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Determining preventable acute care spending among high-cost patients in a single-payer public health care system

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Abstract

Background Research has shown that a small proportion of patients account for the majority of health care spending. The objective of this analysis was to determine the amount and proportion of preventable acute care spending among high-cost patients.

Methods We examined a population-based sample of all adult high-cost patients using linked administrative health care data housed at ICES in Toronto, Ontario. High-cost patients were defined as those in and above the 90th percentile of the cost distribution. Preventable acute care (emergency department visits and hospitalisations) was defined using validated algorithms. We estimated costs of preventable and non-preventable acute care for high- and non-high-cost patients by category of visit/condition. We replicated our analysis for persistent high-cost patients and high-cost patients under 65 years and those 65 years and older.

Results We found that 10% of all acute care spending among high-cost patients was considered preventable; this figure was higher for non-high-cost patients (25%). The proportion of preventable acute care spending was higher for persistent high-cost patients (14%) and those 65 years and older (12%). Among ED visits, the largest portion of preventable care spending was for primary care treatable conditions; for hospitalisations, the highest proportions of preventable care spending were for COPD, bacterial pneumonia and urinary tract infections.

Conclusions Although high-cost patients account for a substantial proportion of health care costs, there seems to be limited scope to prevent acute care spending among this patient population. Nonetheless, care coordination and improved access to primary care, and disease prevention may prevent some acute care.

Keywords High-cost patients · Preventable acute care · Administrative health care data · Algorithms

JEL Classification I (Health Education and Welfare) · I0 (General) · I1 (Health)

Introduction

Health care costs are rising. As such, policy makers are seeking ways to bend the cost curve [1, 2]. Previous work has shown that a small proportion of patients account for the majority of health care spending [1, 2]. Thus, focusing on high-cost

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patients is likely to yield the most impact on health system costs. Many jurisdictions have implemented strategies, such as high-risk care management, to reduce costs and improve quality; however, it is not clear which costs can be reduced, especially among patients that require costly care. One potential way to decrease costs, without sacrificing care, may be to target preventable (i.e., potentially unnecessary) acute care among high-cost patients. Previous research has shown that emergency department (ED) visits and inpatient hospitalisations make up more than half of all costs among the high-cost population [1]. Furthermore, some studies have shown that a substantial proportion of ED visits [3, 4] and hospitalisations may be preventable [5–8].

While research has analysed preventable care among the general population or disease-specific sub-populations, little work has been done on high-cost patients. Most of the existing work has been done in the United States (US). Joynt et al. [9] examined preventable and non-preventable acute care among high-cost Medicare patients using validated algorithms [9]. They found only a small percentage (9.6%) of costs was due to preventable acute care. In particular, the largest drivers of acute care spending were orthopaedic procedures and ischemic heart disease, both of which are considered non-preventable. Graven et al. [10] replicated this analysis using the State of Oregon's All Payer All Claims database and Medicaid data from the Oregon Health Authority, which enabled them an almost comprehensive analysis of all patients across a single region for multiple payers [10]. The authors found that preventable acute care spending for high-cost patients accounted for less than 6% of total spending. In Canada, Ronksley et al. [11] examined preventable acute care spending among high-cost patients hospitalised at the Ottawa Hospital [11]. The authors used an ambulatory care sensitive conditions algorithm to determine preventable acute care. They found that, among a high-cost inpatient population, most costs were due to a single, non-preventable, acute care episode and only 6% of costs were due to an ambulatory care sensitive hospital encounter. The main limitation of these studies is that they examined subsets of patient groups, which limits the generalisability of findings to the entire population. Given the interest in identifying strategies to reduce health care costs incurred by high-cost patients, this study seeks to fill this gap by determining the amount and proportion of preventable acute care spending for the *entire* adult high-cost population in Ontario. In addition, it explores whether preventable acute care spending varies by age groups.

