

10-Year Trends in Healthcare Spending among Patients with Schizophrenia in Alberta, Canada


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Tendances sur 10 ans des dépenses de santé chez les patients souffrant de schizophrénie en Alberta, Canada

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Abstract

Objectives: Schizophrenia is characterized by high levels of disability often resulting in increased healthcare utilization and spending. With expanding healthcare costs across all healthcare sectors, there is a need to understand how healthcare spending has changed over time. We conducted a population-based study using administrative health data from Alberta, Canada, to describe changes in medical complexity and direct healthcare spending among patients with schizophrenia over a 10-year period.

Methods: A serial cross-sectional study from January 1, 2008, to December 31, 2017, was conducted to determine changes in demographic characteristics, medical complexity, and costs among all adults (18 years or older) with schizophrenia. Total healthcare spending and sector-specific costs attributable to hospitalizations, emergency department visits, practitioner billings, and prescriptions were calculated and compared over time.

Results: Over the 10-year period the contact prevalence of patients with schizophrenia increased from 0.6% ($n = 16,183$) to 1.0% ($n = 33,176$) within the province. There was a marked change in medical complexity with the number of patients living with 3 or more comorbidities increasing from 33.0% to 47.3%. Direct annual healthcare costs increased 2-fold from 321 to 639 million CAD (493 million USD) with a 7-fold increase in medication expenditures over the 10-year time frame. As of 2017, spending on pharmaceutical treatment surpassed hospitalizations as the leading spending category in this population.

Conclusions: Healthcare spending among patients with schizophrenia continues to increase and may be partially attributable to growing rates of multimorbidity within this population. Although promising second-generation antipsychotic medications have entered the market, this has resulted in considerable changes in the distribution of healthcare spending over time. These findings will inform policy discussions around resource allocation and efforts to curb health spending while also improving care for patients with schizophrenia.

Abrégé

Objectifs: La schizophrénie se caractérise par des niveaux élevés d'incapacité qui entraînent souvent une utilisation accrue des soins et des dépenses de santé. Comme les frais de santé s'accroissent dans tous les secteurs des soins de santé, il faut

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comprendre comment les dépenses de santé ont changé avec le temps. Nous avons mené une étude dans la population à l'aide des données de santé administratives de l'Alberta, Canada pour décrire les changements de la complexité médicale et les dépenses de santé directes chez les patients souffrant de schizophrénie sur une période de 10 ans.

Méthodes: Une étude en série transversale du 1^{er} janvier 2008 au 31 décembre 2017 a été menée afin de déterminer les changements des caractéristiques démographiques, de la complexité médicale et des coûts chez tous les adultes (18 ans ou plus) souffrant de schizophrénie. Le total des dépenses de santé et des frais propres à un secteur attribuables aux hospitalisations, aux visites au service d'urgence, aux factures du praticien, et aux prescriptions a été calculé et comparé avec le temps.

Résultats: Sur la période de 10 ans, la prévalence des contacts des patients souffrant de schizophrénie est passée de 0,6% (n = 16 183) à 1,0% (n = 33 176) dans la province. Il y a eu un changement marqué de la complexité médicale car le nombre de patients vivant avec 3 comorbidités ou plus s'est accru de 33,0% à 47,3%. Les dépenses de santé annuelles directes ont augmenté 2 fois, de 321 à 639 millions de dollars CAD (493 millions de dollars USD) et les dépenses de médicaments ont augmenté 7 fois sur cette même période de 10 ans. En 2017, les dépenses de traitement pharmaceutique ont dépassé les hospitalisations à titre de principale catégorie de dépenses dans cette population.

Conclusions: Les dépenses de santé chez les patients souffrant de schizophrénie continuent d'augmenter et peuvent être attribuables en partie aux taux croissants de multimorbidité au sein de cette population. Bien que les médicaments antipsychotiques prometteurs de deuxième génération aient pénétré le marché, il en a résulté des changements considérables de la distribution des dépenses de santé avec le temps. Ces résultats éclaireront les discussions politiques au sujet de l'allocation des ressources et des initiatives pour contenir les dépenses de santé tout en améliorant les soins des patients souffrant de schizophrénie.

Keywords

Schizophrenia, health services research, comorbidity, economic analysis

Introduction

Schizophrenia is a mental disorder characterized by the inability to distinguish between what is real and unreal, to think clearly, and manage emotions, resulting in considerable impairment to daily functioning.¹ Beyond expert clinical assessment, there is no gold standard for the diagnosis of schizophrenia making it difficult to estimate the number of Canadians living with this disorder. However, contact prevalence (defined as prevalence based on the number of individuals with a diagnosis of schizophrenia who contact the health care system) is commonly used as a proxy measure and has been found to range from 0.3 to 1.3%.^{2–5} Although the prevalence of other mental health disorders is higher in Canada (e.g., 8% for major depression, 12% for anxiety disorder, 6–9% for personality disorders⁶), the 2017 Global Burden of Disease Study ranked schizophrenia as having the greatest disability burden of the 354 diseases assessed.⁷ This high level of disability is a function of both positive and negative symptoms of the disease, but also underlying comorbidities that co-occur within this population.⁸ As rates of all-cause mortality continue to decline in this population, patients are living longer and accumulating more age-related chronic diseases.⁹ This has important implications as increased medical complexity results in increased healthcare utilization.¹⁰

