How should developing countries manage diabetes?

In 2003, 194 million people 20 to 79 years of age had diabetes mellitus, almost three-quarters of them living in the developing world. By 2025 this number will have increased by 72%: 333 million cases are predicted, with a doubling of the prevalence in the Middle East, North Africa, South Asia and Sub-Saharan Africa. Almost 1 million people die because of diabetes each year, two-thirds of these in developing countries[1] (see Appendix 1, available online at www.cmaj.ca/cgi/content/full/175/7/733/DC1).

This growing problem will have a significant impact on national and individual economies as well as on individual health; however, it has proven difficult to determine just what that impact is. Good data on the direct medical costs of diabetes are not available for most developing countries, although extrapolation from information gathered in developed countries is possible. Worldwide estimates suggest that the annual direct medical costs of diabetes total at least US$129 billion and may be as high as US$241 billion, or 2.5% to 15.0% of global annual health care budgets[2] (see Appendix 1, available online at www.cmaj.ca/cgi/content/full/175/7/733/DC1). The indirect costs of diabetes (such as lost productivity) are at least as high and increase as more economically productive people are affected. To lessen the impact, how should governments in developing countries tackle this burgeoning problem?

Most interventions to prevent and treat diabetes and its complications have a significant effect on health services utilization. Determining which of these interventions are most cost-effective in developing countries is difficult because of insufficient data. Nonetheless, high-quality efficacy evidence for strategies to prevent diabetes and its complications are available from developed countries and can be used to make useful estimates about the costs and likely benefits of implementing different types of care in developing countries.

To make estimates for developing countries, we updated an earlier comprehensive review[3] of cost-effectiveness studies to 2003 (see Appendix 2, available online at www.cmaj.ca/cgi/content/full/175/7/733/DC1). We then estimated the cost-effectiveness ratio (CER) of diabetes interventions for the 6 developing regions, assuming that the effectiveness of these interventions (in quality-adjusted life years [QALYs]) was the same as for developed countries but that their costs were different (Table 1). CERs for developing regions were calculated by multiplying the CER for the developed countries by the ratio of costs in the developing region to costs in the developed countries. We estimated the costs of diabetes care in the 6 developing regions using the framework of Mulligan and associates,[4] which calls for the development of a relative cost index for health care services across regions and the availability of information about costs for one region. We estimated the relative cost index using data from Mulligan and associates, assuming that the cost of diabetes care in the United States (where most studies were conducted) was 8.6 times the cost for the Latin America and the Caribbean region.[5] The costs of diabetes care in the other 5 developing regions were calculated by multiplying the cost of care in the Latin America region by the relative cost index. A more complete description of the methods is available in the relevant chapter of the online publication *Disease control priorities in developing countries*.[5]

Having established cost-effectiveness data for the 6 developing regions, we then assessed which interventions should have priority on the basis of their CERs and feasibility of implementation (Box 1). Feasibility was judged from 4 aspects: difficulty of reaching the intended population, technical complexity, capital intensity and cultural acceptability. Level 1 interventions are both cost saving and feasible, although a short-term increase in intervention costs may be a barrier to their implementation (Table 1 and Table 2). Level 2 interventions are cost saving but moderately feasible (e.g., it may be difficult to reach all women needing preconception care) or cost less than US$1500 per QALY (e.g., angiotensin-converting enzyme [ACE] inhibitors) but are fully or moderately feasible. They represent good value for money but may present some challenges in terms of feasibility. Some interventions are more cost-effective according to patients' age (e.g., screening and treatment for diabetic retinopathy in older people) or are more sensitive to drug prices (e.g., use of ACE inhibitors). Lowering drug prices is a key factor for the success of some drug therapies in developing countries. Smoking cessation appears to be the least cost-effective of the level 2 interventions but its cost-effectiveness is probably underestimated, as our calculations took into account only the projected reduction in risk of cardiovascular disease. Adding the health benefits associated with pre-

Box 1: Levels of interventions and feasibility

Levels of intervention

1: Cost saving, fully feasible

2: Cost saving or cost below US$1500 per QALY, some feasibility challenges

3: Cost between US$1650 and US$8550 per QALY, significant feasibility challenges

Assessment of feasibility

- Difficulty of reaching the intervention population
- Technical complexity
- Capital intensity (amount of capital required)
- Cultural acceptability in terms of social norms, religious beliefs

Note: QALY = quality-adjusted life-year.

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venting cancer and pulmonary diseases might improve the cost-effectiveness of smoking cessation.

