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Diabetes

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In recent years there has been growing concern that diabetes mellitus is becoming more common, mainly in the more urbanized and industrialized countries, where the prevalence rates of the disease in the total population are often 1 to 3 percent or more. In these countries it is widely agreed that diabetes is a significant public health problem, particularly among people in the older age groups. There are also well-documented populations in developing countries in which diabetes has become much more frequent in the past ten to twenty years. Given the changing age structures and health patterns of the populations of developing countries, what public health priority should be given to diabetes, now and for the next twenty years or so?

In order to answer this question, we summarize in this chapter the information on the frequency and time trends for diabetes in developing countries and on the indirect and direct costs of the disease. We consider the evidence for prevention and case management strategies and assess the feasibility and cost of these strategies. Until recently little consistent information was available on diabetes in developing countries, but under the leadership of the International Diabetes Federation and the World Health Organization (WHO), interest in the subject has grown steadily during the past ten to fifteen years. A great deal of this information has been well summarized in a World Health Organization Technical Report (WHO 1985).

Diabetes mellitus is a chronic and noncommunicable disease which is largely irreversible. Although it can occur at any age, its onset is most frequent among the young and older persons. Diagnosis is based on finding an abnormally high level of glucose in the blood, a condition caused by poorly functioning beta cells in the pancreas gland and an insufficient output of the hormone insulin. The actual underlying etiological mechanisms that lead to this pathological state, however, are still largely unknown.

Despite the fact that all diabetes cases have been classified and reported under one code (number 250) in the *International Statistical Classification of Diseases, Injuries, and Causes of Death* (WHO 1975), it is now generally accepted that epidemiologically there are two main types of the illness, and this is to be acknowledged in the forthcoming revision. The onset of insulin-dependent diabetes mellitus (IDDM) generally occurs among younger age groups (with 25 to 50 percent of patients presenting before the age of fifteen years), and it is nearly always acute in onset. Sufferers require regular doses of insulin, by injection or a similar process at least once per day, in order to sustain life and to avoid acute and more long-term complications. Those with non-insulin-dependent diabetes mellitus (NIDDM) usually suffer from a less severe illness, which has a slower onset and is most common in the older age groups (older than forty years). People with NIDDM, however, may suffer from the same long-term complications as those with IDDM, such as retinopathy, nephropathy, neuropathy, and ischemic heart disease. In this review we will focus on these two types of diabetes and will largely consider their epidemiology separately.

With regard to diabetes incidence by sex, IDDM appears to be about equal in males and females (Rewers and others 1988), but NIDDM may be more frequent in females. A third type of diabetes, now frequently called malnutrition-related diabetes mellitus (MRDM), has been reported from many developing countries. The patients are usually young and have a history of nutritional deficiency. This disease is believed to be clinically distinct, and therefore the separate grouping has been proposed (WHO 1985). It has been extensively reviewed (Abu-Bakare and others 1986), but the incidence rate of MRDM is still largely unknown. Although the etiology is not understood, it is possibly caused by toxins in cassava, other food toxins, or protein-energy malnutrition. The case management is similar to that for IDDM. We will not consider this form of diabetes separately here because there is inadequate epidemiological evidence and the subject clearly needs further research.

Some healthy individuals have lesser degrees of tolerance to glucose, and when challenged with a dose of 75 grams of glucose taken by mouth (WHO 1985) they cannot be classified as diabetics, but they are, nevertheless, at increased risk of coronary heart and peripheral and cerebrovascular diseases. About one-third of these individuals with impaired glucose tolerance will revert spontaneously to a normal state but, as a group, people with impaired tolerance are at higher risk of subsequently developing diabetes mellitus and are believed to make a significant contribution to total mortality (Bennett 1985; Grabauskas 1988).

Gestational diabetes usually presents as NIDDM and only rarely is insulin required. There is poor epidemiological data on this condition in developing countries, and, although its importance is not denied, criteria for its diagnosis remain controversial ("Glucose Tolerance in Pregnancy" 1988).

The classification of diabetes into three main types and the criteria for diagnosing impaired glucose tolerance have gained wide acceptance only during the past five to ten years. This causes considerable difficulty in interpreting much of the older published literature and in comparing newer with older data. The new internationally accepted criteria for diagnosing diabetes and impaired glucose tolerance are shown in appendix 22A.

The Significance of Diabetes to Public Health

Before considering the distribution and time trends for diabetes in various parts of the world, it is important to understand the problems encountered in interpreting the available information, particularly that on incidence.