The healthcare needs of patients with schizophrenia have major implications for health resource allocation and planning. In 2004, it was estimated that total costs for schizophrenia care in Canada (direct and indirect) exceeded \$6.8 billion CAD¹¹ and in 2017–2018, the estimated average cost of a

hospital stay for a Canadian patient with schizophrenia was \$12,971, the highest among all mental disorders.¹² Expanding per capita healthcare costs in North America^{13–15} has led to an increased focus on finding efficiencies within health systems. This includes decreasing reliance on acute care services through strategies aimed at improving access to community care, early detection, and initiation of psychosis intervention programs.^{16–18} Further, there have been key advances in the management of schizophrenia over the past decade, which include the use of promising new antipsychotic medications.^{19,20} These changes in management and proposed shifts in the location of care have created a need to understand how overall, and sector-specific healthcare spending has been impacted.

To our knowledge, no studies have explored how healthcare expenditures and medical complexity have changed over the past decade within this patient population. Improving our understanding of trends in healthcare spending and the changing clinical profiles of patients with schizophrenia may uncover important areas where patient outcomes, quality of life, and healthcare resource efficiencies may be realized. With this in mind, we conducted a population-based study using administrative health data to describe changes in clinical complexity and direct health care spending among adult patients with schizophrenia over a 10-year period within Alberta, Canada. We hypothesized that the contact prevalence of schizophrenia may increase due to reduced stigma/improved support structures for this population. We also expected that comorbidity profiles would change over time and there would be incremental increases in healthcare spending across all health sectors.

Patients and Methods

Study Design/Data Sources/Population

We conducted a serial cross-sectional study between January 1, 2008, and December 31, 2017 (i.e., 10 years) using administrative and clinical data from the province of Alberta, Canada. This included information on hospitalizations (Discharge Abstract Database), emergency department visits (National Ambulatory Care Reporting System), practitioner billing information, the patient demographic information (Alberta's Population Health Registry), and Alberta Vital Statistics (for date of death information) maintained by Alberta's Ministry of Health.²¹ Within these sources, we identified all patients with schizophrenia aged 18 years and older using a validated case-ascertainment algorithm. The presence of schizophrenia was defined as: "1 hospitalization or 2 physician billing claims in 2 years or less associated with a F20.X, F21.X, F23.2 or F25.X *International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10)* code or a '295.X' *ICD-9* code."^{22–24} This algorithm has a reported positive predictive value of 87% and a sensitivity of 87%.²² Patients with schizophrenia entered the cohort on the date of their first schizophrenia-specific *ICD* code and were followed until death, outmigration, or end of study follow-up (December 31, 2017). Schizophrenia prevalence was defined for each cohort year by dividing the number of individuals present in the cohort by the total adult population in Alberta.²⁵

Demographic and clinical characteristics of all patients were extracted from the same administrative datasets. This included age, sex, and postal code (to derive urban/rural status). Census data and postal codes were also used to capture material and social deprivation indices as proxies for socioeconomic status.²⁶ Comorbidity profiles were determined through the use of 29 case-ascertainment algorithms defined by Tonelli et al.²² Multimorbidity was categorized as 1, 2, or 3 + comorbid conditions (excluding schizophrenia). A proxy measure of housing stability was also generated by searching healthcare records for a record of homelessness (*Z59 ICD-10* code), or a shelter-associated postal code. Finally, annual prescription information (Anatomical Therapeutic Chemical [ATC] Classification System and date of prescription) was obtained for each patient through Alberta's Pharmaceutical Information Network data repository.

Costing Methodology

Cumulative healthcare spending among patients with schizophrenia was estimated by calendar year from 2008 to 2017. Patient-level estimates (i.e., average cost per patient) were also calculated using four data sources (hospitalizations, emergency department visits, outpatient physician visits, and prescription medications). For the purposes of this

work, each of these data sources were considered to correspond to the different "sectors" of direct healthcare costs. Costed for hospitalizations and emergency department visits were estimated using Resource Intensity Weights (RIWs) for each encounter multiplied by the mean provincial cost of a "typical" encounter. Outpatient physician visits were costed per the Alberta Health Schedule of Medical Benefits. Finally, medication costs for patients with both public and private drug insurance were estimated by multiplying the Alberta Drug Benefit List cost for dispensed medication by the quantity dispensed. These costs include dispensing fees but do not account for patient co-payments. This costing analysis was performed from a public health payer perspective and focused on direct healthcare spending only. Direct nonmedical costs (e.g., transportation and accommodations required to attend medical appointments, informal care provided by unpaid caregivers, formal care provided by professional caregivers, etc.) and indirect nonmedical costs (e.g., incurred by absenteeism from work, forced retirement due to illness, etc.) could not be obtained within the data sources available. Statistics Canada's Consumer Price Index was used to adjust for inflation with all prices representing 2017 equivalents.

