

The cost of major comorbidity in people with diabetes mellitus

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Abstract

Background: People with diabetes mellitus are more likely to have cardiovascular, renal and ophthalmic comorbidity than those without diabetes. Information on the economic impact of diabetes and its complications on the Canadian health care system is limited.

Methods: To estimate health care expenditures for diabetes and its major complications, we identified people with diabetes in 1996 in Saskatchewan, using the administrative databases of Saskatchewan Health. We grouped utilization and expenditure data for prescription drugs, physician services, hospitalizations, day surgery procedures and dialysis services according to cardiovascular, renal and ophthalmic services, according to billing codes and the American Hospital Formulary Services classification for prescription drugs.

Results: Of the 38 124 people identified (48.5% female and 9.7% registered Indians), 46.6% had cardiovascular-related records, 19.8% ophthalmic-related records and 6.6% renal-related records. Registered Indians had significantly fewer ($p < 0.001$) cardiovascular-related records than the rest of the diabetic population (35.1% v. 47.9%, respectively) but more renal-related records (11.7% v. 6.0%, respectively). The total 1996 Saskatchewan Health expenditure for the study group, within the observed categories, was estimated to be \$134.3 million, of which \$35.5 million (26.4%) was for cardiovascular-related services, \$10 million (7.5%) for renal-related services and \$3.3 million (2.5%) for ophthalmic-related services.

Interpretation: In 1996, 36.4% of health care expenditures for people with diabetes was attributable to major comorbidity. Actions to prevent or control such comorbidity will yield significant cost savings.

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Between 5% and 6% of Canadians over the age of 12 years have diabetes mellitus.¹ People with diabetes are at increased risk of macrovascular and microvascular complications^{2,3} and are more likely than people without diabetes to have other cardiovascular risk factors, such as hypertension and hyperlipidemia.^{4,5} These factors contribute to an increased risk of illness and death,^{2,6-9} which places a significant burden on our health care system.

In 1997, the direct expenditures for health care services attributable to diabetes were estimated to be \$44.1 billion in the United States.¹⁰ Management of chronic complications associated with diabetes, such as cardiovascular, renal

and ophthalmic disease, accounted for approximately 27% of these expenditures.¹⁰ Observations from managed care organizations in the United States suggest that annual management costs for people with diabetes are 1.5 to 2 times higher than those for people without diabetes.^{11,12} As diabetes-related complications develop and progress, management costs increase.^{13,14}

Information on the economic impact of diabetes and its complications on the Canadian health care system is limited. The annual cost of diabetes in Canada has been estimated at US\$9 billion from an extrapolation by the Canadian Diabetes Association.¹ Recently, with a top-down costing method, the direct medical costs of hospital services, physician services and medications for diabetes in Canada were estimated at US\$2.6 billion, or approximately 8% of the total medical expenditures in Canada for 1998.¹⁵ Although the model provided some insight, the estimates were limited by the top-down approach and the use of a model rather than direct observation.

Our study was designed to estimate the resource use and associated expenditures for diabetes and major comorbidity from empirical data for the population with diabetes in Saskatchewan in 1996. Resource use and associated costs for registered Indians were included in this analysis; however, expenditures for this group were reported separately because of the different epidemiologic features of diabetes in this subpopulation and the lack of data on prescription drug use of registered Indians in Saskatchewan Health databases. The study was approved by the Health Research Ethics Board of the University of Alberta and the Data Access Review Committee of Saskatchewan Health.

Methods

Setting

We obtained population descriptors and information on prescription drug use, hospitalizations, day surgery procedures, physician services and dialysis from the linkable health care databases of Saskatchewan Health.¹⁶ Nearly all residents of Saskatchewan are eligible for insured health care services, and certain service transactions are tracked by means of a unique health services number for each resident. The prescription drug database contains records of all outpatient dispensations of drugs covered by the Saskatchewan Prescription Drug Plan (SPDP). This database provides information on the drug and quantity dispensed, as

well as the share of the cost that is covered by the SPDP and that covered by the patient. Registered Indians receive prescription drug coverage under a federal program; therefore, their medication use is not recorded in the provincial database. The hospital and physician databases contain records of all medically necessary hospitalizations and physician services that are covered by the provincial health care system. Each hospital separation record contains the dates of admission and discharge, the resource intensity weight (RIW) (an estimated level of acuity for the admission, assigned by the Canadian Institute for Health Information [CIHI]), the primary, secondary and tertiary diagnoses (coded according to the World Health Organization International Classification of Diseases, 9th revision [ICD-9]¹⁷), and the type of discharge (alive or dead). Each physician record includes the ICD-9 diagnosis code, type of physician, fee-for-service procedure codes and approved payment. The continuous and comprehensive health care information for Saskatchewan residents in the Saskatchewan Health databases has been useful for numerous epidemiologic studies.¹⁶