Limitations of the Morbidity and Mortality Information

The diagnosis of new cases of diabetes depends both on clinical symptoms and signs and on the detection of an elevated blood glucose level, or, where this is not possible, on the persistent presence of glucose in the urine and a satisfactory response to the appropriate treatment. The detection and reporting of new cases, therefore, depends heavily on the availability and use of health services, or on the results of large-scale population-based surveys. Access to, and use of, health facilities is poor in many developing countries, and so the reported figures for the frequency of cases (both for incidence and prevalence) of IDDM and NIDDM must be highly suspect. The results of many of the older surveys are also suspect because of the use of non-standardized diagnostic criteria, different screening methods, and inadequate sample sizes. Such surveys were undertaken before the present classification and diagnostic criteria were internationally accepted. This cautionary note is equally if not more important for mortality data. The International Classification of Disease (ICD) statistics, now used by most national death registration and certification systems, is based on naming the "underlying" pathological process, but the ICD data do not distinguish between the epidemiologically different forms of diabetes (that is, between IDDM and NIDDM). Moreover, it is well recognized that in most developing countries the registration of deaths is grossly inadequate, and even the certification of the pathological causes of the registered deaths is often incorrect. In addition, diabetes mellitus is frequently not included by the certifying doctor on death certificates, and coding rules preferentially select cardiovascular diseases and cancers in favor of diabetes (WHO 1985). Studies in the United Kingdom and the United States suggest that up to 75 percent of diabetics may not be counted in the internationally published mortality data (Fuller and others 1983). This situation has led to the following crude, but general, rule. In populations in which diabetes is relatively common, there is probably another case of undiagnosed NIDDM for every one or two diagnosed diabetics in the community.

When interpreting information on the frequency of a chronic and irreversible disease such as diabetes, it is crucial to be clear what the incidence and prevalence estimates may mean. For example, IDDM is a relatively rare disease with regard to incidence, but the prevalence rate can reach 0.5 percent, or 1 in 200 people, because of the long duration of survival with good case management and medical care. Therefore, as the case management for individual cases improves in developing countries, the prevalence rates may rise without any significant change in the real incidence. This has implications in the assessment of alternative strategies for addressing IDDM. Where the incidence is low the costs per new case averted by a preventive strategy may seem relatively high. With regard to case management, however, IDDM may become a relatively common disease, and the cumulative costs per diabetic treated are considerable; thus, substantial savings on treatment could result from an effective preventive strategy. It is, therefore, important to take account not only of control costs but also of treatment savings when assessing preventive strategies. Since the duration of survival varies, it is important when making comparisons of the cost-effectiveness of treating chronic diseases such as IDDM to standardize for illness duration, by using a unit such as cost per year of life saved.