Analysis

Patient demographic and clinical characteristics were summarized using means and standard deviations (SDs), medians and interquartile ranges (IQRs), or proportions as appropriate. Estimates were calculated for each of the 10 years of data, and differences (deltas) between the 2017 and 2008 calendar years were also calculated to explore trends over time. Cost estimates were stratified by age category (18–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80+) and geographic location (urban vs. rural). Similarly, the proportion of patients with multimorbidity was also stratified by age categories. Results were represented graphically using line and bar charts where appropriate. All analyses were completed using STATA 16.²⁷ This study follows the REporting of studies Conducted using Observational Routinely-collected Data (RECORD) statement²⁸ (Appendix A). The University of Calgary Conjoint Health Research Ethics Board approved this study and granted waiver of patient consent.

Results

Between 2008 and 2017 the estimated number of patients with schizophrenia increased from approximately 16,000 individuals to 33,000. This represents 0.6% to 1.0% of Alberta's population (Table 1) and a net increase of approximately 10% in cohort size per year. Mortality ranged between 1.8 and 2.3% of the cohort annually. Cohort demographics remained stable with the median patient age ranging between 46 and 47 years but with an increasing IQR. The sex distribution remained constant with males representing

57.0% of the cohort each year. We also observed net improvements in material and social deprivation over time. Despite this, a higher proportion of patients were classified as unstably housed, with a low of 5.0% in 2008 to a high of 5.8% in 2017.

Clinical Characteristics

Clinical coding for schizophrenia, across the disease spectrum, remained constant over time. Of the *ICD-9* and *ICD-10* codes associated with a schizophrenia diagnosis, the majority were “Paranoid schizophrenia” (295.3, F20.0), “Unspecified schizophrenia” (295.9, F20.3, F20.9), or “Other schizophrenia” (295.0, 205.5, 295.8, F20.8). *ICD* coding for illicit/psychoactive drug use became more common over the study period. The five most reported classes of psychoactive drugs within the 2017 calendar year were alcohol (increasing from 8.0% to 10.2%), “other psychoactive substances” (increasing from 3.0% to 4.7%), “other stimulants” (increasing from 0.3% to 3.2%), cannabis (increasing from 1.1% to 2.0%), and opioids (increasing from 0.8% to 2.0%).

The presence of multimorbidity among patients with schizophrenia also increased. In 2017, almost half of the cohort (47.3%) had 3 or more chronic conditions (Table 2). The most prevalent comorbidities were depression (47.2%), hypertension (31.3%), chronic kidney disease (30.4%), alcohol misuse (27.8%), and diabetes (16.1%). The greatest increases in prevalence from 2008 to 2017 occurred for chronic kidney disease (+ 11.3%), hypertension (+ 6.1%), dementia (+ 4.6%), and alcohol misuse (+ 4.4%) (Appendix B). Age stratified estimates showed that the prevalence of 27 of the 29 comorbidities of interest increased with age. Alcohol misuse and depression were two exceptions to this trend and were found to be the most common in younger patients with schizophrenia aged 18–39 (Appendix C).

Cost Analysis

Direct healthcare expenditures among patients with schizophrenia increased each year. In 2008 an estimated \$321,472,883 was spent on patients in this cohort. This rose to \$638,879,561 in 2017 which represents a 99% increase in spending (Table 3). The mean cost per patient remained relatively stable from \$19,864 (SD: \$76,668) in 2008 to \$19,257 (SD: \$99,176) in 2017. When stratified by age, mean costs were highest among younger patients with schizophrenia while median costs were found to be highest among older patients. Further, total costs rose fastest among younger patients with schizophrenia (Figure 1) and stratified analysis of these data suggests that rising treatment costs in younger patients is primarily a function of increased pharmaceutical costs. There were no major differences in health spending across geographic location over time.

Although healthcare expenditures increased over time across all health sectors of interests, we did observe substantial variation in these trends. In 2008, the greatest contributors to healthcare costs were hospitalizations and practitioner claims (representing 67.0% and 18.0% of direct costs, respectively). This changed over the 10-year period with medication spending becoming the largest contributor to total health spending in 2017 (Figure 2). This represented 42.0% of total healthcare expenditures for the cohort in this year, followed by hospital spending at 35.0%. Over the 10-year study period, the fastest-growing category was medication expenditures with a greater than 7-fold increase in estimated cost over time (3.6-fold increase per capita). In contrast, the slowest growing category for cost was hospitalizations with total expenditures remaining relatively unchanged after accounting for inflation.

