, Monaco, Netherlands, Switzerland

Southern Europe: Albania, Andorra, Bosnia and Herzegovina, Croatia, Gibraltar, Greece, Holy See, Italy, Malta, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain, The former Yugoslav Republic of Macedonia,

Eastern Europe: Belarus, Bulgaria, Czech Republic, Hungary, Poland, Republic of Moldova, Romania, Russian Federation, Slovakia, Ukraine

Western and Central Asia: Afghanistan, Iran, Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, State of Palestine, Syrian Arab Republic, Turkey, United Arab Emirates, Yemen, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

Southeast Asia: Brunei, Cambodia, Indonesia, Vietnam, Thailand, Philippines, Myanmar, Timor-Leste, Laos, Malaysia

South Asia: India, Bhutan, Nepal, Maldives, Bangladesh, Sri Lanka, Pakistan

East Asia: China, Hong Kong, Macao, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea

Africa: Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Réunion, Rwanda, Seychelles, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia, Zimbabwe, Middle Africa, Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome and Principe, Algeria, Egypt, Libya, Morocco, Sudan, Tunisia, Western Sahara, Botswana, Lesotho, Namibia, South Africa, Swaziland, Western Africa, Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Saint Helena, Senegal, Sierra Leone, Togo

Northern America: United States, Bermuda, Greenland, St. Pierre et Miquelon

Central America, Caribbean and Mexico: Mexico, Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Bonaire Saint Eustatius and Saba, British Virgin Islands, Cayman Islands, Cuba, Curaçao, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Puerto Rico, Saint-Barthélemy, Saint Kitts and Nevis, Saint Lucia, Saint Martin (French part), Saint Vincent and the Grenadines, Sint Maarten (Dutch part), Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama

South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Falkland Islands (Malvinas), French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela (Bolivarian Republic of)

Oceania: Australia, New Zealand, Norfolk Island, Melanesia, Fiji, New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu, Micronesia, Guam, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, Northern Mariana Islands, Palau, Polynesia, American Samoa, Cook Islands, French Polynesia, Niue, Pitcairn, Samoa, Tokelau, Tonga, Tuvalu, Wallis and Futuna Islands

Special Care Unit Codes

(used to define location of death as intensive care unit):

- 10—Medical Intensive Care Nursing Unit ("MICU")
- 20—Surgical Intensive Care Nursing Unit
- 25—Trauma Intensive Care Nursing Unit
- 30—Combined Medical/Surgical Intensive Care Nursing Unit ("MSICU")
- 35-Burn Intensive Care Nursing Unit
- 40—Cardiac Intensive Care Nursing Unit
- 45—Coronary Intensive Care Nursing Unit
- 50-Neonatal Intensive Care Nursing Unit
- 60-Neurosurgery Intensive Care Nursing Unit
- 70—Pediatric Intensive Care Nursing Unit
- 80-Respirology Intensive Care Nursing Unit
- 90—Step-down Medical Unit
- 95—Step-down Surgical Unit
- 98—Provincially defined

eAppendix 2. Sensitivity Analysis of Recent Immigrant Decedents Who Leave Ontario Before Death

Consider the main analysis, where 92,270 long-standing resident decedents and 7,410 recent immigrant decedents died in intensive care. For long-standing residents there were a total of 919,499 decedents. However, for recent immigrants there may have been a number of patients who left Canada for end-of-life care outside of an intensive care setting – call this number X – so the total number of recent immigrant decedents is 47,514 + X. Because of the large sample sizes, the confidence intervals are quite small, so we can construct the following equation to estimate the size of X that would render our finding statistically not significant:

$$\frac{7,410}{47,514+X} = \frac{92,270}{919,499}$$
$$\frac{7,410}{92,270} = \frac{47,514+X}{919,499}$$
$$\frac{7,410(919,499)}{92,270} - 47,514 = X$$
$$X = 26,329$$

This number (26,329) equates to 35.6% of recent immigrants (26,296/[47,461+26,296]) and this number is too high to be plausible.

eTable 1. Variables Included in the Analysis

| Level | Variable | Variable Type | Description | Subgroup | Inclusion in a |
|---------|-----------------|---------------|-------------------------------|-------------------|--------------------|
| | | | | Analysis? | linear regression |
| | | | | | model? |
| Patient | Age | Baseline | Patient age | Yes, by age | Yes, by age ranges |
| | | | | ranges | |
| | | | | | |
| | Gender | Baseline | Patient gender | Yes | Yes |
| | Socioeconomic | Baseline | Patient socioeconomic | Yes | Yes |
| | position | | position determined by | | |
| | | | postal code | | |
| | Patient | Baseline | Urban or rural | Yes | Yes |
| | geography | | | | |
| | Charlson | Baseline | Quantitative measure of the | Yes, by CCI range | No, because not |
| | Comorbidity | | extent of comorbidity | | available for all |
| | Index | | | | decedents |
| | Primary | Baseline | ICD codes coded over | Yes, by category | Yes, by category |
| | Diagnoses | | lookback window, sorted by | | |
| | | | major disease category | | |
| | | | (cardiovascular, respiratory, | | |
| | | | neurologic, oncologic, | | |
| | | | psychiatric) | | |
| | Location of | Primary | ICU, hospital, long-term care | No | Yes |
| | death | Outcome | facility, other | | |
| | ICU admission – | Utilization | Cumulative over lookback | No | No |
| | total days | Outcome | window | | |
| | ICU admission – | Utilization | Number of episodes of ICU | No | No |
| | episodes | Outcome | admission during lookback | | |
| | | | window, including ongoing | | |
| | | | admission at start of window | | |
| | ICU admission - | Secondary | Received or not received | No | Yes |
| | proportion | Outcome | over lookback window | | |
| | Hospital | Utilization | Cumulative over lookback | No | No |
| | admission – | Outcome | window | | |
| | total days | | | | |
| | Hospital | Utilization | Number of episodes of | No | No |
| | admission – | Outcome | hospital admission during | | |
| | | | | | |