Methods

Study design and setting

We undertook a population-based, cross-sectional study of all adult high-cost patients in Ontario to determine potentially preventable acute care.

Data

We used administrative health care data available through ICES in Toronto, Ontario, which includes individual-level linkable and longitudinal data on most publicly funded health care services for all legal residents of Ontario, Canada's most populous province. Given universal health care coverage for all insured services, defined as hospital-based care and physician services in the Canada Health Act, virtually all legal residents of Ontario are captured in the data. Data on institution-based care are captured in the Discharge Abstract Database (acute hospitalisations), the Ontario Mental Health Reporting System (psychiatric hospitalisations), the Continuing Care Reporting System (continuing and long-term care), and the National Rehabilitation Reporting System (rehabilitation); data on ambulatory care are recorded in the National Ambulatory Care Reporting System. The Ontario Health Insurance Plan claims database captures data on physician visits, including fee-for-service visits and shadow-billed services, as well as laboratory and diagnostic claims. The Ontario Drug Benefit Program database includes information on all outpatient prescriptions dispensed to individuals covered under the public provincial drug plan (i.e., individuals aged 65 years and older and those under the age of 65 years who are eligible for social assistance). The Home Care Database records all unique visits provided by home care professionals. The ICES data repository also includes other databases, which provide useful information on individuals who contact the health care system. The Registered Persons Database, a population-based registry, provides basic demographic data, such as age and sex, on all legal residents of Ontario and their eligibility for public health care insurance. The Immigration, Refugees and Citizenship Canada database provides information on all legal immigrants and refugees in Canada. The Census data, obtained through Statistics Canada, contain information on neighbourhood-level characteristics, such as median income and degree of rurality. All databases were linked using unique encoded identifiers and analysed at ICES, in compliance with Ontario privacy legislation. A full description of the databases can be found in Table A1 in the Appendix.

Patient cohort

Using the Registered Persons Database, we selected all adult patients (18 years and older) eligible for public health care insurance and residing in Ontario in calendar year 2013. We excluded all patients who died before January 1 2013 or were born after December 31 2013, as well as those who did not contact the health care system in 2013. In addition, we excluded all patients who died in 2013, in line with previous research [9] as assessing the preventability of end-of-life care costs was beyond the scope of this analysis.

Identifying high-cost patients

We used a cost estimation algorithm, available at ICES, to estimate health care costs incurred by patients and borne by the public third-party payer (i.e., Ontario Ministry of Health and Long-term Care) [12] in 2013. This algorithm estimates costs of inpatient hospitalisations (acute and psychiatric), other institution-based care (complex continuing care, long-term care, inpatient rehabilitation), emergency department (ED) visits and other ambulatory care, outpatient clinic visits, physician visits and outpatient care, outpatient prescription drugs, and home care. The costs captured by the algorithm account for roughly 92% of all government paid health care [13].

High-cost patients were defined as those in and above the 90th percentile of the cost distribution (i.e., top decile), in line with previous work [2]. All other patients were defined as non-high-cost patients. We also examined persistent high-cost users, who were defined as all patients who remained in and above the 90th percentile of the cost distribution from 2013 to 2015.

Identifying preventable acute care

Preventable acute care was defined as ED visits and hospitalisations. To identify preventable ED visits, we used an updated version of a validated algorithm created by Billings et al. [14] and used in prior research, [3, 9, 15] and expanded by Johnston et al. [16]. The original algorithm uses specified diagnosis codes to create the following four categories: non-emergent; emergent but primary care treatable; emergent, ED care needed, but preventable; and emergent, ED care needed, and not preventable. Based on these classifications, the authors compiled a set of probabilistic weights that were applied to ED discharge data using primary discharge ICD-10 diagnosis codes to determine the percentage of ED use attributable to each of the four categories [17]. The updated version of the algorithm, developed by Johnston et al. [16], includes additional ED visit categories: alcohol use, drug use, injury and mental health. ED visits with diagnosis codes that were not mapped to any of the eight categories were

assigned to the "unclassified" category. Despite some criticism around its use as a potential triage tool or mechanism to determine whether an ED visit is appropriate for reimbursement by managed care plans, [18] the algorithm has been widely used in the US. In line with previous work, we defined non-emergent, emergent/primary care treatable, and emergent/ED care needed/preventable or avoidable visits as preventable ED visits, and ED care needed, not preventable, alcohol use, drug use, injury and mental health as non-preventable ED visits [9].