In 2008, the five most prescribed drugs among patients with schizophrenia (in order of frequency) were: olanzapine, haloperidol, quetiapine, clozapine, and ziprasidone. This pattern appeared to remain stable until 2013 when aripiprazole supplanted ziprasidone. However, in 2017, 18.5% of patients prescribed antipsychotics were prescribed aripiprazole injectables. Including orally administered drugs, aripiprazole was the fourth most prescribed antipsychotic behind quetiapine (28.5%), olanzapine (26.5%), and risperidone (23.1%). Most of the increase in drug expenditures was found to be associated with the introduction of the injectable form of aripiprazole in 2013. By 2017, aripiprazole injection prescriptions accounted for almost \$160 million CAD of annual healthcare spending in this cohort (Appendix D).

Discussion

Using 10 years of population-based data from Alberta, Canada we found that patients with schizophrenia remain a high healthcare needs group within the population. Although patients appear to be living longer, their management is becoming increasingly complex with a surge in multimorbidity. Spending trends also appear to be shifting toward an increased reliance on higher-cost antipsychotic treatments. This has major implications for health system sustainability and policy discussions on how to curb health spending in this patient population while also improving health outcomes.

Applying a validated case-ascertainment algorithm for schizophrenia, we found that the contact prevalence of schizophrenia in Alberta’s adult population ranged between 0.6% and 1.0%. These estimates align with other Canadian studies despite differences in study period and methods used to define schizophrenia.²⁹ For example, Vanasse et al. found the prevalence of treated schizophrenia among adults in Quebec ranged from 0.59% to 1.46% between 1996 and 2006.³⁰ Similar increases have been observed at a national level in a recent report by the Public Health Agency of Canada.³¹ Interestingly, we also observed a widening inter-quartile age range suggesting that subsets of patients with

Table 1. Demographic Characteristics.

Cohort	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Delta (over 10 years)**
# Patients with Schizophrenia (% Albertan 18-99 +)***	16183 (0.6%)	17941 (0.6%)	19639 (0.7%)	21342 (0.7%)	23051 (0.8%)	24957 (0.8%)	26784 (0.8%)	28771 (0.9%)	30974 (1.0%)	33176 (1.0%)	+ 16993 (+ 0.4%)
Incident Cases (% Cohort)	1876 (11.6%)	2021 (11.3%)	2108 (10.7%)	2172 (10.2%)	2190 (9.5%)	2431 (9.7%)	2432 (9.1%)	2652 (9.2%)	2966 (9.6%)	3022 (9.1%)	-2.5%
Deaths	292 (1.8%)	341 (1.9%)	386 (2.0%)	391 (1.8%)	460 (2.2%)	516 (2.1%)	558 (2.1%)	632 (2.2%)	661 (2.1%)	761 (2.3%)	+ 0.5%