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| | episodes | | | look ongo wino | back window, including oing admission at start of dow | | | | |
|-------------------------------------|--|----------------------|------------------------|--|--|----------------------|-----|-----|-----|
| | Hospital Secondary admission – Outcome | | Rece | Received or not received No over lookback window | | | Yes | | |
| | Emergency department visits | Util Out | Utilization Outcome | | nber of presentations ng lookback window | No | | No | |
| | Dialysis | Secondary Outcome | | Rece look | eived or not during back window | No | | Yes | |
| | Mechanical ventilation | Secondary Outcome | | Rece duri | eived or not received ng lookback window | No | | Yes | |
| | Percutaneous gastrostomy / jejunostomy tube | Sec Out | ondary .come | Rece duri | eived or not received ng lookback window | No | | Yes | |
| | Tracheostomy | Sec Out | ondary come | Rece duri | eived or not received ng lookback window | No | | Yes | |
| | | | | | | | | | |
| Patient – recent | Mother tongu | ie | Baseline | | Mother tongue of immig Cantonese | rant, e.g. | No | | No |
| | Canadian Language Abil | lity | Baseline | | English, French, Both, or analyzes as English/Both French/Neither | Neither, vs | Yes | 5 | Yes |
| Immigratio Level of education | | lass | Baseline | | Type of immigrant divided into economic immigrants, family-related immigrants, and refugees. | | Yes | ; | Yes |
| | | | Baseline | | Level of education divided into 0-9 years schooling and 10 or more years | | Yes | ; | Yes |
| | Country of bir | th | Baseline | | Name of country which we then analyzed by regional groupings (defined in appendix) | | Yes | ; | Yes |
| | Landing date | | Baseline | | Date of immigration to C range eg. 1988-1995, 199 2004-2012 | anada by 96-2003, | Yes | ; | Yes |

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| Variable | Variable Description |
|-------------------------------------|---|
| Mother tongue | Mother tongue of immigrant, e.g. Cantonese |
| Canadian Language Ability | English, French, Both, or Neither |
| Immigration class | Type of immigrant divided into economic immigrants, family-related immigrants, and refugees. |
| Level of education | Level of education divided as follows: 0-9 years schooling, 10-12 years, 13 or more years, trade certificate, non-university diploma, bachelor's degree, master's degree, doctorate |
| Country of last permanent residence | Name of country which we then analyzed by regional groupings (defined below) |
| Landing date | Date of immigration to Canada |

eTable 2. Immigration, Refugees, and Citizenship Canada Data and Variables

Linkage rate of CIC and ORGD varies from 70.5% (1985) to 90.3% (2003) with an overall linkage rate of 86.1%. Total number of records is 1,925,353. The main theoretical gaps are new immigrants who landed in another province and moved to Ontario (no CIC data) and new immigrants who landed in Ontario and immediately moved to another province (no OHIP numbers). In our data, of 47,461 recent immigrant decedents 37,046 (78%) are deterministic matching, and 10,468 (22%) are probabilistic matching. The linkage rates were lowest among patients from East Asia, most likely due to short last names (e.g. Li, Kim, others) which increase the likelihood that a single-character coding error will render linkage improbable.

Landing date is set to the first day of the month and year of landing if no day is specified.

eTable 3. Baseline Recent Immigrant Characteristics

| Characteristic | Recent Immigrants | | | | |
|---------------------------------------|----------------------------|--|--|--|--|
| | N = 47,514 | | | | |
| Region of birth | | | | | |
| Africa | 2,606 (5%) | | | | |
| Central America, Caribbean and Mexico | 3,821 (8%) | | | | |
| East Asia | 8,080 (<mark>17</mark> %) | | | | |
| Eastern Europe | 6,881 (14%) | | | | |
| Northern America | 1,087 (2%) | | | | |
| Northern and Western Europe | 2,618 (6%) | | | | |
| Oceania | 403 (1%) | | | | |
| South America | 2,572 (5%) | | | | |
| South Asia | 9,605 (<mark>20</mark> %) | | | | |
| Southeast Asia | 4,457 (9%) | | | | |
| Southern Europe | 2,014 (4%) | | | | |
| Western and Central Asia | 3,341 (7%) | | | | |
| | | | | | |
| Years in Ontario | | | | | |
| 0-2 | 1,065 (2.2%) | | | | |
| 3-5 | 3,106 (6.5%) | | | | |
| 6-10 | 6,686 (14.1%) | | | | |
| 11-15 | 10,408 (21.9%) | | | | |
| 16-20 | 13,397 (28.2%) | | | | |
| 21-30 | 12,851 (27.0%) | | | | |
| | | | | | |
| Language ability on arrival | | | | | |
| Not fluent in English | 23,262 (49%) | | | | |
| Fluent in English | 24,250 (51%) | | | | |
| | | | | | |
| Education level on arrival | | | | | |
| 9 or fewer years | 21,448 (45%) | | | | |
| 10 or more years | 26,066 (55%) | | | | |
| | | | | | |
| Immigration Class* | | | | | |
| Family | 30,351 (64%) | | | | |
| Other | 1,984 (4%) | | | | |
| Economic | 8,965 (19%) | | | | |
| Refugee | 6,214 (13%) | | | | |

Footnote:

* Canadian immigration separates immigrants into different types, referred to as classes.

eTable 4a. Modified Poisson Regression – Care Provided During Final 6 Months of Life