We used the Prevention Quality Indicators developed by the Agency for Healthcare Research and Quality, and used elsewhere [19–21], to identify potentially preventable hospitalisations [22]. These indicators define potentially preventable hospitalisations as those for which good outpatient care can likely prevent the need for hospitalisation. These include acute conditions, such as bacterial pneumonia and urinary tract infections, as well as chronic conditions, such as COPD and diabetes. We also used the respective Prevention Quality Indicators for common non-preventable clinical diagnosis groups to identify non-preventable hospitalisations. (See Table A2 in the Appendix for a list of diagnoses and codes for preventable and non-preventable hospitalisations.). We adapted the list of diagnosis codes (and procedure codes, where applicable) to the Ontario data. In particular, given that only the first 3 or 4 digits of the ICD-10 hospitalisation diagnosis codes were available in our data, we had to aggregate some diagnostic categories, which, in some cases, may have limited how we classified some hospitalisations (e.g. diabetes-related hospitalisations).

Analysis

We examined two patient groups: high- and non-high-cost patients. Patient groups were characterised and compared in terms of socio-demographic characteristics (sex, age, migrant status, neighbourhood income quintile, and urban/rural residence), and clinical characteristics (chronic conditions, frailty and long-term care residence). We used the existing ICES-derived cohorts/registries to ascertain chronic conditions among patients [23–34] and the Johns Hopkins Adjusted Clinical Groups Software [35] to determine patient frailty. Residence in a long-term care facility was determined through the Continuing Care Reporting System. Patient characteristics between high-cost and non-high-cost individuals were compared through the use of a Chi square test for differences. We estimated total costs of preventable and non-preventable acute care by category of visit (for ED visits) and condition (for inpatient hospitalisations) for both patient groups. We repeated all analyses for persistent high-cost patients. All costs were reported in 2016 constant Canadian dollars using Statistics Canada Consumer Price Index for health care [36].

Sensitivity analysis

Our analysis focused on all adult high-cost patients. However, previous work in the US examined Medicare high-cost patients [9]. Results are likely to differ by sample composition; therefore, we re-ran all analyses on high-cost patients under the age of 65 and those 65 years and older to compare our findings with those from previous research.

All analyses were performed using SAS Enterprise Guide 7.1. The study was approved by the research ethics board of Sunnybrook Health Sciences Centre in Toronto, Ontario.

Results

Patient characteristics

In 2013, 9,941,310 individuals contacted the Ontario health care system, excluding those who died during that year ($n = 90,555$). Among those, 929,726 were high-cost patients. These patients were older (mean age 62 versus 46 years), more often female (58% versus 52%) and non-migrant (89% versus 81%), slightly more represented in the lower neighbourhood income quintile (22% versus 18%) and slightly more likely to live in urban areas (13% versus 11%) compared to non-high-cost patients (Table 1). High-cost patients also had a higher proportion of chronic conditions, such as dementia, congestive heart failure, HIV, psychosis and cancer, a higher degree of frailty, and were more likely to be living in long-term care homes (Table 1).

Costs of preventable and non-preventable acute care

ED visits

Among the high-cost cohort, 32.0% of ED visits were deemed preventable according to the algorithm. These visits were associated with 29.5% of ED costs (Table 2). Proportions were slightly higher for non-high-cost patients, with 37.7% of visits and 34.6% of costs considered preventable. The categories with the highest proportion (excluding other/unclassified) were ED care needed, not preventable (17.9%), injury (13.0%) and emergent, primary care treatable (12.5%) for high-cost patients, and injury (19.3%), not emergent (15.3%) and emergent, primary care treatable (15.2%) for non-high-cost patients.