Annual % Increase in Patients with Schizophrenia	n/a	10.9%	9.5%	8.7%	8.0%	8.3%	7.3%	7.4%	7.7%	7.1%	n/a
Age and sex distribution											
Median Age (25, 75 percentile)	46.2 (34.4, 56.3)	46.5 (34.3, 56.8)	46.7 (34.0, 57.2)	46.9 (33.8, 57.6)	47.0 (33.8, 58.0)	46.9 (33.6, 58.3)	46.9 (33.5, 58.5)	46.7 (33.5, 58.8)	46.5 (33.5, 59.0)	46.3 (33.4, 59.1)	+ 0.1 years
18-29	2504 (15.5%)	2761 (15.4%)	3064 (15.6%)	3306 (15.5%)	3570 (15.5%)	3941 (15.8%)	4215 (15.7%)	4531 (15.8%)	4930 (15.9%)	5271 (15.9%)	+ 0.4%
30-39	2957 (18.3%)	3331 (18.6%)	3645 (18.6%)	4013 (18.8%)	4375 (19.0%)	4812 (19.3%)	5301 (19.8%)	5802 (20.2%)	6325 (20.4%)	6949 (21.0%)	+ 2.7%
40-49	3829 (23.7%)	4023 (22.4%)	4252 (21.7%)	4457 (20.9%)	4633 (20.1%)	4809 (19.3%)	5024 (18.8%)	5297 (18.4%)	5609 (18.1%)	6008 (18.1%)	-5.6%
50-59	3609 (22.3%)	4034 (22.5%)	4411 (22.5%)	4787 (22.4%)	5194 (22.5%)	5525 (22.1%)	5808 (21.7%)	6069 (21.1%)	6331 (20.4%)	6568 (19.8%)	-2.5%
60-69	1801 (11.1%)	2070 (11.5%)	2337 (11.9%)	2648 (12.4%)	2909 (12.6%)	3288 (13.2%)	3689 (13.8%)	4050 (14.1%)	4471 (14.4%)	4867 (14.7%)	+ 3.5%
70-79	915 (5.7%)	1011 (5.6%)	1139 (5.8%)	1240 (5.8%)	1401 (6.1%)	1536 (6.2%)	1627 (6.1%)	1775 (6.2%)	1991 (6.4%)	2131 (6.4%)	+ 0.8%
80 +	568 (3.5%)	711 (4.0%)	791 (4.0%)	891 (4.2%)	969 (4.2%)	1046 (4.2%)	1120 (4.2%)	1247 (4.3%)	1317 (4.3%)	1382 (4.2%)	+ 0.7%
Male Sex	9153 56.6%	10140 56.5%	11143 56.7%	12120 56.8%	13092 56.8%	14166 56.8%	15275 57.0%	16494 57.3%	17715 57.2%	18987 57.2%	-0.6%
Geographic distribution											
Rural area	1797 (11.1%)	2035 (11.3%)	2254 (11.5%)	2477 (11.6%)	2610 (11.3%)	2875 (11.5%)	3092 (11.5%)	3338 (11.6%)	3575 (11.5%)	3863 (11.6%)	+ 0.5%
Small population centre (1,000 to 29,999)	1641 (10.1%)	1823 (10.2%)	1983 (10.1%)	2186 (10.2%)	2379 (10.3%)	2566 (10.3%)	2794 (10.4%)	2930 (10.2%)	3181 (10.3%)	3447 (10.4%)	+ 0.3%
Medium population centre (30,000 to 99,999)	1636 (10.1%)	1834 (10.2%)	2006 (10.2%)	2203 (10.3%)	2428 (10.5%)	2612 (10.5%)	2827 (10.6%)	3068 (10.7%)	3247 (10.5%)	3490 (10.5%)	+ 0.4%
Large urban population centre (100,000 or greater)	9238 (57.1%)	10184 (56.8%)	11186 (57.0%)	12296 (57.6%)	13363 (58.0%)	14403 (57.7%)	15594 (58.2%)	16812 (58.4%)	18065 (58.3%)	19320 (58.2%)	+ 1.2%
Missing	1871 (11.6%)	2065 (11.5%)	2210 (11.3%)	2180 (10.2%)	2271 (9.9%)	2501 (10.0%)	2477 (9.3%)	2623 (9.1%)	2906 (9.4%)	3056 (9.2%)	-2.4%
Material deprivation											
1st Quintile (Least Deprived)	1887 (11.7%)	2122 (11.8%)	2373 (12.1%)	2593 (12.2%)	2827 (12.3%)	3020 (12.1%)	3378 (12.6%)	3755 (13.1%)	4093 (13.2%)	4488 (13.5%)	+ 1.2%
2nd Quintile	1631 (10.1%)	1816 (10.1%)	2001 (10.2%)	2237 (10.5%)	2415 (10.5%)	2658 (10.7%)	2859 (10.7%)	3133 (10.9%)	3471 (11.2%)	3815 (11.5%)	+ 1.4%
3rd Quintile											+ 1.0%