Subject identification

From health care records for 1991 through 1996, we selected for the cohort all persons that we could assume had diabetes because of 1 or more dispensation records for insulin or an oral antidiabetic agent, 2 or more physician service claims for diabetes (ICD-9 code 250) within a 2-year period, or 1 or more hospitalizations with a diabetes code as the primary, secondary or tertiary diagnosis. The physician and hospital components of this algorithm are highly specific for diabetes.^{18,19} The addition of prescription drug use to the algorithm likely improves its sensitivity. However, because prescription drug use is not recorded for registered Indians, the prevalence of diabetes in this group was underestimated; consequently, the resource use and expenditures for this group were also underestimated.

Identification of expenditures

We abstracted information on prescription drug use, hospitalizations and physician services for the cohort in 1996 from the corresponding databases. For day surgery procedures, we abstracted the date of service, ICD-9 diagnosis code and day procedure RIW from the hospital services files. Using the physician services database, we identified people receiving dialysis services from fee-for-service codes, then determined the type and duration of dialysis from the physician service claims for initiation of hemodialysis, maintenance hemodialysis and peritoneal dialysis.

Expenditures for prescription drugs and physician services in 1996 were taken directly from corresponding database records. We estimated hospitalization expenditures with the use of a weighted cost per RIW of \$2165, derived from the Saskatchewan acute care funding pool for 1996–97. For the approximately 21% of hospital separation records in 1996 that lacked an RIW, we imputed one from Saskatchewan Health estimates for hospitals of similar size. We estimated expenditures for day surgery procedures by multiplying the weighted cost per RIW (\$2165) by the mean day procedure RIW for cohort members in 1996 (0.29). To estimate dialysis expenditures, we deflated to 1996 dollars the annual costs for hemodialysis and peritoneal dialysis estimated in 2000 dollars by Lee and colleagues,²⁰ using the Saskatchewan Consumer Price Index for Health Care Services. All expenditures are reported in 1996 Canadian dollars.

Complication categories

We grouped the ICD-9 diagnosis and procedure codes according to cardiovascular, renal, ophthalmic and other conditions (Appendix 1). According to CIHI coding rules, the primary diagnosis is the diagnosis most responsible for the length of stay and the resources consumed during the stay; therefore, we grouped hospitalizations by the primary diagnosis. We grouped the physician service claims by diagnosis and service codes. When there was a discrepancy between these codes (e.g., the diagnosis code referred to one comorbidity and the procedure code to a different comorbidity), we assigned a single comorbidity to the claim, using a hierarchical system. Types of comorbidity were ranked in descending order of importance as follows: cardiovascular, renal, ophthalmic and other. We grouped the physician claims for dialysis services and the estimated expenditures for outpatient dialysis services under renal comorbidity. Prescription drugs were classified according to the American Hospital Formulary Service and grouped in the same categories of comorbidity (Appendix 2).

Statistical methods

We used descriptive statistics for demographic information and expenditures and an ordinary least-squares regression model for evaluating the association among various subject characteristics, the presence of major diabetes-related comorbidity and the estimated expenditures for care.^{21,22} To compare registered Indians with the rest of the diabetic population, we used the sum of expenditures for physician services, hospitalizations, day surgery and dialysis services as the estimated expenditure for care in the regression model. Previous evaluations with this data set have found a positive skew for this estimate; that is, a small percentage of the cohort had very high expenditures.²³ Therefore, the natural log transformation of the estimate (ln expenditure) was used as the dependent variable and regressed against age, sex, registered Indian status and presence of major comorbidity.

Results

Detailed information on the 38 124 people in Saskatchewan identified as having diabetes in 1996 is provided elsewhere.²³ The registered Indian group was younger than the general population with diabetes and had a higher proportion of women (Table 1).

The total 1996 Saskatchewan Health expenditure for the cohort, within the observed categories, was estimated to be \$134.3 million. Hospitalization accounted for the largest portion (54.9%), and prescription drugs, physician services, dialysis services and day surgical procedures for smaller portions in decreasing order (Table 2). The mean total health care expenditure per person was \$3524. When prescription drug expenditures were excluded, the mean was \$2768. Expenditure patterns were similar in the general population and the registered Indian group until the age of 60 (Fig. 1); thereafter, the median expenditure increased more rapidly for registered Indians.

