Access to palliative care by disease trajectory: a population-based cohort of Ontario decedents

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ABSTRACT

Objectives To examine access to palliative care between different disease trajectories and compare to other geographic areas.

Design A retrospective population-based decedent cohort study using linked administrative data.

Setting Ontario, Canada.

Participants Ontario decedents between 1 April 2010 and 31 December 2012. Patients were categorised into disease trajectories: terminal illness (eg, cancer), organ failure (eg, chronic heart failure), frailty (eg, dementia), sudden death or other.

Interventions Receipt of palliative care services from institutional and community settings, derived from a validated list of palliative care codes from multiple administrative databases.

Outcome measures Receiving any palliative care services in the last year of life (yes/no), intensity (total days) and time of initiation of palliative care, in hospital and community sectors. Multivariable analysis examined the association between disease trajectory and the receipt of palliative care in the last year of life.

Results We identified 235,159 decedents in Ontario. In the last year of life, 88% of terminal illness, 44% of organ failure and 32% of frailty decedents accessed at least one palliative care service. Most care was provided during an inpatient hospitalisation. Terminal illness decedents received twice as many palliative care days (mean of 49 days) compared with organ failure and frailty decedents. Patients with terminal illness initiated palliative care median of 107 days before death compared to median of 19 days among those using the US Medicare hospice benefit.

Conclusions Terminal illness decedents are more likely to receive any palliative care, with increased intensity and earlier before death than organ failure or frailty decedents. These data serve as a useful comparison for other countries with similar and different healthcare systems and eligibility criteria.

INTRODUCTION

With the population ageing and living longer with more comorbidities, health systems are focused on providing quality end-of-life care through improved palliative care services. Earlier availability of palliative care to patients with terminal illness has been shown to improve quality of life, reduce late-life health services use and even extend survival. However, palliative care is often not delivered or initiated until very late in the dying trajectory. Research shows that dying occurs in three main trajectories: (1) terminal illness, typical of cancer (high function followed by acute decline); (2) organ failure, typical of heart and lung disease (medium–high function, intermittent acute exacerbations and partial recovery) and (3) frailty, typical of dementia (low function and prolonged gradual dwindling).

Evidence shows that palliative care is more often provided to patients with cancer versus those without cancer because of the ‘predictability’ of decline and the history of hospice care for patients with cancer. This ‘predictability’ can sometimes be formalised into health policy, such as in the US Medicare Hospice Benefit, which requires a doctor’s certification that death is expected within 6 months and that the patient forego any hospital or curative care. Whereas in other countries, like the UK, Australia and Canada, the eligibility criteria for palliative care does not require either condition. Given the growing body of literature of the benefits of...
early palliative care in non-cancer diagnoses, there is a
dearth of research describing how access to palliative care,
particularly to initiation before death and intensity
and type of service use, differs by disease trajectory, and
how that may be influenced by health system and various
criteria to access palliative care at a population level.

This study focuses on patients in Ontario, Canada,
who can access palliative care services in community and
institutional settings without foregoing curative treatment
through its universal insured hospital and physician system.
Criteria for palliative care referral in the hospital is at the physician’s discretion; whereas in the
community, they often use the ‘surprise question’ of
not being surprised if the patient died within a year, combined with performance status decline. In short,
eligibility in Ontario is not formally standardised, which
is unlike the standardised criteria of the Gold Standards Framework, which is widespread in the UK. Ontario
is the largest province in Canada and has the highest
number of deaths. Previous studies have shown that
half of patients in Ontario received at least one palliative care service in their last year of life, though they
did not examine variations by disease trajectory. This
study examines how disease trajectory is associated with
access to palliative care services in multiple settings,
including time of initiation before death and intensity
and type of service use. We also compare our data to
other geographic areas, namely the USA, UK and
Western Australia. Our hypothesis is that compared with
the USA, Ontarians will initiate palliative care services
earlier, across all disease trajectories and compared with
UK and Western Australia, access will be similar across all
disease trajectories.