(continued)

Table 1. Continued.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Delta (over 10 years)**
4th Quintile	2238 (13.8%)	2511 (14.0%)	2702 (13.8%)	2993 (14.0%)	3252 (14.1%)	3505 (14.0%)	3755 (14.0%)	4037 (14.0%)	4358 (14.1%)	4653 (14.0%)	+ 0.0%
5th Quintile (Most Deprived)	2931 (18.1%)	3229 (18.0%)	3567 (18.2%)	3874 (18.2%)	4178 (18.1%)	4537 (18.2%)	4897 (18.3%)	5290 (18.4%)	5637 (18.2%)	6012 (18.1%)	+ 0.0%
Missing	4357 (26.9%)	4766 (26.6%)	5179 (26.4%)	5671 (26.6%)	6138 (26.6%)	6597 (26.4%)	7055 (26.3%)	7420 (25.8%)	7917 (25.4%)	8430 (25.4%)	- 1.5%
	3139 (19.4%)	3497 (19.5%)	3817 (19.4%)	3974 (18.6%)	4061 (17.6%)	4640 (18.6%)	4840 (18.1%)	5136 (17.9%)	5498 (17.8%)	5778 (17.4%)	- 2.08%
Social Deprivation											
1st Quintile (Least Deprived)	1181 (7.3%)	1373 (7.7%)	1523 (7.8%)	1761 (8.3%)	1940 (8.4%)	2116 (8.5%)	2330 (8.7%)	2610 (9.1%)	2825 (9.1%)	3118 (9.4%)	+ 2.1%
2nd Quintile	1041 (6.4%)	1196 (6.7%)	1326 (6.8%)	1487 (7.0%)	1588 (6.9%)	1808 (7.2%)	2044 (7.6%)	2222 (7.7%)	2463 (8.0%)	2721 (8.2%)	+ 1.8%
3rd Quintile	1824 (11.3%)	2088 (11.6%)	2291 (11.7%)	2459 (11.5%)	2682 (11.6%)	2911 (11.7%)	3160 (11.8%)	3451 (12.0%)	3769 (12.2%)	4078 (12.3%)	+ 1.0%
4th Quintile	3110 (19.2%)	3476 (19.4%)	3833 (19.5%)	4181 (19.6%)	4489 (19.5%)	4860 (19.5%)	5151 (19.2%)	5503 (19.1%)	5899 (19.1%)	6326 (19.1%)	- 0.2%
5th Quintile (Most Deprived)	5888 (36.4%)	6311 (35.2%)	6849 (34.9%)	7480 (35.1%)	8111 (35.2%)	8622 (34.6%)	9259 (34.6%)	9849 (34.2%)	10520 (34.0%)	11155 (33.6%)	- 2.8%
Missing	3139 (19.4%)	3497 (19.5%)	3817 (19.4%)	3974 (18.6%)	4061 (17.6%)	4640 (18.6%)	4840 (18.1%)	5136 (17.9%)	5498 (17.8%)	5778 (17.4%)	- 2.0%
Unstably housed											
Unstably Housed*	861 (5.3%)	893 (5.0%)	972 (5.0%)	1166 (5.5%)	1321 (5.7%)	1527 (6.1%)	1471 (5.5%)	1615 (5.6%)	1761 (5.7%)	1924 (5.8%)	+ 0.5%
Missing Address Information	1737 (10.7%)	1920 (10.7%)	2050 (10.4%)	1997 (9.4%)	2084 (9.0%)	2290 (9.2%)	2273 (8.5%)	2407 (8.4%)	2657 (8.6%)	2777 (8.4%)	- 2.4%
Health system use											
Annual Emergency Department Visits (per 1000 patients)	1466.8	1457.6	1282.4	1415.6	1414.8	1419.0	1398.3	1354.0	1409.2	1442.8	- 24.0
Annual Hospitalizations (per 1000 patients)	465.1	447.5	431.5	436.6	417.5	433.3	409.5	403.8	406.8	372.7	- 92.4
Annual Physician Claims (per patient)	45.6	46.2	45.5	46.0	45.3	45.9	46.7	47.7	47.4	47.5	- 1.9
Annual Prescriptions (per patient)	5.9	6.3	6.5	6.9	7.2	7.3	7.3	7.4	7.4	7.0	+ 1.1

*As defined by a Z59 ICD-10 code or a shelter-associated postal code.

** Difference calculated by subtracting the 2017 percentage from the 2008 percentage.

*** Some variability occurs in estimated cohort size as complete data on interprovincial migration is not available.

Table 2. Trends in Number of Chronic Conditions Over Time.

# of Conditions	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0	9028 (23.4%)	8764 (22.7%)	8541 (22.1%)	8259 (21.4%)	7923 (20.5%)	7569 (19.6%)	7104 (18.4%)	6666 (17.3%)	6050 (15.7%)	5448 (14.1%)
1	9816 (25.5%)	9663 (25.1%)	9510 (24.7%)	9375 (24.3%)	9122 (23.7%)	8800 (22.8%)	8596 (22.3%)	8418 (21.8%)	8203 (21.3%)	7892 (20.5%)
2	6994 (18.1%)	6946 (18.0%)	6926 (18.0%)	6900 (17.9%)	6897 (17.9%)	6935 (18.0%)	6896 (17.9%)	6803 (17.6%)	6877 (17.8%)	7005 (18.2%)
3 +	12737 (33.0%)	13202 (34.2%)	13598 (35.3%)	14041 (36.4%)	14633 (37.9%)	15271 (39.6%)	15979 (41.4%)	16688 (43.3%)	17445 (45.2%)	18230 (47.3%)

schizophrenia are living longer. Although an aging population of “baby-boomers” may have contributed to this finding, it is also possible that improved access to support and treatment has influenced this trend. Further, the cost implications of this finding should not be ignored. As high levels of disability associated with schizophrenia often overshadow other patient needs, we believe that both aging patients and the healthcare system would benefit from a greater focus on preventative medicine approaches earlier in life along with a renewed focus on the provision of healthy aging initiatives. Regardless, this shift in the age distribution represents an important area for future research, particularly the patient, provider, and system-level factors that influence disease prevalence.

Among patients with schizophrenia, total direct healthcare costs were high with costs exceeding \$638 million CAD by 2017. This represents a 2.0-fold increase in total healthcare spending from 2008 and now accounts for ~3% of the total healthcare budget for Alberta.^{32,33} Although difficult to draw direct comparisons from the literature, costs for managing other chronic conditions such as hypertension, diabetes, chronic obstructive pulmonary disease, and coronary artery disease were estimated to be \$6,122 per patient in 2012–13.³⁴ In comparison, we estimated the per-patient cost of schizophrenia in 2013 to be almost three times higher at \$16,718 per patient. Although prior research has found that the cost of managing schizophrenia is higher than other chronic diseases,³⁵ our findings suggest that the direct costs of schizophrenia are expanding at a greater rate than overall healthcare spending in the province. Mental health spending has historically been underrepresented in healthcare budgets³⁶ so at first glance increased spending on patients is promising. However, spending per capita remained stagnant over the 10-year period. Substitution of more recent medications for hospitalizations may have represented an increase in quality of care. This finding may also suggest that early intervention and community treatment programs are meeting with some success. Unfortunately, our data do not indicate to what extent spending on recovery-oriented psychosocial services may have increased during this period.