According to the diagnostic codes, cardiovascular co-

morbidity was present in 46.6% of the cohort, ophthalmic comorbidity in 19.8% and renal comorbidity in 6.6%. Renal comorbidity was more common in the registered Indian group, whereas ophthalmic and cardiovascular comorbidity was more common in the general population (Table 1). Many people had more than 1 type of comor-

bidity, and 1.2% (473) had all 3 major types. Of the total health care expenditure of \$134.3 million, 36.4% was attributable to major comorbidity: \$35.5 million (26.4%) to cardiovascular-related services, \$10 million (7.5%) to renal-related services and \$3.3 million (2.5%) to ophthalmic-related services. The median expenditures by comorbidity and age are shown for the general population and the registered Indian group in Figs. 2A and 2B, respectively. The overall median for those without major comorbidity was \$186, for those with ophthalmic comorbidity alone \$449, for those with cardiovascular comorbidity alone \$508 and for those with renal comorbidity alone \$1050. People with 2 or more types of comorbidity had even higher health care expenditures. It appears that as the number of types of comorbidity increases, health care expenditures increase. Furthermore, expenditures for those with cardiovascular and renal complications were much greater among registered Indians than in the general population with diabetes.

According to the multivariate regression (Table 3), health care expenditures were significantly greater when there was a major type of diabetes-related comorbidity. Age, sex and registered Indian status also had a significant impact on health care expenditure. In this model, the re-

Table 1: Characteristics with significant differences among Saskatchewan residents identified as having diabetes mellitus in 1996

Characteristic*	General population n = 34 444	Registered Indians n = 3 680
Female, no. (and %)	16 305 (47.3)	2 185 (59.4)
Mean age (and SD), yr	63.9 (16.8)	52.2 (15.2)
With comorbidity,† no. (and %)		
Cardiovascular	16 490 (47.9)	1 292 (35.1)
Renal	2 080 (6.0)	430 (11.7)
Ophthalmic	7 123 (20.7)	440 (12.0)

Note: SD = standard deviation.

*Significantly different ($p < 0.001$) by the chi-squared test or, in the case of age, by the *t*-test.

†Not mutually exclusive.

Table 2: Health care expenditures among Saskatchewan residents with diabetes mellitus in 1996

Resource category* and comorbidity	Expenditure, \$				
	Subtotal (and %)	General population		Registered Indians	
		Group total	Per-person mean (and SD)	Group total	Per-person mean (and SD)
Hospitalizations					
All	73 817 661 (54.9)	65 075 649	1889 (7243)	8 742 012	2376 (9439)
Cardiovascular		19 184 779	557 (3744)	2 174 460	591 (7567)
Renal		2 151 601	62 (1316)	602 832	164 (1454)
Ophthalmic		276 806	8 (172)	72 939	20 (390)
Physician services					
All	22 525 542 (16.8)	20 080 639	583 (847)	2 444 903	664 (1001)
Cardiovascular		3 707 246	108 (355)	255 484	69 (278)
Renal		645 221	19 (268)	229 686	62 (510)
Ophthalmic		1 527 859	44 (160)	111 052	30 (143)
Day surgery					
All	3 546 893 (2.6)	3 299 287	96 (311)	247 606	67 (236)
Cardiovascular		251 435	7 (72)	14 678	4 (50)
Renal		55 520	2 (35)	13 401	4 (55)
Ophthalmic		939 372	27 (151)	61 263	17 (117)
Dialysis					
All	5 653 049 (4.2)	3 949 277	115 (2179)	1 703 772	463 (4149)
Prescription drugs					
All	28 811 212 (21.5)	28 811 212	836 (1078)		
Cardiovascular		9 885 642	287 (458)		
Renal		715 379	21 (376)		
Ophthalmic		349 466	10 (60)		

*Prescription drug expenditures were not available for the registered Indian group.

gression coefficients represented the contribution of the variables to the estimated total health care expenditure. For example, the estimated annual expenditure for a 55-year-old male registered Indian with diabetes and cardiovascular disease would be \$1130. The overall model was statistically significant and explained 20.5% of the total variance in health care expenditures.