| N = 967.013 (whole | Hospital | ICU | Mechanical | Dialysis | Feeding Tube | Tracheostomy |
|---|-------------|-------------|-----------------|-------------|--------------|------------------|
| cohort) | Admission | Admission | Ventilation | RR (95% CI) | RR (95% CI) | RR (95% CI) |
| , | RR (95% CI) | RR (95% CI) | RR (95% CI) | | | |
| Migration Status | | | | | | |
| Long-standing | 1 | 1 | 1 | 1 | 1 | 1 |
| resident* | | | | | | |
| Recent immigrant | 1.04 (1.04- | 1.16 (1.15- | 1.28 (1.25- | 1.39 (1.33- | 1.52 (1.45- | 1.61 (1.52-1.72) |
| _ | 1.05) | 1.19) | 1.30) | 1.45) | 1.59) | |
| | | | | | | |
| Age | | | | | | |
| 40 years or fewer* | 1 | 1 | 1 | 1 | 1 | 1 |
| 41-60 years | 1.41 (1.39- | 1.11 (1.09- | 1.03 (1.01- | 1.51 (1.42- | 1.15 (1.08- | 1.28 (1.16-1.41) |
| | 1.43) | 1.14) | 1.06) | 1.61) | 1.23) | |
| 61-80 years | 1.65 (1.62- | 1.11 (1.08- | 0.95 (0.93- | 1.55 (1.46- | 1.23 (1.16- | 1.27 (1.15-1.39) |
| | 1.67) | 1.13) | 0.98) | 1.65) | 1.31) | |
| 80 years or more | 1.51 (1.49- | 0.52 (0.51- | 0.36 (0.35- | 0.50 (0.47- | 0.66 (0.62- | 0.29 (0.27-0.33) |
| | 1.54) | 0.54) | 0.38) | 0.54) | 0.71) | |
| | | | | | | |
| Sex | | | | | | |
| Female* | 1 | 1 | 1 | 1 | 1 | 1 |
| Male | 1.03 (1.03- | 1.14 (1.13- | 1.11 (1.10- | 1.30 (1.27- | 1.27 (1.24- | 1.26 (1.21-1.31) |
| | 1.04) | 1.15) | 1.12) | 1.33) | 1.30) | |
| | | | | | | |
| Income Quintile | | | | | | |
| First (lowest)* | 1 | 1 | 1 | 1 | 1 | 1 |
| Second | 1.01 (1.00- | 1.02 (0.99- | 1.01 (0.99- | 1.06 (1.02- | 0.99 (0.95- | 1.02 (0.96-1.08) |
| | 1.03) | 1.04) | 1.04) | 1.10) | 1.03) | /> |
| Third | 1.00 (0.99- | 0.99 (0.97- | 0.97 (0.95- | 1.01 (0.97- | 0.96 (0.92- | 0.94 (0.89-1.00) |
| | 1.02) | 1.02) | 1.00) | 1.05) | 1.00) | 0.07 (0.00 1.01) |
| Fourth | 0.99 (0.97- | 0.98 (0.96- | 0.97 (0.95-1.00 | 1.02 (0.97- | 0.94 (0.90- | 0.95 (0.89-1.01) |
| F : f + b (b : b b c c + b) | 1.00) | 1.01) | 0.00 (0.00 | 1.07) | 0.98) | 0.02 (0.00 0.00) |
| Fifth (highest) | 0.97 (0.96- | 0.96 (0.93- | 0.96 (0.93- | 1.00 (0.96- | 0.93 (0.89- | 0.92 (0.86-0.98) |
| | 1.00) | 0.99) | 0.99) | 1.04) | 0.97) | |
| Matropolitan | | | | | | |
| Influence 7 one^{α} | | | | | | |
| None* (least urban) | 1 | 1 | 1 | 1 | 1 | 1 |
| Weak | 0.99 (0.97- | 0.91 (0.88- | 1 12 (1 08- | 1 21 (1 16- | 1 28 (1 22- | 1 25 (1 16-1 35) |
| Weak | 1 00) | 0.91 (0.00 | 1 16) | 1 27) | 1 35) | 1.25 (1.10 1.55) |
| Moderate | 0.96 (0.94- | 0.91 (0.88- | 1 18 (1 13- | 1 18 (1 11- | 1 20 (1 13- | 1 42 (1 31-1 53) |
| | 0.98) | 0.95) | 1.23) | 1.24) | 1.27) | (1.51 1.55) |
| Strong (most urban) | 1.04 (1.03- | 1.01 (0.98- | 1.40 (1.35- | 1.28 (1.22- | 1.64 (1.56- | 1.72 (1.60-1.85) |
| | 1.06) | 1.05) | 1.45) | 1.34) | 1.72) | (|
| | , | | , | | | |
| Category of Cause of | | | | | | |
| Death ⁺ | | | | | | |
| Other* | 1 | 1 | 1 | 1 | 1 | 1 |
| Cancer | 1.25 (1.24, | 0.57 (0.56- | 0.44 (0.43- | 0.29 (0.28- | 0.94 (0.91- | 0.46 (0.44-0.49) |
| | 1.26) | 0.58) | 0.44) | 0.30) | 0.97) | |
| Cardiovascular | 0.91 (0.90, | 1.14 (1.12- | 1.03 (1.02- | 0.82 (0.80- | 0.79 (0.77- | 0.72 (0.69-0.76) |
| | 0.91) | 1.15) | 1.05) | 0.84) | 0.82) | |
| Sepsis | 1.21 (1.20, | 1.63 (1.61- | 1.78 (1.75- | 1.59 (1.52- | 1.46 (1.39- | 2.12 (1.98-2.27) |
| | 1.22) | 1.66) | 1.81) | 1.65) | 1.53) | |
| | | | | | | |

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Footnote:

*Denotes reference variable among each set of characteristics;

- α Describes the extent to which an area is urbanized, with "Strong" being the most urbanized
- + Diagnostic categories defined in Appendix;

Note that each column shows adjusted relative risks from a separate modified Poisson regression model. Modified Poisson regression performed using the binary outcome location of death (intensive care vs elsewhere). Exposure variables in modified Poisson regression analyses: all rows in this table as well as date of death, relative risks greater than 1 indicate characteristics associated with increased risk of death in intensive care.