METHODS
We conducted a retrospective cohort study of Ontario dece-
dents who died between 1 April 2010 and 31 December 2012.
We used linked administrative health databases, held at the
Institute for Clinical Evaluative Sciences (ICES), to identify
palliative care services used across multiple health sectors in
the 12 months before death. We used a previously derived
comprehensive list of palliative care billing codes to capture
palliative care services provided by physicians, nurses and
personal support workers in multiple sectors from multiple
administered databases. The databases included: Physi-
cian claims database, which captured palliative care services
billed by physicians in both community and hospital settings;
Home Care Database and the interRAI databases captured
publicly funded home care services, such as nursing or
personal support care, with palliative care intent; Discharge
Abstract Database and the National Ambulatory Care
Reporting System captured hospitalisations and emergency
department (ED) visits, respectively, where palliative care
was the main reason for admission or consulted; Continuing
Care Reporting System captured palliative care provided in
long-term care and complex continuing care settings. We
also linked with the Vital Statistics database for date of death,
sex, age and postal code and Statistics Canada Census data
for income quintile and rurality via postal codes.

We further categorised decedents by the major trajecto-
ries of functional decline at end of life, defined by main
cause of death as per prior research, which have also
been validated in Canada. Using International Classifi-
cation of Diseases 10th Revision codes from the death certif-
cicate as defined previously, decedents were classified into
these trajectories: terminal illness (eg, cancer), organ failure
(eg, chronic heart failure), frailty (eg, Alzheimers), sudden
death (eg, accident) and other (see online supplementary
appendix 1 for main causes of death).

Outcomes of interest
The primary outcome of interest was whether a decedent
received palliative care at least once in the last 12 months of
life. We further categorised palliative care services deliv-
ered in ‘any institutional care’ setting (ie, hospital inpa-
tient, complex continuing care (analogous to subacute care),
long-term care and ED) and ‘any community care’
settings (ie, outpatient care, home care and home-based
physician billing). If both a home care and a physician
home visit occur on the same day, they count as a sepa-
rate home care day and separate physician home visit in
subcategory analysis. However, both care events count as
a single community care day in ‘any community care’ so
as not to double count for community care that happen
on the same day and count more care days than calendar
days. The same definition applies to ‘any institutional
care’. In an acute hospital setting, palliative care days
were counted for the entire duration of stay when the
most responsible diagnosis for the hospital stay was palli-
ative, palliative medicine was a service provider or a palli-
ative service was provided. For all remaining palliative
acute hospital encounters only a single day of the hospita-
tisation was counted (eg, patient had a postadmission
palliative diagnosis). In the community-based settings of
care, a palliative care day must have a record of a pallia-
tive care service in billing codes; we did not assume that
care following the initiation of a palliative care code had
a palliative intent in the community settings.

We also examined timing to initiation of palliative care,
defined as first instance of any palliative care service
captured in the last year of life. If a decedent had the first
palliative care service outside of the window, initiation
was represented as 365 days. We also examined intensity
of palliative care by totalling the number of days palliative
care was delivered, categorised by service type.

Statistical analysis
Descriptive mean and median statistics describe the usage
patterns of decedents as well as the trajectory of care in the
last year of life. Multivariate logistic regression was used to
predict the likelihood of any use of palliative care. A nega-
tive binomial regression was used to predict the number
of days of palliative care that a decedent would receive
in the last year of life. Covariates included in the models
include: sex, age, income quintile, rurality and number

of chronic conditions. The number of chronic conditions is derived using a combination of validated Institute for Clinical Evaluative Sciences (ICES) algorithms that use prior hospital and physician claims records to identify the disease and hospital and physician claims records in the prior 2 years before death. Ethics approval for this study was received from the Ottawa Hospital Research Institute Ethics Board in Ottawa, Canada.

RESULTS
During the study period, we identified 235 159 decedents, who used a total of 4 497 685 days of palliative care services in the last year of life (mean 19.1 days per decedent). Our cohort was categorised into end-of-life trajectories: 32% as terminal illness, 31% organ failure, 29% frailty, 5% other and 3% as sudden death (table 1). Decedent characteristics were similar across all the trajectories, with the exception of frailty which had more older women and sudden death which had younger decedents with fewer comorbidities. Men and women were equally represented, and 80% were aged 65 years or older. Seventy-nine per cent of the cohort had three or more comorbidities, where hypertension was the most prevalent, followed by osteoarthritis, cancer, diabetes and congestive heart failure. Remaining results will focus on the three major disease trajectories: terminal illness, organ failure and frailty.