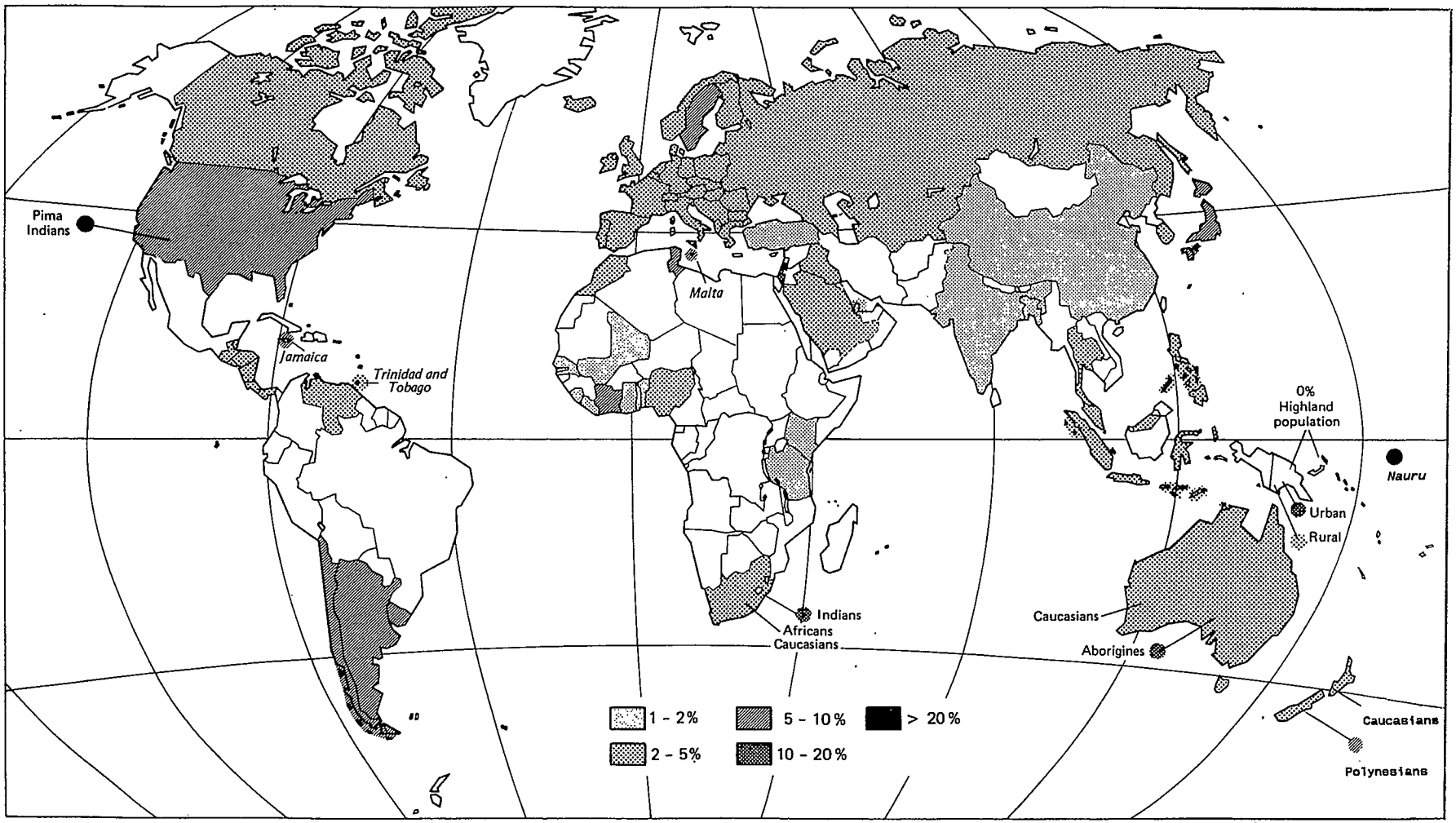
In general, industrial countries have good information on the epidemiology of IDDM and NIDDM, but for many developing countries the national data are very scanty or do not exist. This is well illustrated by map 22-1, which represents data collected by the World Health Organization up to the early 1980s (WHO 1985) and shows unrealistic and low prevelance levels for many areas, especially in Latin America and Africa.

Current Trends for Insulin-Dependent Diabetes

There is considerable discussion about the etiology of IDDM, but it is clear that both genetic and environmental factors are involved (Krolewski and others 1987). Studies of identical twins show an overall concordance rate for developing diabetes of over 50 percent, rising to about 70 percent if certain genetic markers are also included. These rates contrast with the fact that 85 percent of newly diagnosed diabetics have no close relative with the same condition (Bennett 1985). Other evidence also suggests that although the clinical onset is acute and severe, there is probably a long latent period before the illness becomes apparent (Tarn and others 1988).

The incidence of new cases of IDDM has been found to vary considerably with the seasons, more new cases presenting during the winter months (DERI 1988). This variation has been linked to the possibility that IDDM may be caused by a viral infection, but a number of extensive reviews have concluded that, apart from a few instances, no good epidemiological evidence exists for this hypothesis (Gamble 1980; Barratt-Connor 1985). It should also be remembered, however, that a viral infection occurring early in a person's life may not be detected and hence not associated with the later onset of IDDM.

Map 22-1. Prevalence of Diabetes Mellitus in Some Countries



Note: The rates shown include both NIDDM and IDDM, though the latter represents a small proportion of the total. Rates are derived from many sources, principally national and regional surveys but also hospital statistics in some developing countries. In most cases WHO standardized diagnostic criteria have not been used.

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In addition, the incidence of IDDM does not appear to have fallen with the much wider use of childhood vaccines. On the basis that an infective process may be involved in triggering off the onset of diabetes, it has been suggested that large-scale immunization may even lead to an increase in IDDM in developing countries (King 1987).

The incidence of IDDM appears to vary greatly between different ethnic groups, being commonest in white people and in the northern temperate zone. Indeed, there may be as much as a tenfold increase in incidence rates from southern Europe to Finland, which has one of the highest rates worldwide, and there is a thirty-four-fold difference in the childhood incidence of the disease between the highest in Finland and Japan (DERI 1987). The Finnish incidence of diabetes in children between the ages of zero to fourteen (in which about half of the new IDDM cases would be expected to occur) is estimated at 29 per 100,000 persons per year. Assuming an average duration of survival of fifteen to twenty years, the prevalence of IDDM in Finland in the total population would be about 0.5 percent.