Hospitalisations

Within the high-cost group, 9.0% of hospital admissions were attributable to preventable causes, which corresponded to 8.5% of spending (Table 3). For non-high-cost patients,

3.4% of all hospital admissions were preventable while 3.9% of spending was classified as preventable. The preventable hospitalisations with the highest proportions of spending among high-cost patients included COPD (2.6%), bacterial pneumonia (1.8%) and urinary tract infections (1.5%) (and diabetes if all related hospitalisations were combined); this was also the case for non-high-cost patients (albeit different rankings). The non-preventable hospitalisations with the highest proportions of spending were orthopaedic conditions (7.3%), ischemic heart disease (7.3%) and cancer and chemotherapy (7.2%) for high-cost patients, and GI infections and disorders (2.9%), orthopaedic conditions (1.6%), and syncope and dizziness (1.0%) for non-high-cost patients.

Combining both ED and inpatient settings, 10.4% of high-cost patients' costs were considered potentially preventable while the corresponding value was 24.8% for non-high-cost patients.

Persistent high-cost cohort

We also examined a cohort of patients who persisted in the high-cost state from 2013 to 2015. Of the 929,726 high-cost patients, 53.7% ($n = 498,906$) remained in the high-cost category in 2014 while 37.0% ($n = 343,337$) remained in the high-cost category in both 2014 and 2015. Patients in the persistent high-cost cohort ($n = 343,337$) were on average older than other high-cost patients (68 versus 58; p value < .0001) and more likely to live in low-income neighbourhoods (26% versus 21%; p value < .0001) but similar on all other socio-demographic characteristics. Not surprisingly persistent high-cost patients had a higher proportion of chronic conditions (in particular HIV) than other high-cost patients (see Table A3 in the Appendix). Among the persistent group, 33.1% of ED visits were considered preventable, which corresponded to 31.3% of total ED costs (Table 4). With regard to hospitalisations, 14.4% were deemed preventable, which corresponded to 12.0% of total hospitalisation costs (Table 4). (See Tables A4 and A5 in the Appendix for a more detailed breakdown.). As a whole, 13.8% of all acute care spending was considered preventable.

Sensitivity analysis

We re-ran all analyses on high-cost patients under the age of 65 and those 65 years and older. We found that older high-cost patients were more likely to be Canadian born and less likely to live in low-income neighbourhoods compared to younger high-cost patients. In addition, older high-cost patients had a higher proportion of dementia and congestive heart failure but a lower proportion of HIV, chronic kidney disease and psychosis. Older high-cost patients also had a higher proportion of preventable acute