|--|

| N = 967,013 (whole cohort) | Hospital Admission | ICU Admission | Mechanical Ventilation | Dialysis Number of | Feeding Tube Number of | Tracheostomy Number of |
|---|-----------------------|-------------------|---------------------------|-----------------------|---------------------------|---------------------------|
| | decedents | decedents | decedents | (percentage) | (percentage) | (percentage) |
| Migration Status | (percentage) | (percentage) | (percentage) | | | |
| Long-standing | 626 739 | 176 417 | 125 246 | 31 639 (3 4%) | 27 438 (3 0%) | 9 978 (1 1%) |
| resident | (68.2%) | (19.2%) | (13.6%) | 51,055 (5.470) | 27,430 (3.070) | 5,578 (1.170) |
| Recent immigrant | 34,261 | 11,840 | 10,227 | 2,615 (5.5%) | 2,627 (5.5%) | 1,091 (2.3%) |
| | (72.1%) | (24.9%) | (21.5%) | , , , | , , , | |
| | | | | | | |
| Age | | | | | | |
| 40 years or fewer | 12,817 (44.2%) | 7,139 (24.6%) | 6,499 (22.4%) | 1,212 (4.2%) | 1,058 (3.7%) | 504 (1.7%) |
| 41-60 years | 77,835 | 30,445 | 24,520 | 6,143 (5.1%) | 4,746 (4.0%) | 2,212 (1.8%) |
| | (64.9%) | (25.4%) | (20.4%) | | | |
| 61-80 years | 272,540 | 91,921 | 67,992 | 18,544 (5.1%) | 14,710 (4.0%) | 6,361 (1.8%) |
| 80 voars ar mara | (75.0%) | (25.3%) | (18.7%) | | 0 551 (2 19/) | 1 002 (0 49/) |
| ab years of more | 297,808 | 58,752 (12.9%) | 30,402 (8.0%) | 8,355 (1.8%) | 9,551 (2.1%) | 1,992 (0.4%) |
| | (05.576) | (12.570) | | | | |
| Sex | | | | | | |
| Female | 324,795 | 82,642 | 58,952 | 13,545 (2.8%) | 12,586 (2.6%) | 4,330 (0.9%) |
| | (67.0%) | (17.1%) | (12.2%) | , , , | | |
| Male | 336,205 | 105,615 | 76,521 | 20,709 (4.3%) | 17,479 (3.6%) | 6,739 (1.4%) |
| | (69.7%) | (21.9%) | (15.9%) | | | |
| | | | | | | |
| Income Quintile | | | | | | 0 =0= (4, 00() |
| First (lowest) | 154,232 | 45,677 | 33,319 | 8,244 (3.6%) | 7,332 (3.2%) | 2,787 (1.2%) |
| Second | (68.1%) | (20.2%) | (14.7%) | 7 5/2 (2 7%) | 6 500 (2 2%) | 2 480 (1 2%) |
| Second | (69.7%) | (20.1%) | (14.6%) | 7,545 (5.7%) | 0,309 (3.270) | 2,409 (1.276) |
| Third | 126.469 | 35.595 | 25.229 | 6.401 (3.5%) | 5.660 (3.1%) | 2.033 (1.1%) |
| | (68.9%) | (19.4%) | (13.7%) | -, - (, | - / (/ | |
| Fourth | 121,051 | 34,009 | 24,378 | 6,183 (3.5%) | 5,405 (3.0%) | 1,960 (1.1%) |
| | (68.0%) | (19.1%) | (13.7%) | | | |
| Fifth (highest) | 114,890 | 31,234 | 22,317 | 5,639 (3.3%) | 5,035 (2.9%) | 1,753 (1.0%) |
| | (67.1%) | (18.3%) | (13.0%) | | | |
| | | | | | | |
| Influence Zone ^{α} | | | | | | |
| None (least urban) | 79,394 | 23,711 | 13,308 | 3,422 (2.9%) | 2,590 (2.2%) | 893 (0.8%) |
| | (67.6%) | (20.2%) | (11.3%) | | | |
| Weak | 198,469 | 54,633 | 37,662 | 10,442 (3.5%) | 8,470 (2.9%) | 2,915 (1.0%) |
| NA - dawa ta | (67.1%) | (18.5%) | (12.7%) | C 24 A (2 A)() | 4.002 (2.70() | 2 000 (4 40() |
| Moderate | 120,505 | 33,505 | 24,395 | 6,214 (3.4%) | 4,903 (2.7%) | 2,008 (1.1%) |
| Strong (most urban) | 262 562 | 76 389 | 60.092 | 1/ 169 (3.8%) | 1/ 100 (3.8%) | 5 253 (1 /%) |
| Strong (most droan) | (71.0%) | (20.7%) | (16.3%) | 14,105 (5.070) | 14,100 (3.876) | 5,255 (1.470) |
| | (/1:0/0] | (2017)07 | (10.070) | | | |
| Category of Cause of Death [†] | | | | | | |
| Other | 299,363 | 93,612 | 72,400 | 20,154 (4.4%) | 14,813 (3.2%) | 6,151 (1.3%) |
| | (64.9%) | (20.3%) | (15.7%) | | | |
| Cancer | 185,364 | 29,706 | 17,765 (8.0%) | 3,426 (1.5%) | 7,601 (3.4%) | 1,766 (0.8%) |
| | (83.0%) | (13.3%) | | | | |
| Cardiovascular | 144,499 | 53,043 | 35,654 | 8,272 (3.4%) | 5,908 (2.4%) | 2,198 (0.9%) |

| | (59.6%) | (21.9%) | (14.7%) | | | |
|--------|---------|---------|---------------|--------------|--------------|------------|
| Sepsis | 31,774 | 11,896 | 9,654 (24.2%) | 2,402 (6.0%) | 1,743 (4.4%) | 954 (2.4%) |
| | (79.6%) | (29.8%) | | | | |
| | | | | | | |

Footnote:

 α Describes the extent to which an area is urbanized, with "Strong" being the most urbanized

⁺ Diagnostic categories defined in Appendix.

eTable 5. Multinomial Logistic Regression by Location of Death, Using Intensive Care Location of Death as Baseline (N = 967,013, whole cohort)