Another concerning trend is the prevalence of multimorbidity in this population. We found the proportion of patients with three or more comorbidities increased from 33.0% to 47.3% and though prior work has shown that multimorbidity is increasing in the Canadian population,³⁷ this magnitude of change combined with increasing longevity has important implications for the future management of schizophrenia. This includes increased reliance on multidisciplinary care strategies to not only address underlying mental health concerns but the co-management of common chronic conditions such as hypertension and diabetes—particularly in younger patients.

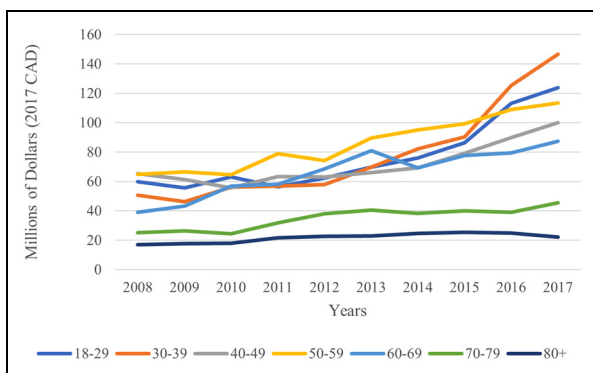
Patients with schizophrenia are often heavy users of acute healthcare services (i.e., emergency department encounters and hospitalizations)¹² and our data supports this. In 2017, hospitalization costs represented 35% of direct healthcare costs. This high level of spending remained remarkably

Table 3. 10-Year Trends in Sector-Specific Healthcare Spending*.

	Emergency department costs		Hospitalization costs		Physician billing costs		Medication costs		Total health spending	
	Total	Per Capita**	Total	Per Capita	Total	Per Capita	Total	Per Capita	Total	Per Capita
2008	10,454,335	646	216,805,466	13,397	57,859,385	3,575	36,353,697	2,246	321,472,883	19,865
2009	11,298,338	630	199,619,555	11,126	65,790,135	3,667	39,643,324	2,210	316,351,352	17,633
2010	11,146,192	568	205,975,094	10,488	68,857,505	3,506	52,120,888	2,654	338,099,680	17,216
2011	12,329,697	578	237,297,777	11,119	74,295,596	3,481	43,039,568	2,017	366,962,638	17,194
2012	14,264,297	619	229,589,957	9,960	78,899,739	3,423	63,620,388	2,760	386,374,381	16,762
2013	16,680,271	668	262,593,209	10,522	88,190,871	3,534	72,123,101	2,890	439,587,452	17,614
2014	18,373,862	686	275,950,581	10,303	96,474,334	3,602	63,535,233	2,372	454,334,010	16,963
2015	18,919,385	658	254,871,806	8,859	106,533,669	3,703	117,574,158	4,087	497,899,019	17,306
2016	20,917,366	675	225,528,973	7,281	115,515,264	3,729	218,328,977	7,049	580,290,579	18,735
2017	21,710,841	654	226,188,877	6,818	124,055,325	3,739	266,924,518	8,046	638,879,561	19,257
10-year Cost Change Ratio	2.1x	1.0x	1.0x	0.5x	2.1x	1.0x	7.3x	3.6x	2.0x	1.0x

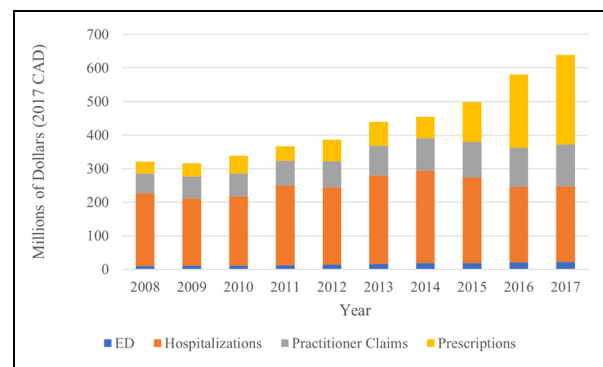
*All costs adjusted to 2017 CAD.

** Per Capita costs calculated by dividing the total cost by the number of patients in a given cohort year.

**Figure 1.** Total direct healthcare costs stratified by age.

stable over the 10-year period with hospitalization costs expanding slightly from \$217 million to \$226 million CAD. Interestingly, total hospitalization costs grew at the slowest rate of the four spending categories with a drastic decline in per-capita spending. Although this trend may suggest that community-based treatments and early interventions are reducing the number of patients admitted to the hospital, future work is required to determine their impact on all-cause and condition-specific hospitalizations over time within Alberta. In contrast to hospitalization costs, total and per-capita medication expenditures grew at the highest rate. As alluded to above, this is likely a function of changing management strategies and prescribing patterns over time.

