

Blood Glucose Test Strip Use

Patterns, Costs and Potential Cost Reduction Associated with Reduced Testing



ICES Investigative Report

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About ICES

Ontario's resource for informed health care decision-making

The Institute for Clinical Evaluative Sciences (ICES) is an independent, non-profit organization that produces knowledge to enhance the effectiveness of health care for Ontarians. Internationally recognized for its innovative use of population-based health information, ICES' evidence supports health policy development and guides changes to the organization and delivery of health care services.

Key to our work is our ability to link population-based health information, at the patient-level, in a way that ensures the privacy and confidentiality of personal health information. Linked databases reflecting 12 million of 30 million Canadians allow us to follow patient populations through diagnosis and treatment, and to evaluate outcomes.

ICES brings together the best and the brightest talent under one roof. Many of our scientists are not only internationally recognized leaders in their fields, but are also practicing clinicians who understand the grassroots of health care delivery, making the knowledge produced at ICES clinically-focused and useful in changing practice. Other team members have statistical training, epidemiological backgrounds, project management or communications expertise. The variety of skill sets and educational backgrounds ensures a multi-disciplinary approach to issues and creates a real-world mosaic of perspectives that is vital to shaping Ontario's future health care system.

ICES receives core funding from the Ontario Ministry of Health and Long-Term Care. In addition, our faculty and staff compete for peer-reviewed grants from federal funding agencies, such as the Canadian Institutes of Health Research, and project-specific funds are received from provincial and national organizations. These combined sources enable ICES to have a large number of projects underway, covering a broad range of topics. The knowledge that arises from these efforts is always produced independent of our funding bodies, which is critical to our success as Ontario's objective, credible source of *Evidence Guiding Health Care*.

Executive Summary

Background

Self-monitoring of blood glucose (SMBG) is common in patients with diabetes, but recent evidence suggests the practice has limited clinical benefit in many patients and may, in fact, be harmful in some cases. The use of blood glucose test strips has risen sharply over the past decade; however, the financial implications of this rise in use have not been explored. The purpose of this study was to examine the costs associated with rising blood glucose test strip use over the past 12 years. Furthermore, this study explores the cost impact of reducing glucose test strip use in elderly Ontarians with diabetes.

The Study

We conducted a retrospective cross-sectional time series analysis of annual prescription claims for blood glucose test strips between 1997 and 2008 for Ontarians with diabetes aged 65 years and older. Patients were stratified into one of four hierarchical diabetes therapy groups according to the most intensive glucose-lowering treatment received during each calendar year: insulin, oral glucose-lowering drugs with the potential to cause hypoglycemia, other oral glucose-lowering drugs, and no glucose-lowering therapy. Use and costs of blood glucose test strips were calculated annually for each group over the study period, and costs were projected to 2013. We then estimated potential cost reduction associated with five focused policy scenarios where blood glucose test strip use was reduced in subgroups of patients with diabetes.

Findings

- In 2008, more than 50% (n=263,513) of people with diabetes aged 65 years and older filled a prescription for blood glucose test strips, at a total cost of \$85.5 million. Almost half of these patients were at low risk for drug-induced hypoglycemia, and these individuals accounted for nearly one-third of all costs associated with blood glucose test strips in this age group.
- During the study period, test strip use and costs increased in all patient subgroups. The number of patients receiving no glucose-lowering drugs who were dispensed blood glucose test strips increased more than four-fold over the twelve-year period, and the associated costs in this patient group were six times higher in 2008 compared with costs in 1997.
- The total cost of test strips for older Ontarians between 2009 and 2013 is projected to exceed \$500 million; however, five potential policy scenarios in which test strip use was limited based upon patient characteristics have the potential to reduce overall costs by at least \$26 million, and as much as \$302 million.

Interpretation

Our analysis of the costs associated with blood glucose test strips in elderly Ontarians found that the implementation of policies that focus self-monitoring of blood glucose (SMBG) test strip use on patients likely to benefit from them could yield substantial cost reduction over the next five years. These resources could be redirected to more effective interventions for patients with diabetes.