Compared with level 1 and 2 interventions, level 3 interventions are less feasible and may not always be justifiable — in the short-term — for all people in developing countries, given limited health care resources. The cost-effectiveness of metformin therapy for preventing type 2 diabetes among people at high risk (e.g., those with prediabetes) and of cholesterol control for people with total cholesterol above 200 mg/dL would improve if drug costs could be lowered (i.e., if generic versions of the drug could be made available).

We also considered the cost-effectiveness of diabetes education, community-based prevention and improvement of quality care. Evaluating the effectiveness of health education is challenging because of the difficulty of separating the effect of education from that of other interventions. A review of literature published in the United States

Table 1: Cost-effectiveness of interventions for preventing and treating diabetes and its complications in developing regions*

	Region; cost per QALY, in 2002 US$						
Intervention†	East Asia and Pacific	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa	Feasibility‡
Level 1							
Moderate glycemic control if HbA_{1c} > 9%	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	++++
Blood pressure control if pressure > 160/95 mm Hg	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	++++
Foot care in people at high risk of ulcers	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	++++
Level 2							
Preconception care for women of reproductive age	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	Cost saving	++
Lifestyle interventions to prevent type 2 diabetes	80	100	130	110	60	60	++
Influenza vaccinations for elderly people with type 2 diabetes	220	290	360	310	180	160	++++
Annual eye examination	420	560	700	590	350	320	++
Smoking cessation	870	1170	1450	1230	730	660	++
ACE inhibitor use	620	830	1020	870	510	460	+++
Level 3							
Metformin therapy to prevent type 2 diabetes	2180	2930	3630	3080	1820	1640	++
Cholesterol control if total cholesterol level > 200 mg/dL	4420	5940	7350	6240	3680	3330	+++
Intensive glycemic control (reduce HbA_{1c} to < 8%) if HbA_{1c} between 8% and 9%	2410	3230	4000	3400	2000	1810	++
Screening for undiagnosed diabetes	5140	6910	8550	7260	4280	3870	++
Annual screening for microalbuminuria	3310	4450	5510	4680	2760	2500	++

Note: QALY = quality-adjusted life-year, HbA_{1c} = glycosylated hemoglobin, ACE = angiotensin-converting enzyme.
*Data based on authors' calculations.
†Level 1 interventions are cost saving and highly feasible; these interventions have first priority for implementation. Level 2 interventions are cost saving or cost less than $1500 per QALY but pose feasibility challenges; these interventions have second priority for implementation. Level 3 interventions cost between $1640 and $8550 per QALY and pose significant feasibility challenges; these interventions have the lowest priority for implementation.
‡Feasibility was assessed on the basis of difficulty of reaching the intended population (the capacity of the health care system to deliver an intervention to the targeted population), technical complexity (the level of medical technology or expertise needed for implementing an intervention), capital intensity (the amount of capital required for an intervention) and cultural acceptability (the appropriateness of an intervention in terms of social norms and religious beliefs). The number of plus symbols in a cell indicates the number of aspects for which that intervention is feasible (e.g., ++++ represents feasibility for all 4 aspects).

Table 2: Key cost-effective interventions for preventing and treating diabetes and its complications

Intervention*	Description	Applicable population	Major impact
Level 1			
Moderate glycemic control	Insulin, oral glucose-lowering agents, diet, exercise	People with diabetes, all ages, HbA_{1c} level > 9%	Reduction in microvascular disease
Blood pressure control	Medication	People with diabetes and hypertension, all ages	Reduction in macrovascular disease, microvascular disease, deaths
Foot care	Patient and provider education, foot examination, foot hygiene, appropriate footwear	People with diabetes, middle-age or older	Reduction in serious foot diseases, amputations
Level 2			
Preconception care	Patient self-management	Women with diabetes who plan to become pregnant	Reduction in HbA_{1c} level, reduction in hospital expenses of mother and baby
Lifestyle interventions to prevent diabetes	Behavioural change, including diet and physical activity, to reduce body weight	People at high risk for type 2 diabetes	Reduction in incidence of type 2 diabetes by 58%
Influenza vaccination	Vaccination	Elderly people with diabetes	Reduction in hospital admissions, respiratory conditions, deaths
Annual eye examination	Eye examination to screen for and treat eye diseases	People with diabetes, middle-age or older	Reduction in serious loss of vision
Smoking cessation	Physician counselling, nicotine replacement therapy	People with diabetes who smoke, all ages	Increase in quitting rate, reduction in cardiovascular disease
ACE inhibitor use	Medication	People with diabetes	Reduction in nephropathy, cardiovascular disease, deaths
Level 3			
Metformin therapy to prevent diabetes	Medication	People at high risk for type 2 diabetes	Reduction in incidence of type 2 diabetes by 33%
Cholesterol control	Cholesterol-lowering medication	People with diabetes and high cholesterol, all ages	Reduction in cardiovascular disease events, deaths
Intensive glycemic control (reduce HbA1c to < 8%)	Insulin or oral glucose-lowering therapy, or both	Diabetes, all ages, with HbA_{1c} level between 8% and 9%	Reduction in microvascular disease
Screening for undiagnosed diabetes	Screening and treatment of people who test positive	People at high risk for type 2 diabetes	Reduction in microvascular disease
Screening for microalbuminuria	Screening and treatment of people who test positive	People with diabetes, all ages	Reduction in kidney disease
Essential background intervention†			
Diabetes education	Patient self-management	People with diabetes, all ages	Reduction in HbA_{1c} level, better compliance with lifestyle changes
Other promising intervention‡			
Polypill	Hypothetical pill combining low dose of antihypertensive medication, ASA, statin and folate	People with diabetes, all ages	Reduction in cardiovascular disease