Interpretation

The 38 124 people identified in this study as having diabetes represented 3.6% of the Saskatchewan population in 1996.²⁴ We estimated that the health care expenditure for the cohort was \$134.3 million, or approximately 15% of the total expenditure for hospitalizations, physician services and prescription drugs in Saskatchewan that year. The expenditures for people with concurrent ophthalmic, cardiovascular or renal disorders in the cohort were much higher than the expenditures for those with no major comorbidity. As the number of major complications increased, expenditures grew significantly.

We estimated that 36.4% of the cohort's diabetes-related expenditures were attributable to major comorbidity. This estimate is similar to that of Selby and associates,¹¹ who reported that 33.9% of the excess costs of care for diabetes were attributable to cardiovascular disease, end-stage renal disease and ophthalmic disease. Others^{25,26} have re-

ported that 41% to 50% of expenditures for people with diabetes could be attributable to long-term complications; however, the subjects of these studies primarily had type 2 diabetes. The inclusion of younger subjects with type 1 diabetes may have lowered the prevalence of complications in our cohort.

Several limitations of our study should be noted. First, we drew data from administrative health care databases and, as such, relied on the accuracy and completeness of the records. The Saskatchewan Health databases have, however, been used in numerous epidemiologic studies and are recognized as providing well-validated and comprehensive data.¹⁶ Second, the algorithm used to identify people with diabetes from the administrative records likely underestimated the true prevalence of diabetes in the province; therefore, the total health care expenditures were likely underestimated. In addition, registered Indians with diabetes were not identified from their prescription drug use. Furthermore, people with less than moderate diabetes during the study period may not have met the inclusion criteria; that is, their diabetes was never severe enough to require medication, 2 physician visits in a 2-year period or a hospitalization. Third, some physicians in Saskatchewan, particularly in the northern regions, are salaried; therefore, our use of physician service records underestimated the use of services by all people with diabetes in Saskatchewan. Finally, the databases that we used do

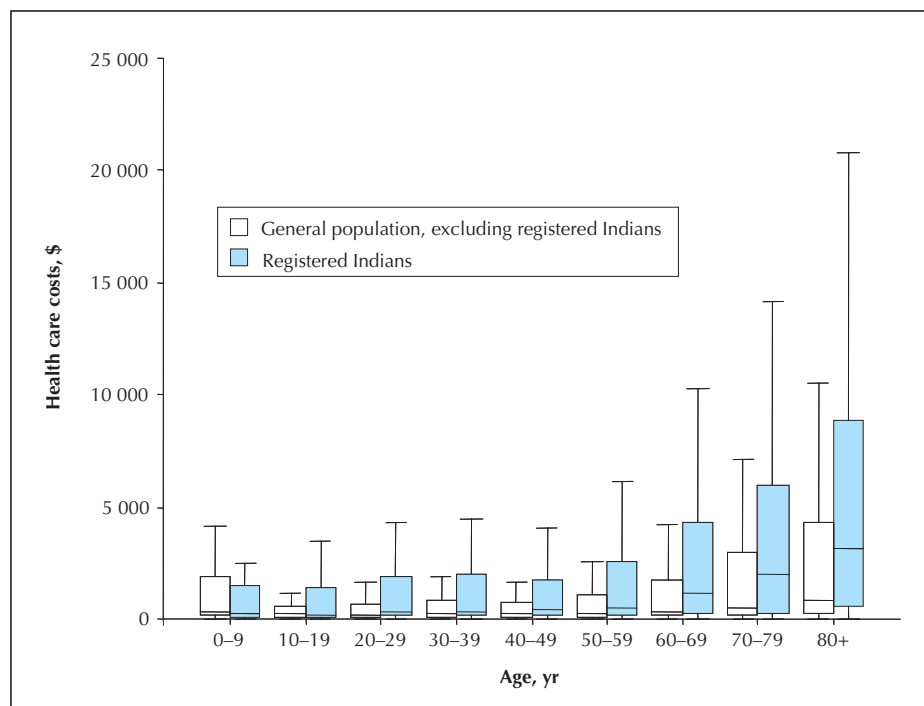


Fig. 1: Health care expenditures according to age and population status for Saskatchewan residents identified as having diabetes mellitus in 1996. The lower and upper portions of the bars represent the 25th and 75th percentiles, respectively; the midline represents the median; the projecting lines represent the most extreme values in the data set that were not more than 1.5 times the height of the bar beyond either quartile.