| | Multinomial Odds Ratio (95% Confidence Interval) | | | |
|-----------------------------|--|--------------------|------------------|------------------|
| | Baseline Relative to Baseline§ | | | |
| | Intensive Care | Hospital (non-ICU) | Long-term Care | Other |
| Migration Status | | | | |
| Long-standing resident* | 1 | 1 | 1 | 1 |
| Recent immigrant | 1.35 (1.32-1.39) | 0.82 (0.80-0.85) | 0.70 (0.67-0.74) | 0.68 (0.66-0.70) |
| | | | | |
| Demographics | | | | |
| Age < 40 years* | 1 | 1 | 1 | 1 |
| Age 40-60 years | 1.01 (0.97-1.04) | 1.93 (1.85-2.03) | 2.74 (2.50-3.00) | 0.75 (0.72-0.78) |
| Age 60-80 years | 0.85 (0.83-0.88) | 3.05 (2.92-3.19) | 4.67 (4.28-5.10) | 0.69 (0.67-0.71) |
| Age > 80 years | 0.29 (0.28-0.30) | 8.16 (7.80-8.53) | 13.3 (12.2-14.6) | 2.15 (2.08-2.23) |
| | | | | |
| Sex | | | | |
| Female* | 1 | 1 | 1 | 1 |
| Male | 1.12 (1.11-1.14) | 0.96 (0.94-0.97) | 0.89 (0.88-0.91) | 0.84 (0.83-0.85) |
| | | | | |
| Income Quintile | | | | |
| First (lowest)* | 1 | 1 | 1 | 1 |
| Second | 1.03 (1.01-1.05) | 0.99 (0.97-1.01) | 0.99 (0.96-1.02) | 0.95 (0.93-0.97) |
| Third | 1.00 (0.98-1.02) | 0.99 (0.97-1.01) | 0.95 (0.93-0.98) | 1.02 (1.00-1.04) |
| Fourth | 0.98 (0.96-1.00) | 0.97 (0.95-1.00) | 0.94 (0.91-0.97) | 1.06 (1.04-1.08) |
| Fifth (highest) | 0.99 (0.97-1.01) | 0.93 (0.91-0.95) | 0.92 (0.89-0.95) | 1.09 (1.07-1.11) |
| | | | | |
| Metropolitan Influence Zone | | | | |
| None* (least urban) | 1 | 1 | 1 | 1 |
| Weak | 1.13 (1.10-1.16) | 0.83 (0.81-0.85) | 1.25 (1.21-1.30) | 0.88 (0.86-0.91) |
| Moderate | 1.16 (1.13-1.19) | 0.75 (0.73-0.77) | 0.73 (0.71-0.76) | 0.96 (0.93-0.98) |
| Strong (most urban) | 1.35 (1.32-1.38) | 0.77 (0.75-0.78) | 1.06 (1.03-1.10) | 0.69 (0.67-0.70) |
| | | | | |
| Category of Cause of Death† | | | | |
| Other* | 1 | 1 | 1 | 1 |
| Cancer | 0.35 (0.35-0.36) | 3.50 (3.42-3.58) | 5.86 (5.70-6.02) | 1.94 (1.89-1.98) |
| Cardiovascular | 1.20 (1.18-1.22) | 0.70 (0.69-0.72) | 0.55 (0.53-0.57) | 0.97 (0.96-0.99) |
| Sepsis | 2.63 (2.55-2.71) | 0.61 (0.59-0.63) | 0.22 (0.20-0.23) | 0.24 (0.23-0.25) |

Footnote:

+ Diagnostic categories defined in Appendix 6

*Denotes reference variable among each set of characteristics

§ To compare multinomial odds ratios to modified Poisson regression relative risks, each of the non-baseline locations (Hospital non-ICU, Long-term care, Other) must be divided by the multinomial odds ratio associated with the baseline.

Exposure variables in multinomial logistic regression analysis: age, sex, income quintile, urbanization of place of living, date of death, cause of death (categories – cancer, cardiovascular, sepsis, other).

eTable 6. Modified Poisson Regression – Recent Immigrant Location of Death (intensive care versus all other) (includes Recent Immigrant Cohort only)

| N = 47,514 (recent | Adjusted Relative | | Adjusted Relative |
|-----------------------------|-------------------|-----------------------------|-------------------|
| immigrant cohort) | Risk (95% CI) | | Risk (95% CI) |
| Age | | Region of Birth | |
| 40 years or fewer* | 1 | Northern and Western Europe | 0.83 (0.67-1.01) |
| 41-60 years | 1.11 (1.02-1.22) | Northern America* | 1 |
| 61-80 years | 1.07 (0.99-1.17) | Southern Europe | 1.04 (0.84-1.28) |
| 80 years or fewer | 0.53 (0.48-0.59) | Eastern Europe | 1.08 (0.90-1.30) |
| | | Oceania | 1.27 (0.96-1.70) |
| Sex | | East Asia | 1.29 (1.07-1.55) |
| Female* | 1 | Central America and Mexico | 1.28 (1.07-1.54) |
| Male | 1.05 (1.01-1.10) | South America | 1.29 (1.06-1.55) |
| | | Africa | 1.42 (1.18-1.71) |
| Income Quintile | | Western and Central Asia | 1.42 (1.18-1.71) |
| First (highest)* | 1 | South-east Asia | 1.42 (1.19-1.71) |
| Second | 0.94 (0.88-1.00) | South Asia | 1.46 (1.22-1.74) |
| Third | 0.99 (0.93-1.05) | | |
| Fourth | 0.89 (0.83-0.96) | Recency of Immigration | |
| Fifth (lowest) | 0.92 (0.85-1.00) | 0-2 years* | 1 |
| | | 3-5 years | 0.89 (0.78-1.02) |
| Metropolitan Inf | luence Zone§ | 6-10 years | 0.91 (0.80-1.03) |
| None* (rural) | 1 | 11-15 years | 0.86 (0.76-0.97) |
| Weak | 1.39 (1.09-1.78) | 16-20 years | 0.87 (0.77-0.99) |
| Moderate | 1.59 (1.24-2.03) | 21-30 years | 0.86 (0.76-0.97) |
| Strong (urban) | 1.60 (1.27-2.03) | | |
| | | Immigration Class | |
| Cause of Death ⁺ | | Family* | 1 |
| Other* | 1 | Economic | 1.08 (1.02-1.15) |
| Cardiovascular | 1.23 (1.17-1.29) | Refugee | 1.05 (0.98-1.12) |
| Cancer | 0.41 (0.38-0.44) | Other | 1.11 (0.99-1.24) |
| Sepsis | 2.05 (1.91-2.20) | | |
| | | Language Ability | |
| | | English/Both* | 1 |
| | | French/Neither | 1.00 (0.95-1.05) |
| | | | |
| | | Education Level | |
| | | 9 or fewer years* | 1 |
| | | 10 or more years | 1.04 (0.99-1.09) |

Footnote:

*Denotes reference variable among each set of characteristics

§ Describes the extent to which an area is urbanized, with "Strong" being the most urbanized

⁺ Diagnostic categories defined in Appendix

Modified Poisson regression performed using the binary outcome location of death (intensive care versus elsewhere). Exposure variables in modified Poisson regression analyses: age, sex, income quintile, urbanization of place of living, date of death, cause of death (categories – cancer, cardiovascular, sepsis, other). Relative risks greater than 1 indicate characteristics associated with increased risk of death in intensive care.

eTable 7. Missing data.

| Variable | Recent Immigrant (N = 47,514) | Long-standing Resident (N = 919,499) |
|----------------------------------|-------------------------------|---|
| Charlson Comorbidity Index* | 4,641 (9.8%) | 94,951 (10.3%) |
| Income quintile | 107 (0.2%) | 5,184 (0.6%) |
| Local Health integration network | 35 (0.1%) | 601 (0.1%) |
| Rural | 35 (0.1%) | 601 (0.1%) |

*Note that patients who were not admitted to hospital in the final 2 years of life are counted as missing.