In many developing countries, particularly in Africa, IDDM is considered to be a rare disease, but no reliable estimates are available. If, for the sake of illustration, we assume an incidence rate for a developing country of between 1 and 5 new cases per 100,000 children age zero to fourteen years per year (and that those children are 40 percent of the developing country population), we might expect between 4 and 20 new cases of IDDM per year in children in a population of 1 million people, or approximately twice this number (that is, 10 to 40 new cases) among all age groups per year. Assuming an average duration of survival for IDDM cases in developing countries of five years, we might expect the population prevalence to be 0.005 to 0.02 percent. Even at such low prevalence levels the widespread lack of diagnostic and treatment facilities could lead to a high case-fatality rate within the year following the onset of the disease. Moreover, a high case-fatality rate means that even if the incidence rate were higher than predicted the disease would appear to be very uncommon.

Limited contact with the health system, scarcity of specialist staff, and the lack of regular supplies of insulin and the necessary equipment are bound to lower the prognosis for patients with IDDM in developing countries. A report from a specialist clinic at a large teaching hospital in a capital city in Sub-Saharan Africa put the case-fatality rate at 30 to 40 percent during the first four to six years following diagnosis (Lutalo and Mabonga 1985). Even with appropriate care, patients undergoing insulin therapy may suffer from hypo- (low) or hyperglycemia (elevated blood glucose). They are also especially vulnerable to the potential complications resulting from injections—such as sepsis, hepatitis, and acquired immunodeficiency syndrome (AIDS)—if they do not strictly adhere to sterilization procedures. Education programs need to stress the importance of preventing or immediately combating such problems.

There is an unresolved question about whether the incidence of IDDM is stable or rising, particularly in Europe and the United States. Although incidence appears to be relatively steady, there is some evidence to suggest that recently it has been rising, particularly in Finland (Reunanen and others 1982), Scotland (Patterson and others 1983), and Poland (Rewers and others 1987). The authors of another analysis of standardized epidemiological data from sixteen population-based IDDM case registries (all in industrial countries) have concluded that there has been a linear increase in incidence during the past two decades in Europe and the western Pacific but not in North America (Diabetes Epidemiology Research International [DERI] 1990). The situation in developing countries is inconclusive because of the very poor data base. Even if the incidence is rising, IDDM is still, in general, considered to be a rare disease in most developing countries.

Current Trends for Non-Insulin-Dependent Diabetes

When considering the balance between genetic and environmental factors in the etiology of NIDDM, we find that the evidence for a genetic susceptibility appears in some ways to be stronger than that for IDDM. The concordance rate in identical twins is higher for NIDDM, but so far no genetic markers have been discovered. There is good evidence that the incidence of NIDDM does vary considerably between different ethnic and racial groups, such as Indians and Chinese (Zimmet 1982). It is also generally agreed that the prevalence (and probably incidence) of NIDDM can rise in the relatively short period of one to two decades as more people, such as the population of Nauru (Schooneveldt and others 1988) and Australian aborigines (Cameron, Moffitt, and Williams 1986), become urbanized and "westernized." Studies have shown that increased food intake, obesity, and lack of exercise can all be associated with NIDDM. Considerable discussion still exists, however, as to whether these are causal factors operating in susceptible individuals or ethnic groups and whether reversing these trends in populations would lead to a reduction in the incidence of NIDDM.

Eighty-five to 90 percent of all diabetics in industrial countries suffer from NIDDM, and the rapid rise in the prevalence of diabetes in the United States from just under 1 percent of the general population in 1960 to over 2.5 percent by the late 1970s was largely due to an increase in NIDDM (Zimmet 1982). Although some of this increase may have been the result of improved diagnosis and prognosis, there is good evidence that the incidence of NIDDM has also risen. In 1936 the incidence of diabetes in the United States was reported as 5 per 10,000 population per year and by 1973 it was 29.7 per 10,000, a sixfold increase. Worldwide, the most spectacular rise in the incidence of NIDDM has been clearly documented in the Pima Indians of North America (Godhes 1986) and in certain Melanesian, Micronesian, and Polynesian island populations in the Pacific (King and others 1984; King and Zimmet 1988).