Although long-acting injectable antipsychotics (LAIs) are not novel, the prescribing of specific expensive medications may explain our findings. Specifically, aripiprazole was prescribed at a much higher rate than any other LAIA in Alberta. Aripiprazole is a second-generation antipsychotic

**Figure 2.** Trends in cumulative cost over time (stratified by type of health spending).

that was approved for use in the province in 2014 as an injectable delayed-release formulation,³⁸ and we hypothesize that the rapid adoption of this drug indicates a paradigm shift in the way antipsychotics are delivered to this population. A single injection of this drug provides coverage for up to 30 days whereas oral formulations place an additional burden on patients to maintain treatment adherence and prevent relapse.³⁹ Drug adherence is a major concern for many patients with schizophrenia and it appears that healthcare professionals in Alberta are increasingly prescribing delayed-release antipsychotic therapy which may improve patient outcomes. Similar trends have been observed in Manitoba, Canada, where prescription rates for second-generation LAIs also increased within a similar time frame.⁴⁰ Prior work has suggested improved tolerability of aripiprazole compared with other first- and second-generation injectable antipsychotics.⁴¹ The use of aripiprazole has also been associated with significant

reductions in rehospitalization (hazard ratio: 0.73; 95% CI: 0.66-0.81).⁴² Together these findings suggest that increased use of second-generation LAIAs may partially explain the stability in hospital spending within this population over time. However, this represents an important area for future investigation.

We also found that treatment costs rose most rapidly among young patients (those aged 18–39) with schizophrenia. Again, this trend may be a function of changing treatment patterns mentioned above where we have seen increases in prescriptions for newer (and more expensive) formulations for newly diagnosed patients over the past 5 years. If this hypothesis is correct, we can expect antipsychotic costs to continue to rise until less expensive alternatives become available from competitors or at patent expiry. Unfortunately, it is difficult to determine when a generic form will enter the market due to Canada's regulatory system.⁴³ Regardless, future research should investigate whether changes in sector-specific healthcare spending are realized through changes in drug policy or increased use of community-based interventions such as Assertive Community Treatment.

Strengths and Limitations

This study has several strengths including the use of population-based administrative data that allowed for a comprehensive evaluation of health spending across several sectors. Furthermore, by assessing trends from 2008 to 2017 this work captures an important period that includes the introduction of injectable second-generation antipsychotic medications. This allowed for the assessment of how advances in treatment have impacted health spending over time. However, the use of administrative data for this investigation does have some unavoidable limitations. First, schizophrenia is characterized by a spectrum of positive and negative symptoms that vary over time. The implication of using a case ascertainment algorithm that relies on contact with the healthcare system creates a scenario where some individuals living with schizophrenia will be missed. This is a reasonable assumption given the high proportion of individuals with schizophrenia that are unstably housed. Second, data were only available for adult patients which limited our ability to describe early-onset patients. The implications of these factors are that the population estimates and subsequent costs may underestimate the true burden of schizophrenia in Alberta. However, given the comprehensive nature of Alberta's health data repositories, we expect this bias to be minimal. Third, while we are confident in the methodology used to estimate direct costs, our estimation procedures do have some inherent limitations. Costs associated with mental health hospitalizations are largely driven by length of stay which is highly variable in this population. As a result, hospitalization cost estimates derived from RIWs are less precise compared to other patient groups. Although micro-costed data would be the preferred method for

estimating total hospital spending in this population, unfortunately it is not available outside of select inpatient centers in Alberta. Therefore, the use of population-based RIWs was deemed to be a satisfactory starting point for facilitating the discussion of 10-year trends. Finally, community/indirect costs associated with schizophrenia were not available within these datasets. This limited our ability to quantify the total cost attributable to schizophrenia or the potential role community support programs play on the trends observed for our direct cost estimates. Despite the above limitations, we believe that our description of 10-year trends in direct spending provides important context into the delivery of healthcare services to this important patient population.

Conclusion

Total healthcare spending among patients with schizophrenia continues to increase, approximately at the same rate as contact prevalence, so that per capita spending has remained roughly constant. The evidence presented here suggests that the complexity of Alberta's population of patients with schizophrenia has increased between 2008 and 2017. However, we did observe significant changes in the distribution of healthcare expenditures which appear to be multifactorial in nature. Further work is needed to address the changing needs of patients with schizophrenia, including ways to address increasing rates of multimorbidity. These findings will inform policy discussions around future resource allocation and continued efforts to curb health spending while also improving care for patients with schizophrenia.

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Authors' Note

Paul Ronksley, Andrew Stewart, and James Wick had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. We are not able to make our data set available to other researchers due to our contractual arrangements with the provincial health ministry (Alberta Health), who is the data custodian.


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Supplemental Material

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