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Introduction

Self-monitoring of blood glucose

Diabetes mellitus is a chronic condition affecting approximately 1.4 million people in Canada in 2000. It is expected that over 2.4 million Canadians will be living with diabetes in 2016, costing the health care system over \$8 billion.¹ Among patients with diabetes, self-monitoring of blood glucose (SMBG) is one of several approaches to monitoring of glycemic control recommended for use by the Canadian Diabetes Association (CDA) and the American Diabetes Association (ADA).^{2,3} SMBG allows patients with diabetes to collect information on their blood glucose levels – information that can then be used to adjust dietary choices, physical activity and medications, thereby facilitating the maintenance of stable glucose levels.^{3,4}

Optimal frequency guidelines and evidence

Both the CDA and ADA publish clear guidelines regarding the use of blood glucose test strips in patients treated with insulin, suggesting that patients with type 1 diabetes test three or more times daily in order to monitor their condition. However, the effectiveness and optimal frequency of SMBG in patients treated with oral glucose-lowering drugs and those with no glucose-lowering drug therapy is controversial and highly debated, and, therefore, SMBG optimal frequency guidelines do not exist for these populations.⁵⁻¹⁰

Several lines of evidence suggest a lack of clinically relevant improvement in diabetes-related outcomes, such as glycemic control, body weight, quality of life, diabetes-related complications and mortality associated with SMBG in patients with diabetes who are not treated with insulin.¹¹⁻¹⁸ A systematic review published by the Canadian Optimal Medication Prescribing and Use Service (COMPUS) in 2009 found that regular SMBG was associated with only a minimal reduction in hemoglobin A1c values (used to monitor blood glucose control in patients with diabetes).¹⁷ However, this reduction is of questionable clinical significance, and other recently published evidence suggests that regular SMBG is associated with significantly lower quality of life and worsening depression scores.^{15,17} After weighing the available evidence of risks and benefits of SMBG, COMPUS recently recommended that blood glucose testing should be restricted to patients receiving insulin and to women with gestational diabetes.^{17,19}

Costs of blood glucose test strips

The costs associated with SMBG are significant, with each test strip costing between \$0.40 and \$0.77 in 2008.²⁰ In fiscal year 2007, blood glucose test strips represented the third largest cost to the Ontario Public Drug Program—over \$107 million, or 3.3% of total drug expenditures in the program—after atorvastatin (a statin) and amlodipine (a calcium channel blocker).²¹ As a result, the potential policy and cost implications of more focused blood glucose testing may be significant.

Study purpose

We sought to characterize test strip use patterns and costs among older Ontarians according to the nature of their diabetes therapy. We also projected future costs for blood glucose test strips over the next five years, and estimated the potential cost reduction associated with five policy scenarios where test strip use was reduced in patient groups for which testing has not been shown to impart clinically important benefits.

Data Sources and Methods

Data sources

We identified prescriptions for blood glucose test strips dispensed in Ontario by examining computer-based claims for prescription medications reimbursed under the Ontario Public Drug Program. This database contains comprehensive records of all prescriptions dispensed to beneficiaries, including highly accurate information about the product and quantity dispensed, product costs, professional fees, and any copayments or deductibles.²² The Ontario Diabetes Database (ODD), a validated registry of patients diagnosed with diabetes, was used to identify diabetes status in the study population. This database is derived from hospital admission records and physician claims for diabetes diagnoses in Ontario, and is described in more detail by Hux et al.²³

Setting

We conducted a retrospective cross-sectional time series analysis of annual prescription claims for blood glucose test strips reimbursed by the Ontario Public Drug Program over a 12-year period (January 1997 to December 2008) for Ontarians aged 65 years and older. Ontario is Canada's most populous province and has a universal health insurance program that provides full coverage for hospital care and physician services to all 13 million residents, as well as prescription drug coverage to seniors and social assistance recipients.

Identification of patients and diabetes therapy groups

Patients were included in the study if they filled at least one prescription for blood glucose test strips between 1997 and 2008, and were aged 65 years and older at the time of dispensing. Patients were assigned to yearly cohorts if they filled at least one test strip prescription during the calendar year. They were then stratified into one of four hierarchical and mutually exclusive groups each year according to the most intensive diabetes therapy received during that year (Exhibit 1). We stratified oral diabetes therapies according to their potential to induce hypoglycemia based on the rationale that, even in the absence of demonstrable clinical benefit, SMBG testing is more easily justified for safety reasons in patients whose diabetes therapy places them at risk for hypoglycemia.

