Using Linked Health Administrative Data to Assess the Clinical and Healthcare System Impact of Chronic Diseases in Ontario

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The rising incidence and prevalence of chronic diseases is of major global concern (World Health Organization [WHO] 2002). Worldwide, the proportion of overall burden of disease from all causes attributable to non-communicable diseases (NCDs) and mental disorders is expected to increase from 36% in 1990 to 57% in 2020 (WHO 2002). The burden from NCDs, or chronic disease, exceeds that of communicable diseases in all of the six WHO regions except Africa (WHO 2003). This increasing trend has been credited to longer life expectancy due to advances in medical treatment, public health initiatives, social development, demographic shifts and changes in lifestyle and working environments. Thus, chronic disease is a significant burden to patients, families, healthcare providers and healthcare systems.

From clinical and healthcare system management perspectives, there is a growing recognition that many chronic diseases have similar risk factors and can be managed with similar medical and psychosocial strategies. The Ontario Chronic Disease Prevention and Management Framework (Ontario Ministry of Health and Long-Term Care 2007) calls for the integration of health system organizations, healthcare providers, community partners and family supports to improve patient outcomes and system impacts. This initiative is consistent with a WHO report suggesting that a paradigm shift is required so that "decision-makers can take actions that will reduce the threats chronic conditions pose to the health of their citizens, their healthcare systems, and their economies. Their actions regarding financing, resource allocation, and healthcare planning can significantly diminish negative effects. Armed with essential elements for improvement, *informed decision-makers can make a difference*" (WHO 2002: 4).

Because the Canadian healthcare system is managed publicly, Ontario's call to action can be planned, in part, by using comprehensive, population-based health administrative data collected at the point of care. With scientific input, these data can be linked and used to inform decision-makers and healthcare providers about the needs of people with chronic diseases and the extent and appropriateness of the healthcare system's response to these needs. In order to create such an effective information management system, however, we need to understand the extent to which routinely collected health administrative data accurately depict individuals with one or more chronic diseases.

Identification and Evaluation of Chronic Disease Cohorts Using Linked Administrative Data

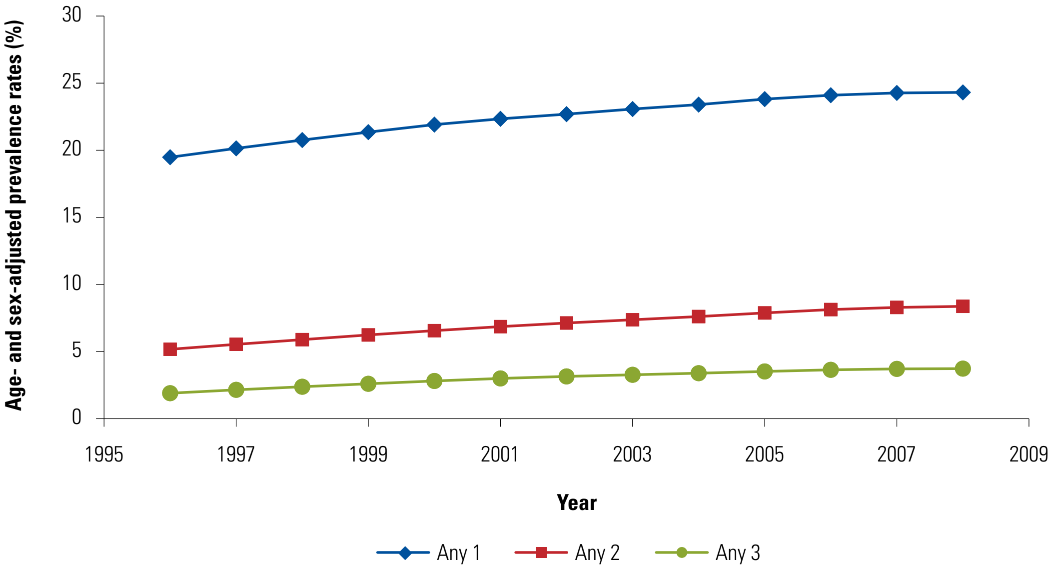
The clinical and healthcare system impacts of a range of chronic diseases are being evaluated at the Institute for Clinical Evaluative Sciences (ICES) using its large repository of annually updated, de-identified, individual-level health administrative data. Disease-based cohorts are created using health administrative case definitions that link hospital in-patient and outpatient care, physician claims and drug benefits data over time using an anonymous, unique identifier. The benefits of using these linked data cohorts for health system planning and evaluation are many: they are population based, are comprehensive (they do not rely on a single database), capture real health system use, are longitudinal and are relatively inexpensive to construct and use. In addition, individual health administrative records can also be linked to other data (clinical registry, public health, socioeconomic etc.) to inform a large number of health system initiatives.