| Table 1 Cohort demographics by end-of-life disease trajectory |
|---------------------------------------------------------------|
| Terminal illness | Organ failure | Frailty | Other | Sudden death | Overall |
|---|---|---|---|---|---|
| N  | %  | N  | %  | N  | %  | N  | %  | N  | %  |
| Total cohort* | 75 657 | 32 | 72 363 | 31 | 67 513 | 29 | 11 784 | 5 | 7 842 | 3 | 235 159 | 100 |
| Sex | | | | | | | | | | | | |
| Male | 39 125 | 52 | 34 371 | 48 | 30 703 | 45 | 5 295 | 45 | 4 987 | 64 | 114 481 | 49 |
| Female | 36 532 | 48 | 37 992 | 53 | 36 810 | 55 | 6 489 | 55 | 2 855 | 36 | 120 678 | 51 |
| Age | | | | | | | | | | | | |
| <19 | 172 | <1 | 691 | 1 | 47 | <1 | 827 | 7 | 435 | 6 | 217 | 1 |
| 19–44 | 1 886 | 2 | 1 601 | 2 | 479 | 1 | 3 32 | 3 | 2 636 | 34 | 6 934 | 3 |
| 45–54 | 5 454 | 7 | 3 247 | 4 | 1 738 | 3 | 4 42 | 4 | 1 547 | 20 | 1242 | 5 |
| 55–64 | 12 311 | 16 | 6 631 | 9 | 4 193 | 6 | 7 30 | 6 | 1 090 | 14 | 24 955 | 11 |
| 65–74 | 18 042 | 24 | 10 885 | 15 | 7 472 | 11 | 1 229 | 10 | 6 76 | 9 | 38 304 | 16 |
| 75–84 | 22 790 | 30 | 21 447 | 30 | 18 990 | 28 | 2 959 | 25 | 7 80 | 10 | 66 966 | 28 |
| 85–94 | 13 730 | 18 | 23 514 | 32 | 27 641 | 41 | 4 257 | 36 | 5 92 | 8 | 69 734 | 30 |
| 95+ | 1 272 | 2 | 4 347 | 6 | 6 953 | 10 | 1 008 | 9 | 86 | 1 | 1 366 | 6 |
| Income† | | | | | | | | | | | | |
| Lowest | 16 014 | 21 | 17 288 | 24 | 15 637 | 23 | 2 545 | 22 | 2 008 | 26 | 53 492 | 23 |
| Low | 15 931 | 21 | 15 344 | 21 | 13 634 | 20 | 2 317 | 20 | 1 626 | 21 | 48 852 | 21 |
| Middle | 14 698 | 19 | 13 727 | 19 | 13 059 | 19 | 2 086 | 18 | 1 474 | 19 | 45 044 | 19 |
| High | 14 621 | 19 | 13 074 | 18 | 12 884 | 19 | 2 063 | 18 | 1 358 | 17 | 44 000 | 19 |
| Highest | 13 996 | 19 | 12 136 | 17 | 11 850 | 18 | 1 967 | 17 | 1 258 | 16 | 41 207 | 18 |
| Rurality† | | | | | | | | | | | | |
| Urban | 6 4302 | 85 | 6 1171 | 85 | 5 7853 | 86 | 9 752 | 83 | 6 564 | 84 | 199 642 | 85 |
| Rural | 1 123 | 15 | 1 074 | 15 | 9558 | 14 | 1 286 | 11 | 1 211 | 15 | 34 027 | 14 |
| No. of Chronic Diseases | | | | | | | | | | | | |
| 0 | 3 348 | <1 | 2 049 | 3 | 1 649 | 2 | 1 166 | 10 | 1 791 | 23 | 7 003 | 3 |
| 1 | 6 496 | 9 | 3 732 | 5 | 3 674 | 5 | 6 72 | 6 | 1 891 | 24 | 16 465 | 7 |
| 2 | 11 338 | 15 | 6 463 | 9 | 7 144 | 11 | 1 150 | 10 | 1 358 | 17 | 27 503 | 12 |
| 3 | 14 846 | 20 | 9 543 | 13 | 9 710 | 14 | 1 559 | 13 | 1 022 | 13 | 36 680 | 16 |
| 4 | 14 238 | 19 | 11 296 | 16 | 11 059 | 16 | 1 815 | 15 | 6 74 | 9 | 39 082 | 17 |
| 5 | 11 260 | 15 | 11 772 | 16 | 10 730 | 16 | 1 740 | 15 | 4 57 | 6 | 35 959 | 15 |
| 6+ | 17 081 | 23 | 27 508 | 38 | 23 547 | 35 | 3 682 | 31 | 6 49 | 8 | 72 467 | 31 |