Exhibit 1 Description of the four diabetes therapy groups used to stratify study patients

Diabetes Therapy Group	Description
1. Insulin	At least one prescription for insulin regardless of other diabetes drug therapy
2. Hypoglycemia-inducing oral glucose-lowering drugs	At least one prescription for an oral glucose-lowering drug that can cause hypoglycemia (sulfonylureas, repaglinide), but no insulin treatment
3. Non-hypoglycemia-inducing oral glucose-lowering drugs	At least one prescription for an oral glucose-lowering drug not generally associated with hypoglycemia (metformin, thiazolidinediones, acarbose), but no treatment with insulin or the other oral glucose-lowering drugs described above
4. No glucose-lowering drug therapy	Diabetes controlled through diet and exercise

Blood glucose test strip use and costs

For each year of the 12-year study period, we determined the total number of prescriptions for blood glucose test strips and the number of test strips dispensed to patients in each diabetes therapy group. The cost per patient and the total cost for all patients were calculated annually based upon the sum of the amount reimbursed by the Ontario Public Drug Program and the deductible paid by the patient, excluding pharmacy dispensing fees. A sensitivity analysis explored the costs paid by the Ontario Public Drug Programs, including dispensing fees but excluding any deductible paid by the patient. All costs were expressed in Canadian dollars on the date of dispensation.

We used all patients aged 65 years and older meeting the criteria outlined in Exhibit 1, regardless of blood glucose test strip prescription history, as the denominator for the test strip use rates within each diabetes therapy group. Among patients receiving no glucose-lowering drug therapy, the denominator was determined from the Ontario Diabetes Database. Because the ODD is only complete to 2007, the number of patients with diabetes receiving no drug therapy in 2008 was linearly extrapolated.

Scenarios of reduced blood glucose test strip use

A recent report by COMPUS recommended SMBG by patients using insulin and in women with gestational diabetes.¹⁹ Despite evidence that SMBG does not improve glycemic control in patients not requiring insulin, there is a prevalent belief that SMBG promotes patient engagement and awareness regarding diabetes. Furthermore, patients who control their diabetes with oral glucose-lowering drugs may find periodic SMBG useful for the detection of hyperglycemia or hypoglycemia.^{2,3} We, therefore, modeled the cost implications of five different SMBG testing frequencies within our four diabetes therapy groups. In each scenario, the annual number of test strips was reduced in selected patient groups, and the total cost associated with each scenario was estimated.

Exhibit 2 outlines the details of the five scenarios for changes to blood glucose test strip use. The first scenario estimates the impact of implementing the recent COMPUS recommendation: limiting SMBG testing to patients treated with insulin. The second scenario extends the COMPUS recommendations by allowing a limited number of blood glucose test strips (100 per year) for patients treated with oral glucose-lowering drugs, equivalent to a testing frequency of approximately twice per week. In both scenarios, we imposed no limit on the number of strips dispensed to patients treated with insulin. In the last three scenarios, there is no change in blood glucose test strip use among patients at risk of drug-induced hypoglycemia (diabetes therapy groups 1 and 2), but reduced test strip use among patients at low risk for drug-induced hypoglycemia (diabetes therapy groups 3 and 4). The test strip use thresholds were 100 (twice weekly), 200 (every second day) and 400 (daily) strips per year for scenarios 3, 4 and 5, respectively.

Exhibit 2 Description of the five scenarios related to testing frequency, based on diabetes therapy group