Table 1 Patient characteristics

	High-cost patients (n=929,726)		Non-high-cost patients (n=9,011,584)		All patients (n=9,941,310)		p value
Sex							
Female	539,440	58.0	4,708,789	52.3	5,248,229	52.8	<.0001
Male	390,286	42.0	4,302,795	47.7	4,693,081	47.2	
Age (mean/SD)	61.6	19.6	46.3	17.2	47.8	18	<.0001
Migrant status							
Non-immigrant	827,491	89.0	7,309,311	81.1	8,136,802	81.8	<.0001
Immigrant	83,219	9.0	1,430,684	15.9	1,513,903	15.2	<.0001
Refugee	19,016	2.0	271,589	3	290,605	2.9	<.0001
Neighbourhood income quintile							
Missing	4888	0.5	32,597	0.4	37,485	0.4	<.0001
1—Low	208,252	22.4	1,604,803	17.8	1,813,055	18.2	
2—Medium low	188,513	20.3	1,751,292	19.4	1,939,805	19.5	
3—Medium	179,974	19.4	1,814,811	20.1	1,994,785	20.1	
4—Medium high	180,107	19.4	1,948,399	21.6	2,128,506	21.4	
5—High	167,992	18.1	1,859,682	20.6	2,027,674	20.4	
Rural residence							
No	811,907	87.3	8,002,447	88.8	8,814,354	88.7	<.0001
Yes	117,819	12.7	1,009,137	11.2	1,126,956	11.3	
Chronic conditions							
Arthritis	32,437	3.5	76,001	0.8	108,438	1.1	<.0001
Asthma	179,426	19.3	1,251,414	13.9	1,430,840	14.4	<.0001
Cancer	187,770	20.2	369,422	4.1	557,192	5.6	<.0001
COPD	218,776	23.5	598,215	6.6	816,991	8.2	<.0001
Diabetes	287,852	31	981,064	10.9	1,268,916	12.8	<.0001
HIV	8670	0.9	7141	0.1	15,811	0.2	<.0001
Hypertension	548,100	59.0	2,285,472	25.4	2,833,572	28.5	<.0001
Chronic heart failure	126,524	13.6	112,075	1.2	238,599	2.4	<.0001
Crohn's/colitis	17,555	1.9	61,211	0.7	78,766	0.8	<.0001
Chronic kidney disease	4278	0.5	1925	0.0	6203	0.1	<.0001
Myocardial infarction	63,478	6.8	108,895	1.2	172,373	1.7	<.0001
Psychosis	58,115	6.3	97,324	1.1	155,439	1.6	<.0001
Dementia	115,864	12.5	56,404	0.6	172,268	1.7	<.0001
Other clinical characteristics							
Frailty	134,198	14.4	51,207	0.6	185,405	1.9	<.0001
Long-term care residence	80,192	8.6	364	0.0	80,556	0.8	<.0001

SD standard deviation, *COPD* chronic obstructive pulmonary disease, *HIV* human immunodeficiency virus

care costs than younger high-cost patients for both ED visits (31.4% versus 27.6%) and hospitalisations (10.4% versus 6.3%). (See Tables A6–A8 and A9–A11 in the Appendix for patient characteristics, and preventable and non-preventable acute care spending for high-cost patients 65 years and older, and those under the age of 65 years, respectively.) Overall, 12.1% and 8.3% of acute care spending was classified as preventable for patients 65 years and older and patients under the age of 65 years, respectively.

Discussion

We examined preventable acute care spending among a population-based sample of all adult high-cost patients in Ontario. We found that 29.5% of ED visit costs and 8.5% of hospitalisations costs could potentially be avoided. Overall, 10.4% of high-cost patients' acute care costs were considered potentially preventable. This percentage was slightly higher for persistent high-cost patients (13.8%) and those 65 and older (12.1%). The largest drivers of acute care costs were hospitalisations for catastrophic illnesses, such as

Table 2 Costs of preventable and non-preventable ED visits

Category of visit	High-cost patients (n = 929,726)		Non-high-cost patients (n = 9,011,584)		All patients (n = 9,941,310)	
	Spending, $	%	Spending, $	%	Spending, $	%
Not emergent (A)	62,554,632	10.4	99,491,515	15.3	162,046,147	12.9
Emergent, primary care treatable (B)	75,642,707	12.5	98,815,029	15.2	174,457,737	13.9
ED care need, preventable (C)	39,904,709	6.6	27,040,891	4.1	66,945,600	5.3
ED care needed, not preventable	107,961,476	17.9	80,346,336	12.3	188,307,812	15.0
Alcohol related	6,959,306	1.2	5,520,426	0.8	12,479,732	1.0
Drug related	2,321,173	0.4	1,862,706	0.3	4,183,879	0.3
Injury	78,646,203	13.0	126,095,144	19.3	204,741,347	16.3
Mental health related	25,832,149	4.3	17,706,134	2.7	43,538,282	3.5
Other/unclassified	203,141,530	33.7	194,911,460	29.9	398,052,990	31.7
Total preventable (A + B + C)	178,102,048	29.5	225,347,435	34.6	403,449,484	32.2
Total non-preventable	221,720,307	36.8	231,530,746	35.5	453,251,052	36.1
Not classified	203,141,530	33.7	194,911,460	32.3	398,052,990	31.7
Total	602,963,885	100.0	651,789,641	100.0	1,254,753,526	100.0