eTable 8. Location of Death and Care Received in the Final Six Months of Life Comparing Deterministic and

Probabilistic Matching

| | Deterministically- matched | Probabilistically- matched | Absolute Percentage Difference |
|-----------------------------------|-------------------------------|-------------------------------|-----------------------------------|
| | N = 37,046 | N=10,449 | (95% CI) |
| Location of death | | | · · |
| Intensive care (ICU) | 5,823 (15.7%) | 1,587 (15.2%) | 0.5% (-0.3 to 1.3) |
| Acute care hospital (not ICU) | 13,173 (35.6%) | 4,100 (39.2%) | -3.7% (-2.6 to -4.7) |
| Long-term care facility | 2,748 (7.4%) | 860 (8.2%) | -0.8% (-1.4 to -0.2) |
| Other (including home) | 15,302 (41.3%) | 3,921 (37.5%) | 3.8% (2.7 to 4.8) |
| Care received in final six months | | | |
| Hospital admission | 26,396 (71.3%) | 7,865 (75.1%) | -4.0% (-5.0 to -3.1) |
| Intensive care unit admission | 9,363 (25.3%) | 2,477 (23.7%) | 1.6% (0.6 to 2.5) |
| Mechanical ventilation | 8,060 (21.8%) | 2,167 (20.7%) | 1.0% (0.1 to 1.9) |
| Dialysis | 2,087 (5.6%) | 528 (5.0%) | 0.6% (0.1 to 1.1) |
| Percutaneous feeding tube | 2,013 (5.4%) | 614 (5.9%) | -0.4% (-1.0 to 0.1) |
| Tracheostomy | 877 (2.4%) | 214 (2.0%) | 0.3% (0.0 to 0.6) |
| Care episodes in final six months | | | P-value |
| Hospital admission (days) | 7 (0-22) | 8 (1-22) | <0.001 |
| Hospital admissions (count) | 1 (0-2) | 1 (1-2) | 0.006 |
| ICU admission (days) | 0 (0-1) | 0 (0-0) | <0.001 |
| ICU admissions (count) | 0 (0-1) | 0 (0-0) | 0.06 |
| Emergency dept. visits (count) | 1 (1-2) | 1 (1-2) | 0.61 |

Footnote:

Each relative risk calculated in binary fashion e.g. death in ICU compared to death in all other locations. Exposure variables in modified Poisson regression analyses: age, sex, income quintile, urbanization of place of living, date of death, cause of death (categories – cancer, cardiovascular, sepsis, other).

This table shows the outcome data with unadjusted relative risk and adjusted relative risk based on modified Poisson regression showing the magnitude and significance of any differences. Positive absolute percentage differences indicate increased percentage of recent immigrants as compared to long-standing residents. Care episode data shows the median and interquartile range for the number of emergency department visits, hospital admissions, and ICU admissions per decedent, as well as the median and interquartile range of the duration of hospital and ICU admission per decedent.

ICU=intensive care unit.

Sensitivity Analysis of Deterministic versus Probabilistic Matching

| Characteristic | Deterministic-Match | Probabilistic-Match | Standard Difference |
|------------------------------|---------------------|---------------------|---------------------|
| | N = 37,046 | N = 10,468 | |
| Age at Death | | | |
| Median (IQR) | 74 (57-84) | 77 (61-85) | |
| 40 or fewer years | 2,667 (7.2%) | 583 (5.6%) | 0.07 |
| 41-60 years | 8,180 (22.1%) | 1,989 (19.0%) | 0.08 |
| 61-80 years | 13,545 (36.6%) | 3,722 (35.6%) | 0.02 |
| 81 or more years | 12,654 (34.2%) | 4,174 (39.9%) | 0.12 |
| | | | |
| Sex | | | |
| Female | 17,744 (47.9%) | 5,473 (52.3%) | 0.09 |
| Male | 19,302 (52.1%) | 4,995 (47.7%) | 0.09 |
| | | | |
| Income Quintile ⁺ | | | |
| First (lowest) | 11,344 (30.7%) | 3,029 (29.0%) | 0.04 |
| Second | 8,274 (22.4%) | 2,604 (24.9%) | 0.06 |
| Third | 7,108 (19.2%) | 1,921 (18.4%) | 0.02 |
| Fourth | 5,968 (16.1%) | 1,724 (16.5%) | 0.01 |
| Fifth (highest) | 4,268 (11.5%) | 1,167 (11.2%) | 0.01 |
| | | | |
| Cause of Death* | | | |
| Ischemic heart disease | 4,134 (11.2%) | 955 (9.1%) | 0.07 |
| Lung cancer | 1,687 (4.6%) | 627 (6.0%) | 0.06 |
| Dementia | 1,256 (3.4%) | 372 (3.6%) | 0.01 |
| Cerebrovascular disease | 1,945 (5.3%) | 651 (6.2%) | 0.04 |
| COPD | 553 (1.5%) | 177 (1.7%) | 0.02 |
| Colorectal cancer | 997 (2.7%) | 326 (3.1%) | 0.03 |
| Diabetes | 981 (2.6%) | 264 (2.5%) | 0.01 |
| Influenza and pneumonia | 806 (2.2%) | 255 (2.4%) | 0.02 |
| Hematologic malignancy | 1,053 (2.8%) | 280 (2.7%) | 0.01 |
| Breast cancer | 921 (2.5%) | 250 (2.4%) | 0.01 |
| Others | 17,746 (47.9%) | 5,001 (47.8%) | <0.01 |
| | | | |
| Charlson Comorbidity Index | | | |
| 2 or less | 13,995 (41.9%) | 3,778 (39.7%) | 0.04 |

eTable 9. Baseline Characteristics of Deceased Recent Immigrant Patients (N=47,514) by Matching Type

| 3-4 | 6,675 (20.0%) | 1,948 (20.5%) | 0.01 |
|------------------|----------------|---------------|------|
| 5 or more | 12,698 (38.1%) | 3,779 (39.8%) | 0.03 |
| Missing§ | 3,678 (10.0%) | 963 (9.2%) | |
| | | | |
| Years in Ontario | | | |
| 0-2 | 927 (2.5%) | 138 (1.3%) | 0.09 |
| 3 – 5 | 2,717 (7.3%) | 389 (3.7%) | 0.16 |
| 6 – 10 | 5,614 (15.2%) | 1,072 (10.2%) | 0.15 |
| 11-15 | 8,228 (22.2%) | 2,180 (20.8%) | 0.03 |
| 16-20 | 10,102 (27.3%) | 3,295 (31.5%) | 0.09 |
| 21-30 | 9,458 (25.5%) | 3,393 (32.4%) | 0.15 |

Footnote:

⁺ Defined by postal code average income, *selected from most common, § no admissions in final 24 months of life. This table shows baseline characteristics for each cohort in absolute number and percentage along with the standardized mean difference between the cohorts. The standardized difference of means is included as a more appropriate test of difference between subgroups with such large sample sizes. Standardized differences show the ratio of the difference in means and standard deviation. Values less than 0.1 are generally considered to reflect negligible differences between subgroups.