Such data from "special" populations has strengthened the belief that genetic susceptibility to NIDDM is unmasked as such people undergo urbanization and modernization (Zimmet 1982; Zimmet and others 1986). For example, studies comparing Indian immigrants and indigenous people living in coun-

tries as diverse as Fiji (Zimmet 1982), Singapore (Cheah and Tan 1979), South Africa (Marine and others 1969), and Trinidad and Tobago (Poon-King and others 1968) have shown prevalence rates for diabetes in Indians of 14.0, 6.1, 10.4, and 4.5 percent, respectively, all of which were higher rates than for the indigenous peoples. Both forms of diabetes were previously thought to be uncommon in India, but a recent survey of known diabetics showed a higher prevalence among residents in a wealthy suburb of Delhi than in Indians living in London. The crude prevalence of diabetes in Delhi was found to be 3.1 percent, and as many as 16 percent were being treated with insulin (Mather and Keen 1985; Mather and others 1987). Another community-based survey in Coventry, United Kingdom, found age-adjusted prevalence rates for diabetes of 11.2 percent in Asian men and 8.9 percent in Asian women in contrast to 2.8 percent and 4.3 percent in white men and women, respectively. The difference was not explained by differences in body mass (Simmons and others 1989).

A rise in the prevalence of NIDDM has been fairly widely reported from other migrant groups. For instance, diabetes was thought to be uncommon in mainland China (Shanghai Diabetes Research Cooperative Group 1980), but surveys in Singaporean Chinese revealed that prevalence had risen from 1.6 percent in 1975 to 4.0 percent ten years later (Thai and others 1987). A survey of people age forty years and older in urban and rural Taiwan (China), carried out during 1985–86, revealed age-adjusted prevalence rates of 7.6 percent and 4.7 percent, respectively, and by 1984, diabetes, mainly NIDDM, ranked fifth as a cause of death in Taipei, Taiwan (Tong-Yuan Tai and others 1987). Two other recent surveys are worth noting because they demonstrated surprisingly high prevalence rates. In a rural population in Saudi Arabia a crude prevalence for all ages and both sexes of 4.3 percent was found, but the proportion rose to 13.4 percent for both sexes age fifty-five years or older and to 18.7 percent for the females in this group (Fatani and others 1987). In Tunisia, surveys of an urban and a rural population showed the age-standardized rate to be twice as high or higher in the urban population (4.6 percent as opposed to 2.3 percent in men and 3.5 percent in contrast to 0.6 percent in women). Within the urban sample the prevalence rate was similar for those people born in the urban area as compared with those born elsewhere in the country (Papoz and others 1988).

Some evidence from Sub-Saharan Africa suggests that NIDDM may be increasing in some urban populations. For instance, in a report from a chronic disease register compiled in Zimbabwe it was shown that diabetes was responsible for 12.4 percent of the cases (Lutalo and Mabonga 1985), and in population-based estimates from Tanzania the prevalence in adults was between 0.2 percent and 1.1 percent (Ahren and Corrigan 1985; McLarty and others 1989). Such estimates, however, contrast with a report from rural Nigeria, where no one with diabetes was found in a survey of more than 1,300 villagers (Teuscher and others 1987).

The authors of a most useful review of the world situation on trends in the incidence and prevalence of NIDDM conclude that the information available for Africa and Latin America is incomplete and that very little up-to-date information is available in which the new international guidelines for the diagnosis of NIDDM have been used (King and Zimmet 1988). Most of the available information is for prevalence estimates, and very little data exists on incidence. The information for Latin America is sparse and poorly standardized (Seneday and Masti 1987).

Economic Costs of Diabetes

Using epidemiological and financial data, the economic costs of an illness to society can be calculated by its indirect and direct costs. The former reflect the cost of morbidity and mortality to the community as a whole, and the latter, the costs to the health sector of prevention, diagnosis, and treatment.

Unfortunately, virtually no published economic study has differentiated between the two forms of diabetes. The few studies of the economic burden that are available assess indirect costs with respect to lost production. Only one study for a developing economy has been found (Guam). A review of studies in industrial countries, however, can point to the potential burden diabetes may represent for developing countries and the potential benefits to be gained from prevention and case management programs. In table 22-1 we summarize the main studies that are currently available. These studies inevitably suffer from the weaknesses of the epidemiological and economic data on which they are based and the fact that IDDM and NIDDM are combined as one disease in the analysis.