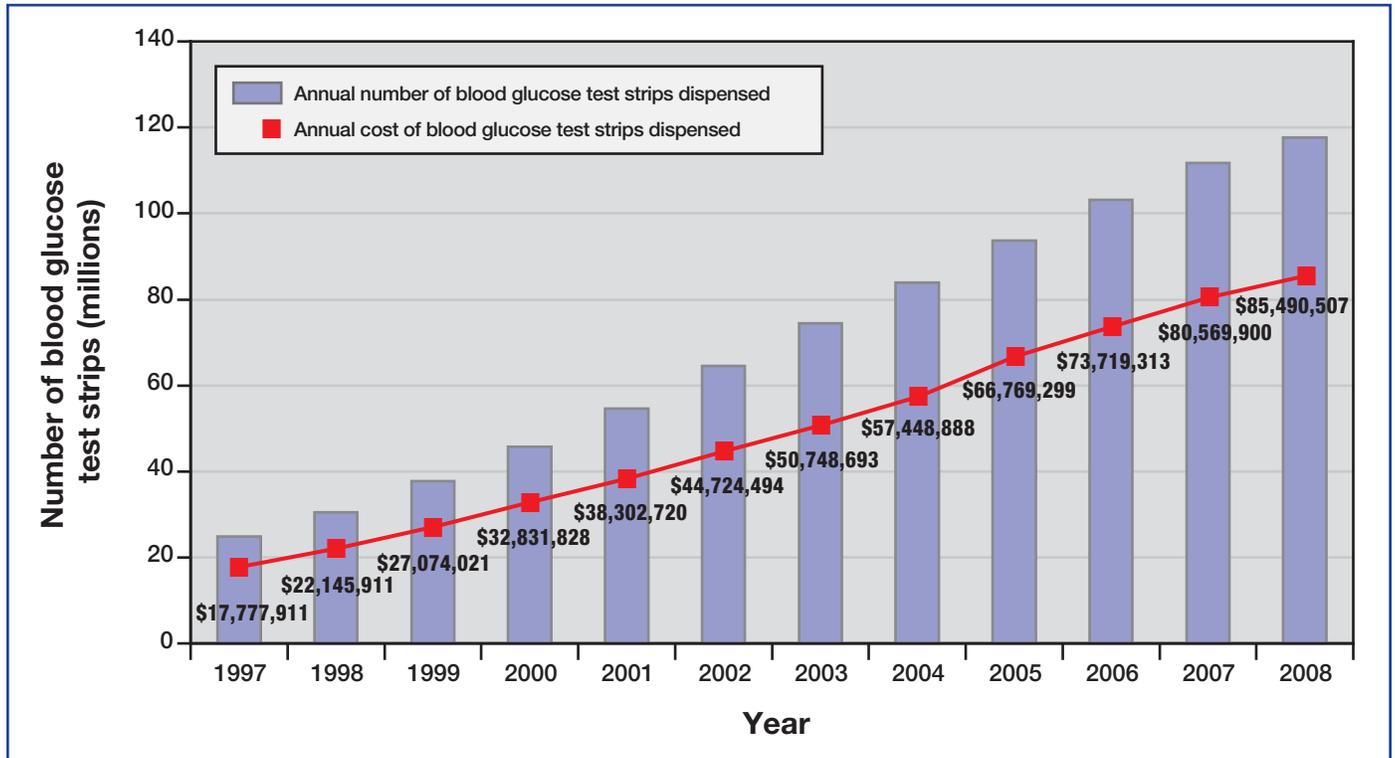
Scenario	Description
1	Unlimited use in Group 1; no SMBG use in Groups 2, 3 and 4
2	Unlimited use in Group 1; a maximum of 100 strips per person per year in Groups 2 and 3; no SMBG use in Group 4
3	Unlimited use in Groups 1 and 2; a maximum of 100 strips per person per year in Groups 3 and 4
4	Unlimited use in Groups 1 and 2; a maximum of 200 strips per person per year in Groups 3 and 4
5	Unlimited use in Groups 1 and 2; a maximum of 400 strips per person per year in Groups 3 and 4

Note: Diabetes therapy groups are described in Exhibit 1.

To estimate blood glucose test strip costs, we used the average cost of the strips used by each patient in a given year. The potential cost reduction associated with each of these scenarios was estimated for 2008. Finally, time series analysis, a collection of techniques for modeling autocorrelation in temporally sequenced data,²⁵ was applied to annual cost data from January 1997 to December 2008 using exponential smoothing models to forecast costs over the five-year period from 2009 to 2013. The potential cost reduction associated with each scenario was computed.

Exhibits and Findings

Exhibit 3 Annual number and cost of blood glucose test strips dispensed to patients aged 65 years and older with diabetes, in Ontario, 1997 to 2008



Findings for Exhibit 3

- From 1997 to 2008, the number of Ontarians aged 65 years and older who were dispensed blood glucose test strips each year increased by almost 250%, from 76,320 people in 1997 to 263,513 in 2008 (data not shown).
- Approximately 53% of the elderly population received diabetes test strips by 2008 (data not shown).
- The total number of blood glucose test strips dispensed each year increased almost five-fold, from 24.9 million strips in 1997 to 117.6 million strips in 2008.
- Consequently, the total annual cost of blood glucose test strips also increased nearly five-fold from almost \$18 million in 1997 to more than \$85 million in 2008.