COPD=Chronic Obstructive Pulmonary Disease.

eTable 10. Trajectories to Intensive Care

To add further context to the Ontario, Canada experience, we assessed trajectories of patients who were admitted to the ICU in their final 30 days of life.

| Location prior to ICU | Percent (N = 138,500) |
|---------------------------------|-----------------------|
| Emergency department | 43.0% (59,559) |
| Direct | 5.3% (17,319) |
| Direct from another institution | 3.5% (4852) |
| Direct non-institution | |
| Day surgery | 0.44% (613) |
| Clinic within hospital | 0.33% (454) |
| Ward* | 40.2% (55,701) |

*admission to ICU more than 1 day after hospital admission.

eTable 11. Causes of Death

Extended table of the causes of death for long-standing resident and recent immigrant decedents, ranked from most to least common. Note that the list of diagnoses in Table 1 ("selected from most common causes") includes the 9 most common causes of death and the 11th most common cause, breast cancer, but not the 10th most common cause, diseases of the urinary system. We elected to include breast cancer in the table because of its increased prevalence among recent immigrant decedents (1,171; 2.5%) compared with longstanding residents (16,886; 1.8%), which was also much higher than the prevalence of urinary system diseases in the recent immigrant cohort (905, 1.8%).

| | Long-standing Residents | Recent Immigrants |
|----|--|---|
| 1 | Ischemic heart disease | Ischemic heart disease |
| 2 | Cancer of lung & bronchus | Cerebrovascular diseases |
| 3 | Dementia and Alzheimer Disease (APHEO) | Cancer of lung & bronchus |
| 4 | Cerebrovascular diseases | Dementia and Alzheimer Disease (APHEO) |
| 5 | Chronic lower respiratory diseases | Cancer of lymph, blood & related |
| 6 | Cancer of colon, rectum, anus (APHEO) | Cancer of colon, rectum, anus (APHEO) |
| 7 | Diabetes | Diabetes |
| 8 | Influenza and pneumonia | Cancer of breast (APHEO) |
| 9 | Cancer of lymph, blood & related | Influenza and pneumonia |
| 10 | Diseases of urinary system | Diseases of urinary system |
| 11 | Cancer of breast (APHEO) | Cancer of liver & intrahepatic bile ducts |
| 12 | Heart failure and complications, ill defined | Cancer of pancreas |
| 13 | Falls | Intentional self harm (APHEO) |
| 14 | Cancer of pancreas | Chronic lower respiratory diseases |
| 15 | Cancer of prostate | Cancer of stomach |
| 16 | Cirrhosis and other liver diseases | Septicemia |
| 17 | Symptoms, signs, ill defined | Heart failure and complications, ill defined hd |
| 18 | Septicemia | Symptoms, signs, ill defined |
| 19 | Intentional self harm (APHEO) | Cirrhosis and other liver diseases |
| 20 | Cardiac arrhythmias | Transport accidents (APHEO) |
| 21 | Hypertensive disease | Falls |
| 22 | Pulmonary oedema and related | Cancer of prostate |
| 23 | Cancer of liver & intrahepatic bile ducts | Cancer of brain, nervous system (APHEO) |
| 24 | Parkinsons (APHEO) | Cancer of ovary |
| 25 | Cancer of bladder | Cardiac arrest |
| 26 | Cardiac arrest | Hypertensive disease |
| 27 | Cancer of oesophagus | Pulmonary oedema and related |
| 28 | Cancer of stomach | Cardiac arrhythmias |
| 29 | Cancer of brain, nervous system (APHEO) | Parkinsons (APHEO) |

Causes of Death (continued)

| | Long-standing Residents | Recent Immigrants |
|----|---|---|
| 30 | Transport accidents (APHEO) | Cancer of the oral cavity & pharynx (APHEO) |
| 31 | Nonrheumatic valve disorders | Assault (APHEO) |
| 32 | Cancer of ovary | Cancer of oesophagus |
| 33 | Aortic aneurysm and dissection | Cancer of kidney (APHEO) |
| 34 | Cancer of skin | Benign neoplasms, in situ and uncertain |
| 35 | Diseases of musculoskeletal and connective | Cancer of corpus & uterus, NOS (APHEO) |
| 36 | Cancer of kidney (APHEO) | Cancer of bladder |
| 37 | Benign neoplasms, in situ and uncertain | Diseases of musculoskeletal and connective |
| 38 | Accidental poisoning | Respiratory failure |
| 39 | Appendicitis, hernia, intestinal obstruct | Accidental poisoning |
| 40 | Intestinal infectious diseases | Nonrheumatic valve disorders |
| 41 | Cancer of the oral cavity & pharynx (APHEO) | Aortic aneurysm and dissection |
| 42 | Respiratory failure | Cancer of cervix uteri (APHEO) |
| 43 | Atherosclerosis | Pulmonary heart disease and related |
| 44 | Pulmonary heart disease and related | Cancer of skin |
| 45 | Cancer of corpus & uterus, NOS (APHEO) | Appendicitis, hernia, intestinal obstruct |
| 46 | Disorders of fluid, electrolyte, etc | Intestinal infectious diseases |
| 47 | Cardiomyopathy | Disorders of fluid, electrolyte, etc |
| 48 | Mental, behav disorders from psychoactive subst use | Cardiomyopathy |
| 49 | Congenital malform, deformations, chromosomal | HIV or AIDS |
| 50 | Injury event of undetermined intent (APHEO) | Accidental drowning (APHEO) |
| 51 | Cancer of gallbladder | Cancer of gallbladder |
| 52 | Accidents by suffocation and foreign body | Tuberculosis |
| 53 | Cancer of larynx | Injury event of undetermined intent (APHEO) |
| 54 | Cancer of cervix uteri (APHEO) | Mental, behav disorders from psychoactive subst use |
| 55 | Chronic rheumatic heart disease | Chronic rheumatic heart disease |
| 56 | Assault (APHEO) | Accidents by suffocation and foreign body |
| 57 | HIV or AIDS | Atherosclerosis |
| 58 | Accidental drowning (APHEO) | Vaccine Preventable |
| 59 | Epilepsy & related | Congenital malform, deformations, chromosomal |
| 60 | Vaccine Preventable | Epilepsy & related |
| 61 | Acute respiratory not flu or pneumonia | Cancer of larynx |
| 62 | Tuberculosis | Pregnancy, childbirth and puerperium |
| 63 | Meningitis | Meningitis |
| 64 | Perinatal conditions | Acute respiratory not flu or pneumonia |
| 65 | Pregnancy, childbirth and puerperium | Malnutrition & nutritional anemias |
| 66 | Malnutrition & nutritional anemias | Vectorborne diseases and rabies |
| 67 | Vectorborne diseases and rabies | Unintentional firearm discharge |