The validity of this approach is critically dependent on the accuracy of disease coding in the administrative records. Accordingly, scientists with clinical expertise at ICES have validated the relevant administrative data case definitions using data collected directly from reviews of medical charts in the community. For example, the positive predictive values (the likelihood that the case definition accurately reflects a true case) of the diabetes and hypertension case definitions are 80% (Hux et al. 2002) and 87% (Tu et al. 2007), respectively.

To date, these validated case definitions have been applied to the following disease cohorts: asthma (Gershon et al. 2009b), congestive heart failure (Schultz and Tu 2010), chronic obstructive pulmonary disease (COPD)(Gershon et al. 2009a), acute myocardial infarction (Austin et al. 2002), diabetes (Hux et al. 2002) and hypertension (Tu et al. 2007). Thus, validated annual cohorts are created at ICES that can be linked anonymously to additional information (e.g., death registry, cancer registry,

FIGURE 1.

Age- and sex-adjusted prevalence of people (≥20 y) with one, two or three or more chronic conditions*, in Ontario, 1996–2008



*Asthma, congestive heart failure, chronic obstructive pulmonary disease, acute myocardial infarction, type 2 diabetes and hypertension.

immigrant status) in order to examine the outcomes of care in the entire cohort and, potentially, in subpopulations of interest.

The Effect of Having Multiple Chronic Diseases

Some chronic diseases share common etiologies (obesity, smoking, genetics); therefore, it is predictable that patients who have certain risk factors will suffer from more than one disease. These patients can be very sick and difficult to manage, and pose challenges to the health system. Most clinical evidence specifically addresses the management of a single disease, making its applicability to patients with two or more diseases unclear. More information about the patterns of multiple diseases and the effect

TABLE 1.

Annual average health services used by Ontarians (≥20 y) who were identified in 2006–2007 with one, two or three or more chronic conditions*

	Crude Annual Average Number of Health Services Used, 2007–2008 and 2008–2009			
Types of Health Services	**One Chronic Condition**	**Two Chronic Conditions**	**Three Chronic Conditions**	**General Population†**
Primary care visits	4.94	6.61	7.71	3.36
Specialist visits	2.19	3.13	3.85	1.15
In-patient hospital stays	0.09	0.16	0.32	0.07
Emergency department visits	0.44	0.59	0.93	0.32
Prescriptions for distinct drugs used by people 65+ y	5.38	7.28	9.06	5.39

*Asthma, congestive heart failure, chronic obstructive pulmonary disease, acute myocardial infarction, type 2 diabetes and hypertension.

†The entire population aged 20–105 years, including people with identified chronic conditions.

of common treatments on their varied outcomes would help to inform strategies to provide more efficient, coordinated and cost-effective care, for instance, through the use of specialized multidisciplinary outreach programs that improve quality of life and reduce hospitalizations.

At ICES, we have anonymously cross-linked the validated chronic disease cohorts at the level of individual patients to examine the frequency of different multiple disease permutations and their clinical and health system impacts. To provide a more comprehensive picture, these multiple disease cohorts have been linked to primary care and specialist services, emergency department and hospital in-patient care and prescription drug use data.

What We Did and What We Found

We aggregated the data by year to illustrate the age- and sex-adjusted prevalence of people diagnosed with one, two or three or more of the conditions (Figure 1). A rising prevalence over time was found. The largest absolute increase was in the number of individuals identified as having one chronic disease. Proportionally greater increases were seen in the numbers of individuals with two and three or more of these diseases who, together, amounted to almost half the number of individuals with a single disease.

For illustrative purposes, we focused on one year (2006–2007) and found that 3.7 million Ontarians aged 20 years and older had at least one of the defined conditions. Sixty-five percent of these people had one condition, 24% had two and 11% had three or more. In general, persons with one condition were younger than those who had more than one, with no gender differences. People with one condition were equally distributed across socio-economic strata (as determined by neighbourhood income quintiles from Canadian census data), but people with two or three or more conditions were more likely than those in the general population to live in lower-income neighbourhoods. Geographical variations across local health integration networks were noted but not analyzed in sufficient detail to draw actionable conclusions.