Exhibit 4 Proportion of patients aged 65 and older with diabetes using blood glucose test strips, by diabetes therapy group, in Ontario, 1997 to 2008

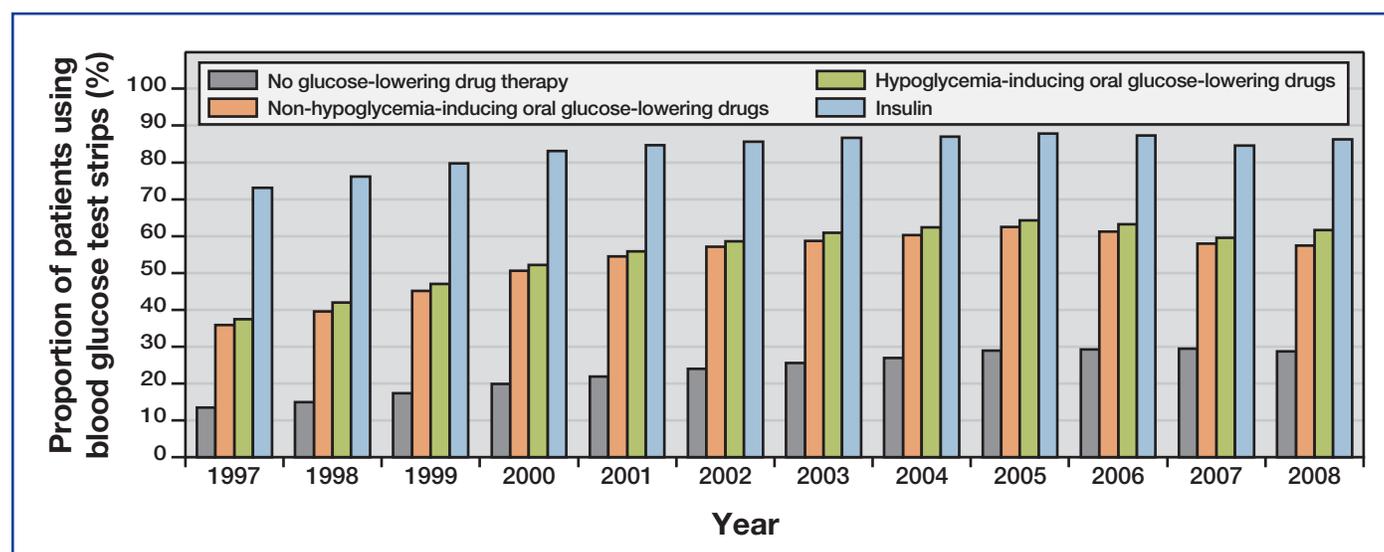
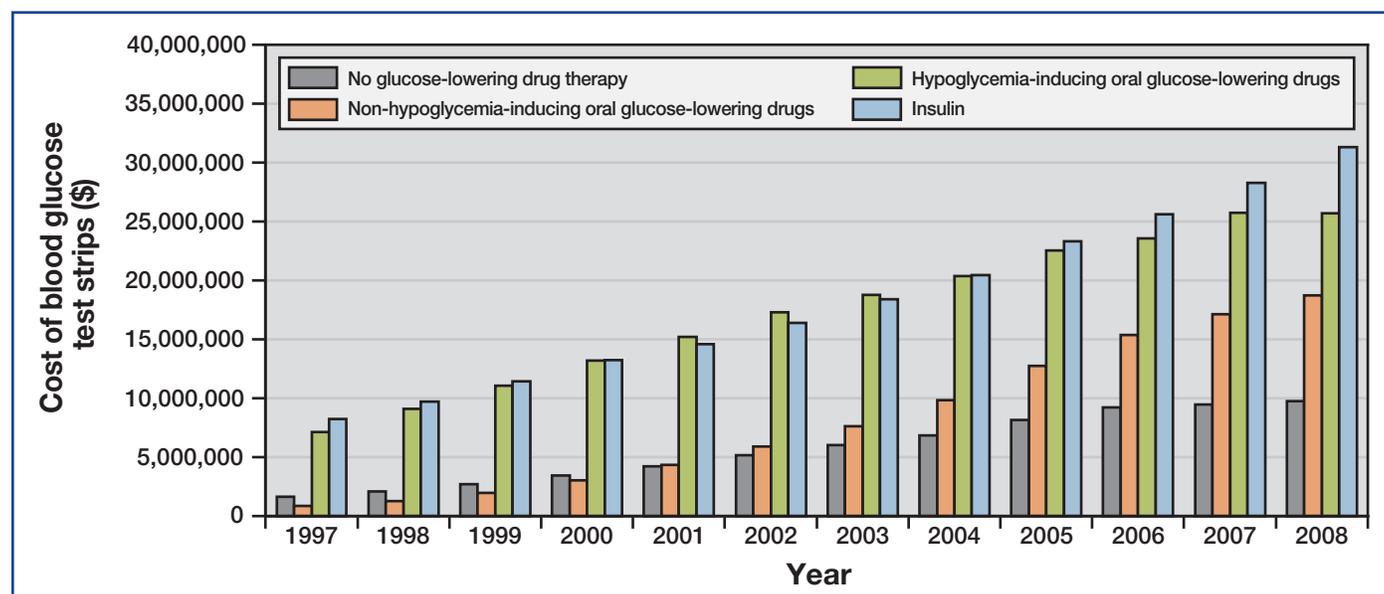