*Percentages of ‘total cohort’ row represent the proportion of the whole cohort. All other percentages in each descriptive category are representative of the proportion of patients in each category under each trajectory and are not summative across a whole row.
†Does not equal 100%: a small number of records are missing this information.
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Palliative care access
Among the full cohort, 54% received at least one palliative care service in the last year of life. Palliative care from an institutional and community setting was mainly delivered by hospital inpatient services (46% of overall cohort) and community outpatient services (25%), respectively. Palliative care physician home visits were delivered to 6% of the overall decedent cohort. However, there was wide variation in use of palliative care across end-of-life trajectories (table 2). Across all settings, 88% of those in the terminal illness trajectory received palliative care compared with 44% of the organ failure trajectory and 32% in the frailty trajectory. Within particular settings, the terminal illness trajectory had nearly twice as many decedents receiving palliative care services in the hospital inpatient setting (76%) than the other trajectories. Many terminal illness decedents received outpatient palliative care (53%) and end-of-life home care services (47%), which was four and eight times more, respectively, than in the other two trajectories. Palliative care physician home visits were delivered to 15% of terminal illness decedents compared with 3% of organ failure decedents and 2% of frailty decedents.

Intensity of palliative care
Among users of palliative care in any setting, terminal illness has the highest mean number of palliative care days, ranging from 17 in an institution and 32 in the community, compared with 12 and 11 for organ failure and 11 and 10 for frailty trajectories. In all trajectories, about half of all palliative care days used occurred in the last 2 months of life, with a twofold increase in the last month of life. For example, decedents in the terminal illness trajectory averaged eight palliative care days in the second to last month before death, which increased to 13 days in the final month of life.

Initiation of palliative care
Decedents in the terminal illness trajectory had palliative care initiated a median of 107 days before death, more than four times earlier than organ failure (median 22 days) and frailty (median 24 days). In terms of intensity, the terminal illness trajectory had palliative care on 37% of days after initiation versus 25% and 23% in organ failure and frailty decedents (table 3).

Multivariable analyses of odds of using any palliative care services
When examining the odds of using any palliative care services in the last year of life, decedents with a terminal illness trajectory have an OR of 17.0 (OR 95% CI 17.03 to 17.09) when compared with those with a frailty trajectory controlling for sex, age, income quintile, rurality and...
Decedents in the organ failure trajectory are nearly twice (OR 1.7, 95% CI 1.68 to 1.72) as likely to use any palliative care compared with frailty trajectory.

Multivariable analyses of number of palliative care days received

Negative binomial regression analysis shows that decedents in the terminal illness trajectory receive seven times more days of palliative care (incidence rate ratio: 6.94, 95% CI 6.91 to 6.97) in the last year of life than decedents with a frailty trajectory. Increasing comorbidity was associated with higher number of days of palliative care received in the last year of life.

Comparison to palliative care access in other countries

In our cohort, among those who received any palliative care services, 55% died from terminal illness, 27%
from organ failure and 18% from frailty illness trajectories. Whereas among those who received the Medicare Hospice Benefit in the USA, 27% had cancer, 17% had dementia and 30% had cardiac, circulatory or respiratory failure. Data from Western Australia shows 69% of patients with cancer and 14% of patients without had access to specialist palliative care services (compared with 88% of cancer and 39% non-cancer in Ontario, Canada). In UK, among palliative care inpatient admissions, 88% had cancer.

Length of stay also varies by country. In Ontario, UK and Western Australia, patients with cancer had longer median lengths of stays (range 37–107 days) than other disease trajectories (range 6–43 days). However in the USA, the trend is the opposite, with patients with dementia having the longest median lengths of stay (56 days) and patients with cancer have the shortest (19 days).

DISCUSSION

Our population-based analysis of decedents in Ontario, Canada shows that while nearly half of decedents receive at least one palliative care service, there are large disparities based on dying trajectory. Eighty-eight per cent of those dying in the terminal illness trajectory (predominantly cancer deaths) received palliative care services compared with organ failure (44%) or frailty trajectories (32%). The terminal illness group also received twice as many palliative care services and four times earlier than the other two trajectories. In our universal insured hospital and physician system that does not require patients to forego curative treatment to receive palliative care, the median time from first palliative care service to death is 107 days for terminal illness, 22 days for organ failure and 24 days for frailty trajectories.