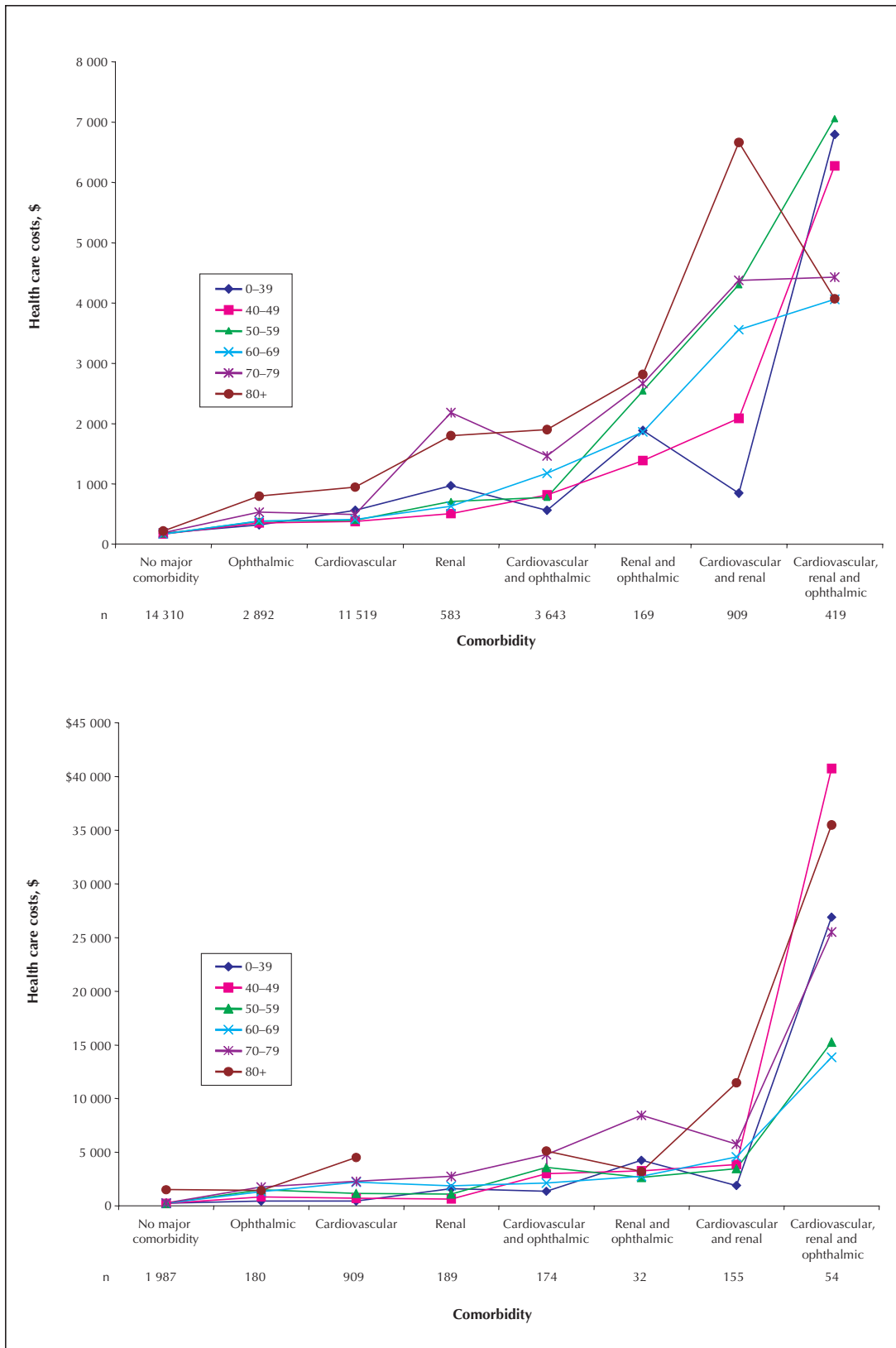


Fig. 2A (top): Median health care expenditures for the general population by comorbidity and age. Fig. 2B (bottom): Median health care expenditures for the registered Indian group by comorbidity and age. The scale is different because of the greater expenditures in this subpopulation.

Table 3: Estimates of the individual contributions of patient characteristics and comorbidity to health care expenditures,* according to multivariate linear regression†

Variable	Regression coefficient (b)‡	Standard error
Intercept§	4.75	0.04
Male	-0.14	0.02
Age (10-year increment)	0.09	0.01
Registered Indian	0.56	0.03
Comorbidity		
Ophthalmic alone	1.18	0.04
Cardiovascular alone	1.41	0.02
Renal alone	1.71	0.07
Cardiovascular and ophthalmic	1.98	0.04
Renal and ophthalmic	2.53	0.13
Cardiovascular and renal	2.80	0.06
Cardiovascular, renal and ophthalmic	3.27	0.09

*Expenditure = hospitalization + physician services + day surgery + dialysis.