ED emergency department

ischemic heart disease and stroke, and orthopaedic conditions and cancer and chemotherapy, all of which were classified as non-preventable. Among preventable acute care, the largest drivers of spending were hospitalisations for COPD, bacterial pneumonia and urinary tract infections.

Our results are largely in line with previous work but differ in some regards. Using data from a large Canadian hospital in Ottawa, Ronksley et al. [11] examined preventable acute care spending among hospitalised high-cost patients using an ambulatory care sensitive conditions algorithm (which included hypertension, diabetes, angina, asthma, COPD, epilepsy, and heart failure/pulmonary edema) [11]. They found that most costs were due to a single, non-preventable, acute care episode and only 6% of costs were due to preventable care. The difference between our results is likely due to the use of different hospitalisation algorithms, given that the Agency for Healthcare Research Quality Prevention Quality Indicators include more conditions than those in the ambulatory care sensitive conditions algorithm, but also the type of population examined (hospitalised adults in one hospital versus entire adult population). Nonetheless, they also found that COPD was most common preventable hospitalisation. Joynt et al. [9] examined preventable and non-preventable acute care among high-cost Medicare patients in the US. The authors found that a small percentage of costs (9.6%) were due to preventable acute care, which is close to our value (10.4%) [9]. Graven et al. [10] replicated the Joynt et al. analysis using Oregon's All Payer All Claims database and Medicaid data from Oregon Health Authority [10]. They found that preventable health care spending for high-cost patients accounted for less than 6% of total spending. We were also interested in replicating the Joynt et al.

[9] study to understand whether their findings would differ for the full adult population. While we found that 29.5% ED visit costs were due to potentially preventable care, this figure was 41.0% for US Medicare population. This is likely due to different population makeup but also the large proportion of unclassified ED visits in our data. We found higher proportions of ED visit costs due to alcohol, drugs and mental health. Although ED visits for substance use and mental health were not broken down into preventable or non-preventable care, it is possible that some care could have been avoided with appropriate outpatient and community care. With regard to preventable hospitalisation costs, we found a slightly lower proportion (8.5%) than in the US Medicare high-cost population (9.6%). In particular, we found a higher proportion of hospitalisation costs for COPD (2.6%) and urinary tract infections (1.5%) (but similar proportion for bacterial pneumonia − 1.8% versus 1.9%), while previous work in the US found higher proportions for congestive heart failure (3.0% versus 0.1%), followed by bacterial pneumonia (1.9%) and COPD (1.7%). Again, our results differed from the US for the proportion of preventable ED visit spending among persistent high-cost patients (31.3% versus 43.3%) but were closer in value for the proportion of preventable hospitalisation spending (12.0% versus 13.5%).

Our results suggest that the percentage of preventable acute care costs varies with age. For example, the proportions of preventable alcohol-, drug- and mental health-related ED visit spending were far greater among younger high-cost patients while older patients had higher proportions of hospitalisation spending for COPD, bacterial pneumonia and urinary tract infections. Overall, we found that older high-cost patients had a higher percentage of preventable acute