Diagnostic categories for logistic regression analyses:

Cancer: Cancer of oesophagus, Cancer of stomach, Cancer of colon, rectum, anus (APHEO), Cancer of liver & intrahepatic bile ducts, Cancer of gallbladder, Cancer of pancreas, Cancer of larynx, Cancer of lung & bronchus, Cancer of skin, Cancer of breast (APHEO), Cancer of cervix uteri (APHEO), Cancer of corpus & uterus, NOS (APHEO), Cancer of ovary, Cancer of prostate, Cancer of kidney (APHEO), Cancer of bladder, Cancer of brain, nervous system (APHEO), Cancer of lymph, blood & related, Benign neoplasms, in situ and uncertain, Cancer of the oral cavity & pharynx (APHEO)

Sepsis: Intestinal infectious diseases, Tuberculosis, Vectorborne diseases and rabies, Meningitis, Septicemia, Influenza and pneumonia

Cardiovascular: Chronic rheumatic heart disease, Hypertensive disease, Ischaemic heart disease, Pulmonary heart disease and related, Nonrheumatic valve disorders, Cardiomyopathy, Cardiac arrest, Cardiac arrhythmias, Heart failure and complications, Cerebrovascular diseases, Atherosclerosis, Aortic aneurysm and dissection

Other: all others.

Below is a comprehensive list of the causes of death in the database, ordered according to their encoding:

Intestinal infectious diseases Tuberculosis Vectorborne diseases and rabies Vaccine Preventable Meningitis Septicemia HIV or AIDS Cancer of oesophagus Cancer of stomach Cancer of colon, rectum, anus (APHEO) Cancer of liver & intrahepatic bile ducts Cancer of gallbladder Cancer of pancreas Cancer of larynx Cancer of lung & bronchus Cancer of skin Cancer of breast (APHEO) Cancer of cervix uteri (APHEO) Cancer of corpus & uterus, NOS (APHEO) Cancer of ovary Cancer of prostate Cancer of kidney (APHEO) Cancer of bladder Cancer of brain, nervous system (APHEO) Cancer of lymph, blood & related Benign neoplasms, in situ and uncertain

Diabetes Malnutrition & nutritional anemias Disorders of fluid, electrolyte, etc. Dementia and Alzheimer Disease (APHEO) Mental, behav. disorders from psychoactive subst. use Parkinson's (APHEO) Epilepsy & related Chronic rheumatic heart disease Hypertensive disease Ischaemic heart disease Pulmonary heart disease and related Nonrheumatic valve disorders Cardiomyopathy Cardiac arrest Cardiac arrhythmias Heart failure and complications, ill defined HD. Cerebrovascular diseases Atherosclerosis Aortic aneurysm and dissection Acute respiratory not flu or pneumonia Influenza and pneumonia Chronic lower respiratory diseases

Pulmonary oedema and related **Respiratory failure** Appendicitis, hernia, intestinal obstruct Cirrhosis and other liver diseases Diseases of musculoskeletal and connective Diseases of urinary system Pregnancy, childbirth and puerperium Perinatal conditions Congenital malform., deformations, chromosomal Transport accidents (APHEO) Falls Unintentional firearm discharge Accidental drowning (APHEO) Accidents by suffocation and foreign body Accidental poisoning Intentional self harm (APHEO) Assault (APHEO) Injury event of undetermined intent (APHEO) Cancer of the oral cavity & pharynx (APHEO) Residual Symptoms, signs, ill defined



eFigure 1. Care Received During Final 24, 12, 6 and 1 Month(s) of Life

Interventions Within Time Intervals Preceding Death

Footnote: Six-panel figure depicting proportion of recent immigrant (RI, red) and long-standing resident (LSR, blue) cohorts who received selected interventions during the last 24, 12, 6, and 1 month(s) of life. Y-axis depicts percentage of decedents who received the selected intervention. X-axis denotes the time interval preceding death in months. Labels on each bar show the actual count of decedents corresponding to each bar. The denominator used for each recent immigrant bar is the whole recent immigrant decedent population (47,514) while the denominator for each longstanding resident bar is the whole longstanding resident decedent population of (919,499). Ventilation means mechanical ventilation, ICU means intensive care unit. Comparisons of proportions at each time point for each intervention show statistically significant differences with p <0.01.

eFigure 2.

Relative Risk 2.0 1.5 1.0 2.7

Relative Risk of Dying in Intensive Care by Region of Origin

eFigure 2: Color map of unadjusted relative risk of dying in intensive care versus dying elsewhere according to region of birth. Comparisons are between recent immigrant decedents (patients who have died) from each region with the entire long-standing resident decedent cohort. Decedents from regions with more yellow had lower relative risk; decedents from the regions with more blue had higher relative risk. Canada is set to a relative risk of 1.00. The upper and lower values on the color bar scale correspond to the maximum and minimum values of the scale.

Footnote: Color map of unadjusted relative risk of dying in intensive care versus dying elsewhere according to region of birth. Comparisons are between recent immigrant decedents (patients who have died) from each region with the entire long-standing resident decedent cohort. Decedents from regions with more yellow had lower relative risk; decedents from the regions with more blue had higher relative risk. Canada is set to a relative risk of 1.00. The upper and lower values on the color bar scale correspond to the maximum and minimum values of the scale.

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