By Gillian Booth and Jan Hux

Chronic Complications of Diabetes: Cardiovascular and Kidney Disease

Diabetes mellitus is a serious and growing health problem. Approximately 6% of Ontarians are diagnosed with diabetes (Hux et al. 2002), however, with the aging of the population and growing rates of obesity, the numbers with this condition are expected to rise (Mokdad et al. 2001). Canadian researchers place the economic burden of diabetes at an estimated $7 billion nationwide based on 1998 figures (Dawson 1998). The largest proportion of expenditures relating to diabetes has been attributed to in-patient costs. Diabetes is a leading cause of cardiovascular disease (Rubin et al. 1992), blindness (Klein and Klein 1995), end-stage renal failure leading to dialysis (Nelson et al. 1995), and amputation (Bild et al. 1989). To examine this further, scientists at the Institute for Clinical Evaluative Sciences (ICES) conducted a series of studies to quantify the burden of diabetes and its associated complications in Ontario. Module 2 of *Diabetes in Ontario: An ICES Practice Atlas*, focuses on rates of chronic complications related to this condition. In this report, findings from analyses of cardiac complications and dialysis rates among persons with diabetes are highlighted.

METHODS

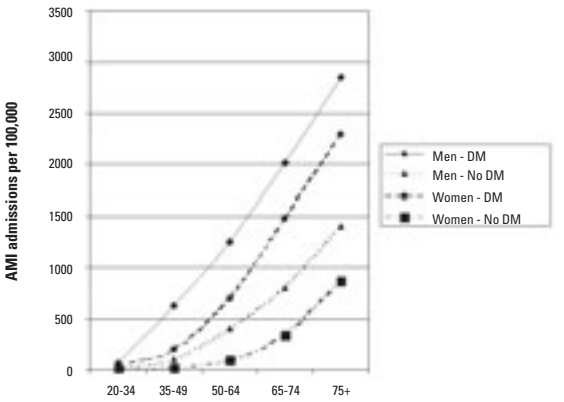
A population-based approach was used to study the impact of diabetes on cardiovascular disease and dialysis rates in Ontario. Using a validated algorithm based on hospitalization and physicians' billing records, all adults with diabetes in Ontario were identified (Hux et al. 2002). The Canadian Institute for Health Information (CIHI) database was also used to identify admissions for acute myocardial infarction (AMI) and other cardiac conditions. Patients on dialysis were identified from physicians' service claims listed in the Ontario Health Insurance Plan (OHIP) database. A cohort of persons free of diabetes was created in order to compare procedure rates in persons with and without diabetes. Since the diabetes population was, on average, older and had a higher proportion of males than the non-diabetic population, rates were age- and sex-adjusted to allow for comparisons.

RESULTS

Cardiovascular Disease

Between fiscal 1995 and 1999, there were 104,471 hospitalizations for AMI in Ontario, nearly one-third of which occurred in individuals with diabetes. Admission rates were over seven-fold greater in persons with diabetes compared to those without. After adjusting for age and sex differences, individuals with diabetes remained up to three times more likely to be admitted for AMI. Although the largest burden of disease was seen in the elderly population, the disparity in rates between the two populations was most pronounced in the youngest age group (Figure 1). Men and women with diabetes between the ages of 20 and 34 had 9- and 30-fold greater odds, respectively, of suffering an AMI than those without diabetes in the same age group. AMI rates among the diabetic population were comparable to those of non-diabetic individuals who were 15 to 20 years older. A similar pattern of early disease and high rates was observed for other cardiac admissions (unstable angina and heart failure).

Figure 1: Acute Myocardial Infarction Admission Rates by Age Group and Diabetes Status

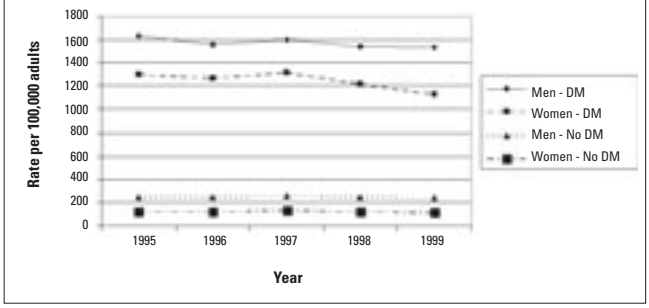


Compared to those without diabetes, individuals with diabetes also had longer lengths of stay (7.3 vs. 6.9 days, $p<0.0001$) and greater odds of mortality at 30 days (OR 1.17 [95% CI 1.12-1.23]) and one-year (OR 1.42 [95% CI 1.37-1.48]) after admission for AMI. Furthermore, one-year readmission rates for myocardial infarction, unstable angina, and heart failure were also higher in people with diabetes (OR for readmission 1.58, 1.17 and 2.16 for the three conditions respectively).