Our hypotheses were incorrect. While our Canadian data demonstrated terminal illness (predominantly cancer) patients received palliative care much earlier before death than in the USA, patients without cancer in Ontario were identified closer to death than in the USA. Importantly, the type of palliative care services offered, the training of providers and the organisation of the delivery system are not equivalent between countries or within Canada. Nonetheless, comparing similar statistics between geographic areas can generate hypotheses on how different eligibility criteria and health systems may explain differences in results. For instance, the in-home visiting hospice insured services offered in the USA includes extensive teams of specialist physicians and nurses and interprofessional providers, which is more comprehensive and coordinated than the services offered across Ontario, Canada. Indeed, our results show the vast majority of palliative care services were delivered in hospital inpatient units, not the home as in the USA. Yet the requirement to forego curative treatment to receive hospice care in the USA may be a factor in its relatively late initiation for patients with cancer, particularly with advancements in cancer treatment. Conversely, the comprehensive home-based focus of the US hospice insured benefit may explain the higher proportion of patients without cancer using it and for longer compared with Ontario, Canada which does not have widespread access to home-based fully insured palliative care teams.

Our data are also interesting compared with UK (universal health system) and Western Australia (mix of public and private health systems), which also have no requirements for an expected death certification or to forego curative treatments. Despite this similarity in eligibility, access to palliative care, use by disease trajectories, initiation before death and intensity and type of service use differ. The physician ratio is lower in Ontario, Canada than the other countries. The UK and USA have more physician specialists (75%) to generalists (25%) (all specialties) compared with Western Australia and Ontario, which is half–half. The availability of human resources and their training likely affects palliative care access and the delivery model (ie, specialist or generalist driven). For instance, in Ontario, one study showed that there were only 276 of 9732 family physicians, where palliative care services comprised more than 10% of their billings (40% of the cohort billed no palliative care at all). Indeed receipt of physician home-based visits for palliative care was very low across all disease trajectories in our data, which may be related to inadequate billing fees for home visits. The limited availability of palliative care physician specialists may explain preferential access to patients with terminal illness, who may traditionally be easier to identify as needing palliative care. Considering the growing body of evidence of efficacious palliative care interventions for non-cancer diseases, the marked disparities in access to patients without cancer ought to be a policy priority and will likely require overcoming the stigma of imminent death and medical failure as well as education on the benefits of early integration.

Limitations of using administrative health data to capture the use of palliative care include the potential undercoding of palliative care delivered, particularly in the community and long-term care. In the community, despite financial incentives to use specialised billing codes for palliative care, physicians may provide care reflecting palliative intent or elements of a palliative approach but not bill as such. This may include discussions about coping, basic symptom management and so on. In long-term care, palliative care billing codes are uncommon, rather, monthly management codes and subsequent visit codes are used. There are potential issues with reliability and validity when using cause of death data to group decedents into disease trajectories, particularly with the non-terminal illness trajectories. For example, not all stroke recovery follow the trajectory pattern of organ failure. We cannot describe the quality of care or include services provided by volunteers, family members.
### Table 4  Comparison of PC access and initiation across geographic areas

| Criteria to access PC | Ontario | UK | USA | Western Australia |
|-----------------------|---------|----|-----|-------------------|
| Universal insured hospital and physician system | 94,000 deaths in Ontario 2014/2015 | 548,000 deaths 2015 | 2.6 M deaths in 2015 | 23,852 deaths in Western Australia in 2009/2010 |
| No restrictions on curative along with PC | | | | Mix of private and government service providers |
| No written document required to initiate PC, though often the ‘surprise question’ of expected death of 1 year to 6 months is used to initiate care | | | | Use ‘normative need’ to assess access to PC specialists |
| Provided by general practitioners, specialists and home-care providers | | | | Are discouraged from providing PC for non-malignant disease |

| Physician ratio | | | | |
|----------------|---|---|---|---|
| 2.2 physicians/1000 ppl (2015) | 2.8 physicians/1000 ppl (2015) | 2.5 physicians/1000 ppl (2011) | 3.5 physicians/1000 ppl (2015) |
| 47%/53%; generalists/specialists | 29%/71%; generalists/specialists | 12%/88%; generalists/specialists | 45%/47%; generalists/specialists (8%: medical doctors not further defined) |

| Per cent that get any service | | | | |
|-----------------------------|---|---|---|---|
| 54% of decedents between 2010 and 2012 | 74% of people who are in need of PC receive either specialist or generalist services | 46% of Medicare (-65 years old) decedents received ≥1 day of hospice care (via the Medicare hospice benefit) in 2015 | 46% of decedents received any PC |
| received at least PC services (from billing claims) in any setting (table 2) | | | |