Note: ACE = angiotensin-converting enzyme, HbA_{1c} = glycosylated hemoglobin.
*Level 1 interventions are cost saving and highly feasible; level 2 interventions are cost saving or cost less than $1500 per quality-adjusted life year but pose feasibility challenges; level 3 interventions cost between $1640 and $8550 per quality-adjusted life year and pose significant feasibility challenges.
†Diabetes education is the backbone upon which many diabetes interventions depend, but empiric data on the effect of diabetes education on outcomes and the precise components of diabetes education that are effective, are still lacking.
‡An intervention that appears promising but needs further research to document its effectiveness and/or safety. The polypill is only a theoretical concept and is not available for implementation.

suggests that education about self-management of diabetes may be cost-effective[3] and also that diabetes self-management training reduces medical costs in developing countries in the short-term.[2] Because the costs of education programs are generally low, this may be a cost-effective strategy. Training patients to better manage their diabetes is also feasible because of its low technical complexity, low capital requirements and cultural acceptability. Diabetes education should be a high-priority intervention for all developing regions.

Data on community- or population-based prevention strategies are sparse, and implementation priorities are unclear. Available studies on preventing type 2 diabetes have used clinic-based approaches targeting high-risk groups, and researchers generally agree that type 2 diabetes can be prevented or its onset delayed. However, the implementation of these results in practice is fraught with unanswered questions: Who would benefit from diabetes prevention? How can those who might benefit be identified? What are the costs, and what is the cost-effectiveness for diabetes prevention at a population level? How should results be extrapolated from developed countries to developing countries, where priorities and approaches may be different?

The quality of diabetes care remains suboptimal worldwide, regardless of a country's level of development, health care system or population.[6] Small, single-site studies have identified several promising interventions to improve quality of care at the patient, provider and system levels.[7] A systematic review[8] has also found that interventions such as regular contact and tracking of patients on computerized tracking systems and the use of nurses to educate patients and facilitate treatment adherence improves care, yet data on the cost-effectiveness of these approaches are sparse.

Future diabetes care in developing countries could be better targeted with the support of well-aimed research. Community-based studies of primary prevention, using lifestyle interventions and/or safer and cheaper drugs to prevent diabetes (when lifestyle interventions are either unfeasible or have failed), are needed. We also need to know the long-term effects of diabetes prevention on cardiovascular and other outcomes and to find more effective and cheaper ways to prevent the major complications of diabetes. Research into noninvasive methods for monitoring blood glucose, effective screening for prediabetes, diabetes and early diabetes complications, and the impact of diabetes education on health outcomes and risk factor control is required.

Epidemiologic and economic data could also support control efforts. Scant data are available on the future burden of diabetes and its complications in developing countries. Data on trends in and effects of diabetes risk factors — obesity, birth weight, physical inactivity, television viewing, dietary factors, socioeconomic factors and the effects of urbanization, industrialization, globalization and stress — are also sparse. More data are needed on the economics of diabetes, its impact on quality of life and the cost-effectiveness of various interventions in the context of developing countries.

Finally, greater emphasis on translational research will support this process, for example, the development of computer models for forecasting burden of disease and research aimed at understanding the trade-offs and best mix of resource allocation for diabetes and chronic disease care needed in developing countries. Well-targeted basic research could lead to better prevention and treatment strategies, such as understanding the role of prenatal influences and gene-environment interactions on diabetes development.

Interventions to reduce the morbidity and mortality associated with diabetes are available and effective, and most, if not all, are feasible to implement in developing countries. It is now up to governments to use these data to address the challenges of a growing diabetes problem.

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