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. Almost 1 million people die because of diabetes each year, two-thirds of these in developing countries (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 (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 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, 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. 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.

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-
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 pre-diabetes) 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

| Intervention† | East Asia and Pacific | Europe and Central Asia | Latin America and Caribbean | Middle East and North Africa | South Asia | Sub-Saharan Africa | Feasibility‡ |
|---------------|-----------------------|-------------------------|----------------------------|-----------------------------|------------|-------------------|-------------|
| Moderate glycemic control if HbA1c > 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 | ++++ |
| 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 | +++ |
| 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 HbA1c to < 8%) if HbA1c 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, HbA1c = 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 |
|---------------|-------------|-----------------------|--------------|
| Moderate glycemic control | Insulin, oral glucose-lowering agents, diet, exercise | People with diabetes, all ages, HbA1c 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 |
| Preconception care | Patient self-management | Women with diabetes who plan to become pregnant | Reduction in HbA1c 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 |
| 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 HbA1c 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 |
| Diabetes education | Patient self-management | People with diabetes, all ages | Reduction in HbA1c level, better compliance with lifestyle changes |
| 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, HbA1c = 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 and also that diabetes self-management training reduces medical costs in developing countries in the short-term. 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. Small, single-site studies have identified several promising interventions to improve quality of care at the patient, provider and system levels. A systematic review 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 non-invasive 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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