| Cancer and non-cancer access | | | | |
|-----------------------------|---|---|---|---|
| 88% of terminal illness, 44% of organ failure and 32% of frailty decedents (or 39% non-cancer) received any PC services (table 2) | 88% of PC inpatients have cancer diagnosis | 46% of Medicare (-65 years old) decedents received ≥1 day of hospice care (via the Medicare hospice benefit) in 2015 | 69% of patients with cancer had access to specialist care |
| | 20% of inpatient referrals are for non-cancer | | 14% of patients without cancer had access to specialist care |
| Among those receiving any PC services, 55% died from terminal illness, 27% from organ failure and 18% from frailty illness trajectories | | | |

| Average Length of stay in PC | | | | |
|-----------------------------|---|---|---|---|
| Median days of initiation of service to death: | Median days on service in one large study in one region (Leeds, UK): | Mean (median) days on service | Median number of days receiving specialist PC was 30 (cancer), 8 (COPD) and 5 (Alzheimers and heart failure) |
| Terminal illness 107 days | 37 days for cancer | Cancer: 47 (19) days | Median days PC initiated before death: 62 (cancer), 6 (Alzheimers) and 43 (COPD) |
| Organ failure 22 days | 16 days for non-cancer | cardiac: 76 (28) days | |
| Frailty 24 days (table 2) | | dementia: 105 (66) days | |
| | | respiratory 69 (19) days | |
| | | stroke 77 (20) days | |

| Location of service (community, home, hospital) | | | | |
|-----------------------------|---|---|---|---|
| 68% of cancer decedents have PC in a community setting | -20% of LTC residents were seen by a PC specialist nurse, 96% were seen by a GP | Home 56.0% | Organ failure patients (eg, liver failure) tended to receive care in hospital over community settings |
| 76% in an acute care setting | Poor access to hospitals. Only 21% of hospitals provide face-to-face PC 24/7 | Nursing facility 41.3% | Motor neuron and cancer decedents had increased access to community services |
| <1% of PC for any trajectory was received in an LTC facility (table 2) | 27% of hospital outpatient PC and 17% of community PC provided to non-malignant disease | Hospice inpatient facility 1.3% | |
| | | Acute care hospital 0.5% | |
| | | Other 0.9% | |

COPD, chronic obstructive pulmonary disease; GP, general practitioner; LTC, long-term care; PC, palliative care; ppl, people.
or private care that is not recorded in the health administrative databases. We also do not have an administrative database for hospice services and cannot account for care provided in a residential hospice. However, only 1%–3% of deaths occur in a residential hospice, and the majority of hospice care occurs after initiation of palliative home care services—which is included in our study.

In conclusion, our study quantifies a large disparity in access to palliative care for those dying from organ failure and frailty trajectories. Decedents with a terminal illness trajectory, exemplified by a cancer diagnosis, are significantly more likely to receive palliative care services than the other dying trajectories; they receive more services (intensity) both in hospital and community, and these services are initiated earlier in the dying trajectory. All trajectories could benefit from increased access to palliative home care services and physician home visits. This data will be useful to compare to in the future since a national palliative care framework was an identified need15,16 and has recently been passed into law.46 These data also serve as a useful comparison for other countries with similar and different health care systems and eligibility criteria to explore palliative care access across disease trajectories.

Contributors HS and PT conceptualised the study and RP performed the data abstraction and analysis. All authors contributed to interpretation and critical analysis of results. ED and HS drafted the first manuscript and all authors were responsible for contributing to the critical content and review of the manuscript. All authors act as guarantors and affirm that the article is an honest, accurate and transparent account of the study being reported; that no important aspects of the study have been omitted and that any discrepancies from this study as planned have been explained. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Competing interests None declared.

Patient consent Not required.

Ethics approval This study has been approved by the research ethics board at the ICES, at Sunnybrook Health Sciences Centre in Toronto, ON, Canada and by the research ethics board at the Ottawa Hospital Research Institute at Ottawa, ON Canada.

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Data sharing statement Using encrypted health card numbers as unique identifiers, records of healthcare use and costs were linked across various administrative databases. No written consent was obtained; all data were encrypted using health card numbers as unique identifiers. Thus, all records used were deidentified and anonymised. All data were housed and analysed at ICES; a prescribed entity for the purposes of section 45 of Ontario’s Personal Health Information Privacy Act.

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