Table 3 Costs of preventable and non-preventable hospitalisations

Category of visit	High-cost patients (n=929,726)		Non-high-cost patients (n=9,011,584)		All patients (n=9,941,310)	
	Spending, $	%	Spending, $	%	Spending, $	%
Chronic obstructive pulmonary disease	160,114,077	2.6	1,409,710	0.5	161,523,787	2.5
Bacterial pneumonia	112,959,510	1.8	3,112,057	1.0	116,071,567	1.8
Urinary tract infection	92,069,234	1.5	2,300,238	0.8	94,369,472	1.4
Lower extremity amputation	24,883,812	0.4	0	0.0	24,883,812	0.4
Perforated appendix	19,938,214	0.3	457,588	0.1	20,395,802	0.3
Long-term diabetes complication	19,633,551	0.3	102,904	0.0	19,736,455	0.3
Hypertension	10,594,686	0.2	970,333	0.3	11,565,020	0.2
Dehydration	9,655,233	0.2	142,683	0.0	9,797,916	0.1
Short-term diabetes complication	9,159,893	0.1	1,262,921	0.4	10,422,813	0.2
Uncontrolled diabetes	8,843,007	0.1	306,659	0.1	9,149,665	0.1
Asthma	6,933,292	0.1	1,075,680	0.4	8,008,973	0.1
Congestive heart failure	6,651,123	0.1	1042	0.0	6,652,166	0.1
Diabetes: other	2,150,893	0.0	321,082	0.1	2,471,975	0.0
Diabetes: unclassified*	48,249,940	0.8	430,817	0.1	48,680,757	0.7
Total preventable	531,836,465	8.5	11,893,714	3.9	543,730,180	8.3
Category of visit						
Ischemic heart disease	455,283,910	7.3	1,125,278	0.4	456,409,188	7.0
Orthopaedic conditions	453,005,683	7.3	4,916,925	1.6	457,922,608	7.0
Cancer and chemotherapy	447,969,882	7.2	1,298,074	0.4	449,267,956	6.9
Stroke, TIA, intracranial haemorrhage	255,222,013	4.1	2,274,250	0.7	257,496,263	3.9
GI infections and disorders	210,300,028	3.4	8,965,130	2.9	219,265,158	3.4
Arrhythmia	135,340,032	2.2	2,367,313	0.8	137,707,345	2.1
Sepsis	119,382,289	1.9	92,395	0.0	119,474,683	1.8
Procedure or device complications	117,731,199	1.9	238,857	0.1	117,970,056	1.8
Kidney failure	95,241,885	1.5	1,105,600	0.4	96,347,485	1.5
Other pulmonary	88,041,165	1.4	65,459	0.0	88,106,624	1.3
Rehabilitation	49,141,902	0.8	2876	0.0	49,144,779	0.8
Cellulitis	48,853,244	0.8	1,033,022	0.3	49,886,266	0.8
Peripheral atherosclerosis	41,811,445	0.7	118,156	0.0	41,929,600	0.6
Syncope and dizziness	33,125,879	0.5	3,067,753	1.0	36,193,632	0.6
Pulmonary embolism and deep-vein thrombosis	28,831,886	0.5	99,682	0.0	28,931,569	0.4
Dementia	20,640,367	0.3	1848	0.0	20,642,215	0.3
Cardiac valve disease	15,359,176	0.2	0	0.0	15,359,176	0.2
Total non-preventable	2,615,281,985	41.9	26,772,618	8.8	2,642,054,603	40.4
Not classified	3,089,498,532	49.5	267,007,647	87.4	3,356,506,180	51.3
Total	6,236,616,982	100.0	305,673,979	100.0	6,542,290,963	100.0

TIA transient ischemic attack, *GI* gastro-intestinal

*includes all diabetes codes that do not fall in any of the other existing diabetes categories

care than younger ones (12.1% versus 8.3%) likely in part due to greater comorbidity. Thus, for older patients, there may be more scope to lower acute care costs through better care coordination programs and improved access to primary care or disease prevention (although not without substantial investments and lead time for changes to occur). Previous research has shown that Bridges to Care, an ED-initiated, multidisciplinary, community-based program, reduced acute care use and increased primary care visits among frequent emergency care users [37]. Moreover, there may be advantages in targeting lower-income high-cost patients [6, 38]. For instance, this could potentially be achieved through improved access to care for low-income individuals and/or targeted prevention/educational interventions to ensure these