In general, admission rates showed a significant decline over the five-year period. Rates of admission for AMI fell by 9.3% (Figure 2) while hospitalizations for heart failure dropped by 24% among those with diabetes. More modest declines were evident in the non-diabetic population.

Geographic patterns suggested higher rates of admission in northern and rural regions of the province. Multivariate analysis revealed several independent predictors of AMI, including increasing age, male gender, lower socioeconomic status, previ-

Figure 2: Rates of Acute Myocardial Infarction

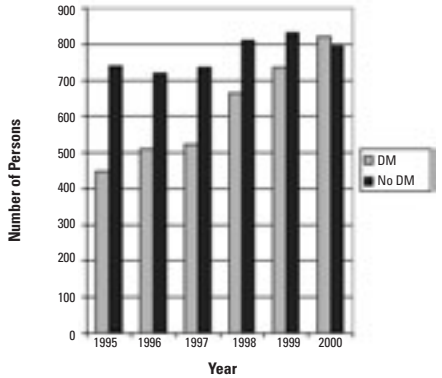


ous myocardial infarction, and presence of other chronic diseases. Additionally, this analysis confirmed an increased risk of AMI among those living in rural areas, but also among those living in regions outside of Toronto and the Eastern planning region.

Kidney Disease and Dialysis

Between fiscal 1994 and 2000, 8,344 people started chronic dialysis in Ontario. Hospital-based hemodialysis was the most commonly used modality (66% and 60% in those with and without diabetes, respectively). Dialysis rates were approximately 12-fold higher in the diabetic population and rates increased modestly over the period of study. However, rising numbers of individuals with diabetes in the general population have led to a substantial increase in the number of persons on dialysis. The population with diabetes starting chronic dialysis grew at an average annual rate of 13.2%, more than eight times the 1.6% annual increase seen in the non-diabetic population. With this significant increase, individuals with diabetes comprised over 50% of new cases starting dialysis in 2000, compared to only 38% in 1995 (Figure 3). The largest degree of growth occurred in the population over age 75, resulting in a dialysis population that is older and more ill. Mortality rates are high in this population: three-year survival rates after starting dialysis were only 55% for those with diabetes and 68% among those without. The higher rates of mortality in persons with diabetes on dialysis were largely explained by underlying differences in the level of co-morbidity between the two populations.

Figure 3: Number of Persons Starting Dialysis in Ontario



DISCUSSION AND IMPLICATIONS

These data confirm the heavy burden of cardiovascular and kidney complications faced by persons with diabetes and the associated requirement for in-patient hospital and dialysis services. Not only were rates of cardiovascular disease high, but people with diabetes tended to experience these complications at much younger ages than persons free of diabetes.

The first module of *Diabetes in Ontario: An ICES Practice Atlas* showed a 31% increase in the prevalence of diabetes between fiscal 1995 and 1999 (Hux et al. 2002). This rising prevalence together with rising rates of diabetes risk factors (Manuel and Schultz 2002) and a demographic shift toward older ages means that there are a rapidly growing number of people at risk for diabetes complications. Thus, for cardiovascular complications, even though the proportion of people with diabetes having an AMI dropped over the study period, the number so affected grew. Similarly, the growth in rate of dialysis was very modest, largely reflecting an extension of service availability to older persons, yet the number of people with diabetes starting dialysis nearly doubled.

To address this growing burden of disease, specific strategies will need to be developed and implemented both in the clinical and policy arenas. From a clinical perspective, a number of therapies are available to lower the risk of cardiovascular complications among individuals with diabetes. There is now compelling evidence from randomized trials that specific medications such as the use of ACE inhibitors (Heart Outcomes Prevention Evaluation Study 2000), antihypertensive medications (U.K. Prospective Diabetes Study 1998) and lipid-lowering agents (Heart Protection Study 2002) can sharply reduce the risk of complications in this population. Previous work in Ontario has shown the use of these agents to be increasing but still suboptimal (Shah et al. 2002).

In addressing the burden of kidney disease, careful management of blood glucose levels, blood pressure and initiation of specific preventive therapies will reduce the rates of end-stage renal disease. Further research is needed to examine how dialysis can optimally be delivered to persons with diabetes who require it. Compared to other forms of dialysis, hospital dialysis is the most costly to provide. Since 1998, at least 16 satellite or self-care dialysis units have opened in Ontario to accommodate the growing dialysis population; however these units are providing only one-tenth of the dialysis treatments in the province. Home-based programs are also being expanded; however, the relatively high levels of comorbidities found in persons with diabetes who are on dialysis raise concerns about the safety of providing dialysis in less supported settings.

Overall, while the rates complications associated with diabetes have remained stable, and in some cases declined over the period of study, the actual number of hospitalizations and services used by those with the disease has increased. These trends are expected to continue, driven largely by increases in the number of people with diabetes. Interventions to translate

research findings regarding the prevention of complications into routine clinical practice are required. At the same time, policy makers and planners will need to address the delivery of services to a growing population of persons with the multiple complications of diabetes.

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