We then calculated the crude annual number of health service encounters over the subsequent two years for the cohorts and for the general population. Health system use across all sectors

TABLE 2.
Clinical impact of persons (≥20 y) with chronic conditions in 2006–2007 on two years of primary care visits* in Ontario

Hypertension	Asthma	Diabetes	COPD	CHF	AMI	Ranked by Annual Average No. of Visits per Person	Annual Average Person-Visits per Year	Persons in ICES Cohort in 2006–2007
▨	▨	▨	▨			9.34	244,465	26,174
▨	▨	▨	▨		▨	9.12	14,966	1,641
▨	▨	▨		▨		9.01	41,023	4,553
▨	▨	▨				8.70	368,436	42,349
▨	▨	▨	▨	▨		8.60	91,860	10,681
▨	▨	▨			▨	8.60	13,622	1,584
▨	▨	▨		▨	▨	8.25	9,875	1,197
▨	▨			▨		8.21	50,828	6,191
▨	▨		▨	▨		8.05	112,620	13,990
▨	▨		▨			8.02	523,546	65,280
	▨	▨		▨		8.01	4,742	592
▨	▨	▨	▨			7.94	72,881	9,179
▨	▨	▨	▨	▨	▨	7.77	21,663	2,788
	▨	▨		▨	▨	7.75	636	82
▨		▨	▨			7.70	404,797	52,571
▨	▨		▨		▨	7.68	21,650	2,819
▨		▨	▨	▨		7.49	133,172	17,780
▨		▨	▨		▨	7.39	30,506	4,128
▨		▨		▨		7.38	253,510	34,351
	▨	▨	▨	▨		7.38	9,668	1,310

AMI = acute myocardial infarction; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; ICES = Institute for Clinical Evaluative Sciences; shaded boxes = presence of disease.

*Average over two years of follow-up (2007–2008 and 2008–2009) using physician billing claims to the Ontario Health Insurance Program.

TABLE 3.
System impact of persons (≥20 y) with chronic conditions in 2006–2007 on two years of primary care person-visits* in Ontario

Hypertension	Asthma	Diabetes	COPD	CHF	AMI	Annual Average No. of Visits per Person	Ranked by Annual Average Person-Visits	Persons in ICES Cohort in 2006–07
▨						5.23	7,002,646	1,338,938
	▨					4.41	2,745,710	622,610
▨		▨				6.75	2,484,884	368,131
		▨				5.09	1,306,852	256,749
▨			▨			6.48	952,061	146,923
▨	▨					6.92	942,774	136,239
			▨			4.51	776,608	172,197
▨	▨		▨			8.02	523,546	65,280
	▨		▨			6.28	406,460	64,723
▨		▨	▨			7.70	404,797	52,571
▨				▨		6.75	375,192	55,584
▨	▨	▨				8.70	368,436	42,349
▨		▨		▨		7.38	253,510	34,351
▨	▨	▨	▨			9.34	244,465	26,174

AMI = acute myocardial infarction; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; ICES = Institute for Clinical Evaluative Sciences; *shaded boxes* = presence of disease.

*Average over two years of follow-up (2007–2008 and 2008–2009) using physician billing claims to the Ontario Health Insurance Program.

rose with increasing numbers of chronic conditions (Table 1). Some of the differences were quite marked. Although this analysis was preliminary and did not include the full measure of the resources that would have been provided to these patients in the course of their usual care, the data illustrate the potential value of this type of analysis.

Clinical and Healthcare System Impacts of Specific Combinations of Chronic Conditions

Of the 3.7 million people in our chronic disease cohort, 36% were diagnosed with hypertension, 17% with asthma, 7% with diabetes and 5% with COPD. In addition, 10% had diabetes and hypertension, 4% had hypertension and COPD, 4% had hypertension and asthma, 2% had asthma and COPD and 2% had hypertension and congestive heart failure. Finally, 2% had a combination of these three chronic conditions: hypertension, asthma and COPD, or hypertension, diabetes and COPD. The rest of the cohort had various other combinations of the conditions. Tables 2 and 3 list the chronic diseases that either singly or in combination had the biggest impact on primary care as denoted by the number of primary care visits patients made. A shaded box indicates the presence of that particular chronic condition. Table 2 ranks the disease combinations by *average number of primary care visits per patient over two years, which likely reflects disease severity or clinical intensity.* This table represents only 8% of the cohort, yet these were persons who had many of these conditions concurrently and were thus more likely to see a primary care provider frequently. Table 3 ranks the disease combinations by *total annual average primary care person-visits, which likely reflects the degree of healthcare system impact.* This table represents 91% of people in the ICES cohort with one or more diseases that affect many people. While these people have less severe disease, as a group they impose a high health system impact. Both of these metrics have implications for system responsiveness and availability of services.

We similarly analyzed the clinical and healthcare system impacts of single and multiple chronic conditions on specialty care, emergency department visits, in-patient hospitalizations and number of prescription drugs. These data are available from the authors.

Next Steps

Our intention is to continue our evaluation of the care provided to patients with these multiple chronic diseases. The present work provides some important baseline data. With more focused analyses and a broader range of validated conditions and outcomes, we will be better able to understand clinical and healthcare system impacts and to develop quality-of-care measures for patients with key combinations of disease. HQ

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