Exhibit 5 Cost of blood glucose test strips dispensed to patients aged 65 and older with diabetes, by diabetes therapy group, in Ontario, 1997 to 2008



Findings for Exhibits 4 and 5

- The proportion of patients using blood glucose test strips increased in both oral glucose-lowering drug groups, rising from approximately 36% in 1997 to 60% in 2008. The associated costs ranged from \$7.1 million to \$25.7 million among patients taking oral glucose-lowering drugs with the potential to cause hypoglycemia, and \$0.8 million to \$18.7 million among patients taking non-hypoglycemia-inducing oral glucose-lowering drugs between 1997 and 2008.
- Over this same period, blood glucose test strip use doubled and costs increased by more than 600% in patients not treated with glucose-lowering drugs. By 2008, 30% of patients receiving no glucose-lowering therapy were being dispensed blood glucose test strips at a cost of nearly \$10 million.
- Since 2000, self-monitoring of blood glucose (SMBG) prevalence has exceeded 80% and costs have exceeded \$13 million in patients treated with insulin.

Exhibit 6 Blood glucose test strip use and costs, by diabetes therapy group, in Ontario, 2008

Diabetes therapy group	Patients prescribed test strips N (%) [*]	Test strips dispensed N (%) [*]	Total cost of test strips (\$)	Cost per patient per day Mean (SD) (\$)
Insulin (N=65,792)	56,772 (86.3)	43,121,314 (36.7)	31,325,717	1.51 (1.10)
Hypoglycemia-inducing oral glucose-lowering drugs (N=134,758)	83,059 (61.6)	35,283,961 (30.0)	25,699,090	0.85 (0.74)
Non-hypoglycemia-inducing oral glucose-lowering drugs (N=130,807)	75,134 (57.4)	25,817,898 (22.0)	18,721,740	0.68 (0.61)
No glucose-lowering drug therapy (N=169,449)	48,548 (28.7)	13,380,519 (11.4)	9,743,960	0.55 (0.54)
Total	263,513	117,603,692	85,490,507	0.89 (0.84)

^{*} Previously published number of patients prescribed SMBG and number of blood glucose test strips dispensed.²⁶

Findings for Exhibit 6

- The largest proportion of test strips were dispensed to patients treated with insulin (36.7%), with a mean daily cost per patient of approximately \$1.51. This is almost 70% higher than the population average of \$0.89. Patients not receiving insulin accounted for 73.4% of all blood glucose test strip use and for roughly two-thirds (63.4%; \$54.2 million) of SMBG expenditures in 2008.
- These analyses were repeated using the total costs to the Ontario Public Drug Program of blood glucose test strips, excluding any deductible paid by the patient. The results of these analyses were consistent with those for test strips alone, changing by less than 2% (data not shown).

Exhibit 7 Reduction in cost of blood glucose strips associated with five scenarios related to testing frequency, for patients with diabetes aged 65 years and older, in Ontario, 2008*