†The following regression model was used: $\ln(\text{expenditure}) = \text{intercept} + b_1 \text{ male} + b_2 \text{ 10-yr age group} + b_3 \text{ registered Indian} + b_4 \text{ ophthalmic} + b_5 \text{ cardiovascular} + b_6 \text{ renal} + b_7 \text{ cardiovascular and ophthalmic} + b_8 \text{ renal and ophthalmic} + b_9 \text{ cardiovascular and renal} + b_{10} \text{ cardiovascular, renal and ophthalmic}$.

‡All variables were individually significant at $p < 0.001$; the overall model was statistically significant ($p < 0.001$) with an adjusted $R^2 = 0.205$.

§The reference subject (a person with "0" for each variable) would be a female nonregistered Indian 0 to 9 year of age with diabetes and no major comorbidity. The estimated annual health care expenditure for this person would be \$115. The annual expenditure for a 55-yr-old male registered Indian with diabetes and cardiovascular disease, in contrast, would be =

$$e^{4.75 + (\text{male} \times -0.14) + (\text{5th decade of age} \times 0.09) + (\text{registered Indian} \times 0.56) + (\text{cardiovascular alone} \times 1.41)} = \$1130.$$

not record services provided at the health district level, such as those associated with diabetes educators and dietitians in both inpatient and outpatient settings and podiatric services, nor do they record auxiliary costs of transplantation (e.g., those for transplant coordinators and living donors); therefore, the overall total costs were underestimated.

The magnitude of the expenditures indicates significant potential savings from prevention initiatives. Aggressive management of hyperglycemia, advocated by the Canadian Diabetes Association and the American Diabetes Association,²⁷⁻²⁹ reduces the risk of many long-term complications of diabetes.³⁰⁻³⁴ Interventions to reduce elevated blood pressure and cholesterol levels, which are common in people with diabetes,^{4,5} also delay the progression of cardiovascular and renal complications.³⁵⁻³⁹ Strategies targeted at preventing the onset of diabetes^{40,41} or delaying the progression of complications⁴² could produce substantial savings to the health care system.

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Appendix 1: Major types of comorbidity in Saskatchewan cohort with diabetes mellitus

Comorbidity	ICD-9 category
Cardiovascular	
Diabetes with cardiovascular complications	250.6
Hypertension	401-405
Myocardial infarction	410
Other ischemic heart diseases	411-414
Diseases of pulmonary circulation	415-417
Congestive heart failure	428
Other forms of heart disease	420-427, 429
Hemorrhagic stroke	430-432
Ischemic stroke	433-434
Transient ischemic attacks	435
Other forms of stroke	436-438
Atherosclerosis	440
Other diseases of arteries, arterioles and capillaries	441-444, 446-448
Diseases of veins or lymphatics and other diseases of circulatory system	451-459
Chronic ulcer of skin	707
Gangrene, including diabetic	785.4
Renal	
Diabetes with renal complications	250.3
Nephritis/nephrotic syndrome	580-583, 587
Renal failure and sequelae	584-586, 588
Infections of the kidney	590
Unspecified disorders of the kidney	593
Cystitis	595
Bladder dysfunction	596
Urinary tract infections	599.0
Proteinuria/albuminuria	791
Ophthalmic	
Diabetes with ophthalmic complications	250.4
Other retinal disorders	362
Iritis	364.4
Glaucoma	365
Cataract	366
Optic neuropathy	377

Note: ICD-9 = International Classification of Diseases, 9th revision.¹⁷

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Appendix 2: Prescription drugs used by the cohort in 1996

Drug	AHFS class
Cardiovascular-related	
Hemorrhologic agents	20:24
Cardiovascular drugs	24:00-24:12
Diuretics	40:28
Renal-related	
Hematopoietic agents	20:16
Ophthalmic-related	
EENT anti-inflammatory agents	52:08 (ophthalmic preparations)
Carbonic anhydrase inhibitors	52:10
Miotics	52:20
Mydriatics	52:24
Miscellaneous EENT drugs	52:36 (ophthalmic preparations)

Note: AHFS = American Hospital Formulary Service, EENT = eye, ear, nose and throat.