Table 4 Costs of preventable and non-preventable ED visits and hospitalisations among persistent high-cost and other high-cost patients

	Persistently high-cost patients ($n=343,337$)		Other high-cost patients ($n=586,389$)		All high-cost patients ($n=929,726$)	
ED visits	Spending, $	%	Spending, $	%	Spending, $	%
Total preventable	75,098,359	31.3	103,003,688	28.4	178,102,048	29.5
Total non-preventable	85,308,297	35.5	136,412,010	37.6	221,720,307	36.8
Not classified	79,904,894	33.3	123,236,635	51.3	203,141,530	33.7
Total	240,311,550	100.0	362,652,333	100.0	602,963,885	100.0
Hospitalisations						
Total preventable	266,333,860	12.0	265,502,605	6.6	531,836,465	8.5
Total non-preventable	994,306,463	44.6	1,620,975,521	40.4	2,615,281,985	41.9
Not classified	967,577,640	43.4	2,121,920,893	52.9	3,089,498,532	49.5
Total	2,228,217,963	100.0	4,008,399,019	100.0	6,236,616,982	100.0

ED emergency department

patients do not delay seeking care until their condition is too advanced. Nonetheless, while disease management may provide some cost savings to the system, previous research suggests that substantial reductions in preventable acute care are not likely to have a large impact on health care spending, despite these visits being expensive at the aggregate level [9]. Our findings are in line with previous research. Thus, other strategies may be required, such as finding ways to make hospital care more efficient and, in turn, inpatient stays less costly [9]. This could potentially be achieved by a greater focus on preventing the development of multi-morbidity in older populations.

Our study adds to prior literature on this topic. We provide estimates of preventable acute care spending for the *entire* adult high-cost population, thus addressing a data limitation that is common when using US data. As such, this analysis will be relevant to other jurisdictions with similar health care systems, such as the United Kingdom and other European countries. Furthermore, we examine how preventable acute care spending varies by age groups. We provide an in-depth characterisation of the high-cost population and follow them over time, which enabled us to examine preventable care among patients who persist in the high-cost state. We made use of rich administrative health care data and were able to account for *all* ED visit and inpatient hospitalisation costs given the presence of a (sole) third-party public payer for acute care in Ontario.

Limitations

We did not examine patients under the age of 18, as some health services for this population are funded by ministries other than the Ontario Ministry of Health and Long-term Care. We did not examine preventability of end-of-life care costs, as this what outside the scope of our analysis. We used previously defined algorithms developed in the US to identify preventable acute care, which are not without limitations [10]. In particular, when applied to the Ontario data, the ED algorithm was not able to classify a large proportion of visits while the Prevention Quality Indicators required more than 4 ICD-10 coding digits for a perfect match. This has likely affected the degree to which we were able to ascertain preventable acute care costs given the large proportion of non-classified events (e.g. for individuals 65 years and older, we found that only 31.4% of ED costs were preventable, while Joynt et al. [9] found that 41.0% of ED costs were preventable for the US Medicare population). Furthermore, while the algorithm was able to classify ED visits into alcohol use, drug use and mental health visits, it did not explore potential avoidable ED visits within each of these categories. This was also the case for the hospitalisation algorithm, which focused on physical health only.

Conclusion

Research suggests that some acute care spending can be preventable. In a time of rising health care costs, focusing on high-cost patients is likely to yield cost-savings. We found there was limited scope to prevent acute care spending among high-cost patients (though this varied by whether high-cost patients persist in that state or whether they are older). Nonetheless, better access to primary care as well as disease prevention may help prevent some acute care. While previous work has examined preventable acute medical care among patients with mental illness or addiction [39, 40], no studies have specifically focused on preventable acute *psychiatric* care. Future work should explore preventable acute psychiatric care, such as ED visits for self-harm or psychiatric hospitalisations for depression, for example.

Compliance with ethical standards

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