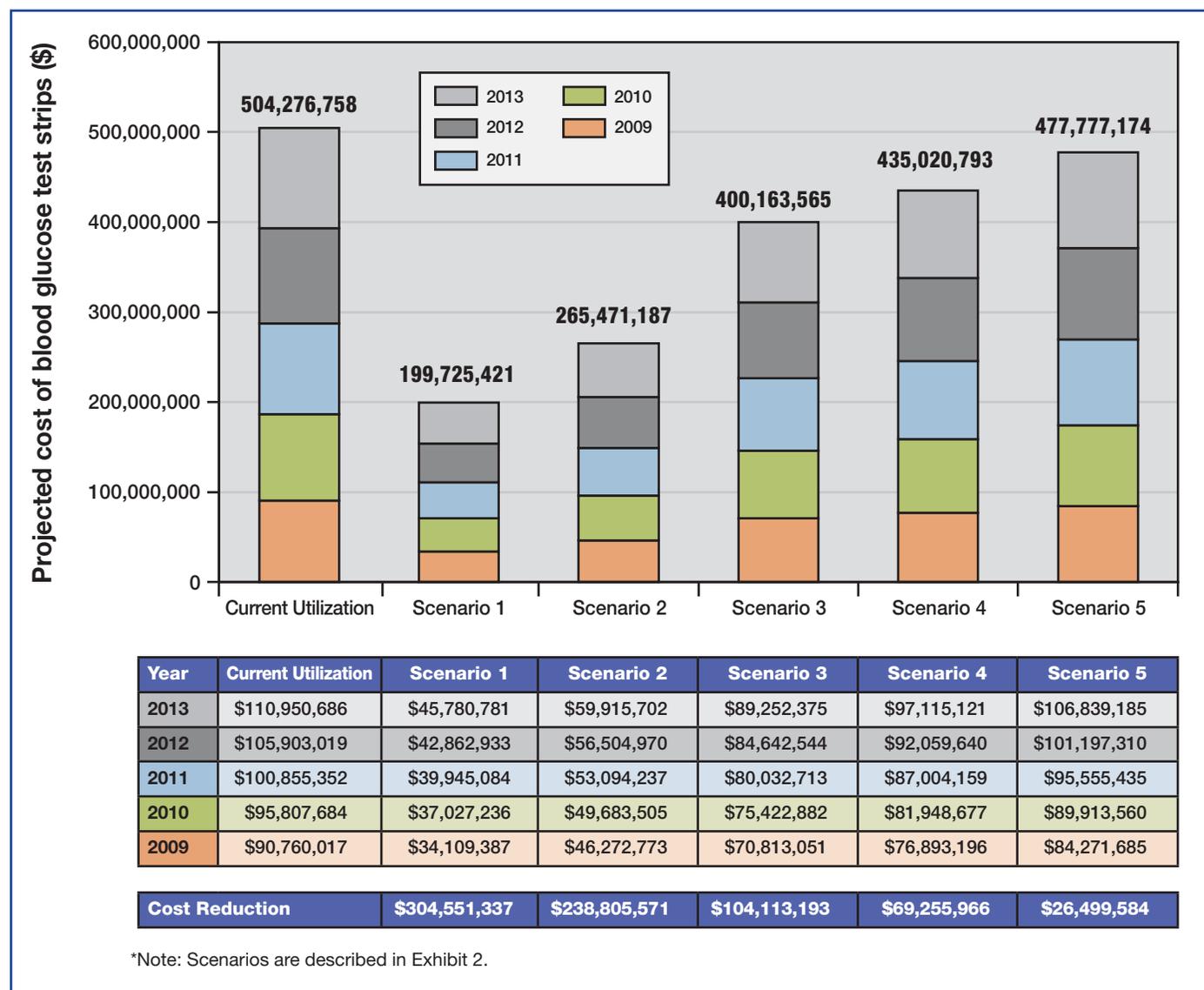
Diabetes drug therapy group	No. of patients prescribed test strips	Cost in 2008 (\$)	Scenario 1 (\$)	Scenario 2 (\$)	Scenario 3 (\$)	Scenario 4 (\$)	Scenario 5 (\$)
Insulin	56,772	31,325,717	31,325,717	31,325,717	31,325,717	31,325,717	31,325,717
Hypoglycemia-inducing oral glucose-lowering drugs	83,059	25,699,090	--	6,042,583	25,699,090	25,699,090	25,699,090
Non-hypoglycemia-inducing oral glucose-lowering drugs	75,134	18,721,740	--	5,462,355	5,462,355	9,275,515	13,930,013
No glucose-lowering drug therapy	48,548	9,743,960	--	--	3,522,238	5,537,392	7,674,988
Total	263,513	85,490,507	31,325,717	42,830,655	66,009,400	71,837,714	78,629,808
Total Cost Reduction			54,164,790	42,659,852	19,481,107	13,652,793	6,860,699

*Scenario details are described in Exhibit 2.
 -- denotes no test strip use.

Findings for Exhibit 7

- Blood glucose test strip use was modeled under the five scenarios described in Exhibit 2 to assess the financial impact of focused SMBG testing in 2008. Potential cost reduction in 2008 ranged from \$6.9 million under the scenario with the least change in use (no change in use in Groups 1 and 2, and a reduction to roughly one test daily in Groups 3 and 4) to \$54.2 million under the scenario with the greatest change in use (test strip use in patients treated with insulin only).
- These cost reductions accounted for 8.0% to 63.4% of the total expenditure on blood glucose test strips among older Ontarians in 2008.

Exhibit 8 Projected costs of blood glucose test strips associated with five scenarios related to testing frequency, in patients with diabetes aged 65 years and older, in Ontario, 2009 to 2013*



Findings for Exhibit 8

- From cost projections for 2009 to 2013 (based on current blood glucose test strip use), as well as projected costs incurred under each of five test strip use scenarios (Exhibit 2), we estimate that if current testing patterns persist, the total costs of test strips will exceed half a billion dollars (\$504 million) over the next five years.
- Modifying test strip use to roughly one test daily in patients whose therapy does not place them at increased risk of hypoglycemia (Groups 3 and 4) would result in a cost reduction of approximately \$26.5 million over five years.
- Alternatively, implementing the COMPUS recommendation (reimbursement for test strips solely among insulin-treated patients)¹⁹ would result in cost reductions of roughly \$300 million over the next five years among Ontarians aged 65 and older.

Interpretation

Over the last 12 years, use of blood glucose test strips among older Ontarians has increased by more than 250%, with costs increasing by almost 400%. Furthermore, in 2008, nearly 30% of patients who used no drug therapy to control their diabetes and 60% of patients treated with oral glucose-lowering drugs not known to induce hypoglycemia were dispensed blood glucose test strips, despite a lack of evidence of clear clinical benefit, and some suggestion of harm. The cost associated with this potentially unnecessary monitoring of blood glucose was over \$28 million.

In light of the overall costs and minimal benefits of self-monitoring of blood glucose (SMBG) in many patients, limiting the use of test strips has been proposed in Canada and other jurisdictions.^{19,27,28} We estimate that under a variety of scenarios of reduced test strip use among older Ontarians, cost reductions ranging from \$7 million to \$54 million (roughly 2% of Ontario's drug plan expenditure on seniors) could have been realized in 2008. These additional resources would have been sufficient, for example, to fund dozens of additional diabetes education teams in the province. Over the next five years, the growing costs of SMBG testing among older Ontarians will amount to roughly \$500 million, and undoubtedly over \$1 billion in Canada. If test strip use was modified to the extent recommended by COMPUS,¹⁹ roughly 60% of these costs could be avoided. Even our most conservative scenario could save \$26 million over the next five years in Ontario alone.

Although the projected cost reduction estimates demonstrated in this study are based upon hypothetical SMBG test frequency scenarios, they serve to illustrate the potential impact of modifying blood glucose test strip use in a manner consistent with available evidence. Substantial cost reductions could be realized without changing the patterns of test strip use among patients treated with insulin. Indeed, potential reductions in expenditures remain considerable without changing test strip use by patients treated with oral glucose-lowering drugs that can cause hypoglycemia. It is important to highlight the fact that these reductions in expenditures would result from a decrease in potentially unnecessary blood glucose test strip use, while still continuing periodic (at least twice weekly) blood glucose monitoring by all patients in the majority of the scenarios described. This would continue to engage patients in their own care, and allow them to gather data that may aid clinical decision-making.

Limitations

Two main limitations merit emphasis. The most important limitation of this study is that its findings were based upon SMBG testing patterns of Ontarians aged 65 years and older. Thus, the findings may not be generalized to younger patients or to seniors in other jurisdictions.

Secondly, patients were assigned to one of four mutually exclusive diabetes therapy groups based upon the highest intensity of drug therapy each patient received during the year of study. It is, therefore, possible that misclassification of diabetes therapy occurred in the analyses if a person changed diabetes therapy during the course of a year.

However, each of these limitations results in conservative estimates of the costs associated with blood glucose test strips and cost reductions achieved from subsequent use reduction scenarios. Therefore, the results of this report can be used to highlight the minimum impact of focused SMBG test strip policies on use and costs in Ontario.

Conclusions

As the prevalence of diabetes continues to rise, the provision of care and treatment of patients living with this condition will place an increasing burden on health care resources in Ontario. As a result, there is a need for policy-oriented research into the safety, appropriateness and cost-effectiveness of diabetes treatments currently being prescribed. Approximately half of older Ontarians with diabetes who were dispensed blood glucose test strips in 2008 were not receiving treatment that might justify frequent testing, costing over \$28 million. Furthermore, 80% of all test strip use occurred in patients who do not meet the recently published recommendations of COMPUS.¹⁹

If current use patterns persist, costs of blood glucose test strips will exceed half a billion dollars over the next five years, with annual costs surpassing \$110 million by 2013. The potential decreases in expenditures associated with even modest reductions in SMBG in these groups is substantial, ranging from approximately \$26 million to \$300 million over the next five years. Such savings could be used to improve access to other diabetes-related products or services for which evidence of benefit is strong, while continuing to provide unlimited access to blood glucose test strips in patient groups for whom use is more easily justified.

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