Two particular problems with using estimates from industrial countries and projecting them for developing countries are that it is unclear what level of disability or death results from illnesses to which diabetes contributes and what the likelihood is that either IDDM or NIDDM patients will develop complications. In general, the only apparent pattern is that the longer a patient survives with either form of diabetes, the more likely it is that such complications will develop (WHO 1985). A WHO study group reports that in industrial countries diabetic kidney disease, for example, is present in one in six diabetics and directly causes or contributes to premature death in 50 percent of those in whom IDDM began in youth (WHO 1985). Nearly all IDDM patients and many NIDDM patients will eventually develop some form of eye disease, but only some of them appear to be at risk of developing the severe life-threatening complications. The risk of coronary heart disease is two to three times higher in both IDDM and NIDDM patients older than forty years in industrial countries. In these countries the outlook for stabilized IDDM patients is good and there is some evidence that good control of the disease can delay (and may even prevent) the onset of long-term pathological complications (WHO 1985; Ward 1988). Indeed, after stabilization, patients with diabetes in industrial countries may live for fifteen or more years before the onset of complications—although life expectancy is generally reduced by up to one-third (WHO 1985). This is true for nephropathy and probably also for the other complications of diabetes, and individual

Table 22-1. Studies on the Economic Burden of Diabetes

Country	Year	Total economic burden	Indirect/direct cost (percent of total cost)	Source
Guam	1976	US$3 million	80/20[a]	Kuberski and Bennet 1979
Sweden	1979	1,317 million Skr	57/43	Jonsson 1983
United Kingdom	1979–80	£144.3 million[b]	42/58	Laing 1981
United States	1969	US$2.6 billion	62/38	SBMLIC c
United States	1973	US$4.0 billion	59/41	SBMLIC c
United States	1975	US$5.3 billion	53/47	SBMLIC[c]
United States	1979	US$15.7 billion	64/36	Platt and Sudovar[d]
United States	1980	US$9.7 billion	51/49	SBMLIC c
United States	1984	US$13.8 billion	46/54	SBMLIC c
United States	1987	US$20.4 billion	53/47	American Diabetes Association 1988

a. Approximate.
b. Excludes cost of 64,047 years lost through premature death.
c. Statistical Bureau of the Metropolitan Life Insurance Company. Discussed in Songer, in press.
d. Discussed in Songer, in press.
Source: See last column.

susceptibility interacts with levels of diabetes control to determine the tissue response, rate of damage, and ultimate severity in the organ concerned. Early recognition and treatment of retinopathy and foot problems, for example, can reduce disability and prolong life. Correction of hypertension and hyperlipidemia are also important to prolong survival.

INDIRECT COSTS. The broad trends shown by the studies suggest that indirect costs are of decreasing importance within the overall economic burden of diabetes (for example, in the United States they fell from about 62 percent in 1969 to 46 percent in 1984). In most studies indirect costs are dominated by the cost of the disability caused by the disease, although the most recent U.S. study (American Diabetes Association 1988) suggests that mortality costs are more important. This finding, however, probably results from the inclusion in the study of deaths in which diabetes was a contributory cause rather than only those deaths directly due to the disease. Unfortunately this study did not also consider the potentially important costs of disability in which diabetes was a contributory factor, instead focusing only on the costs of disability directly caused by diabetes. Taken together, the total of these disability costs would probably exceed mortality costs and dominate indirect costs, even in this study.

The only figures from developing economies that shed light on indirect costs are those reported from Guam (Kuberski and Bennet 1979) and Ghana (Ghana Health Assessment Project Team 1981). Of the total costs attributable to diabetes in Guam, about 80 percent were indirect costs, but it is not clear whether mortality or morbidity costs were dominant. In Ghana, the average age at onset of the disease was estimated to be forty years (suggesting that only NIDDM was considered), with a 50 percent case-fatality rate after fifteen years (average age at death being fifty-five) and 30 percent disablement before death. The total days of life lost were calculated as 217 per 1,000 persons per year; 52 percent of these days were lost because of premature death. This picture of the balance of indirect costs differs from that in most industrial country studies, in which morbidity costs are dominant. The difference may reflect the younger average age at death of diabetics in Ghana; many of the deaths could occur before the onset of complications and other disabilities. It may also reflect technical differences between the studies: the monetary valuation of the costs in industrial country studies and the use of undiscounted days of life lost in the Ghana study.

Overall it is difficult to suggest the likely level of the indirect costs associated with diabetes in developing countries because of poor epidemiological data and the failure to separate the two forms of the disease in the available cost data. Indirect costs will also depend on the level and quality of the health care available. Because IDDM is a rarer disease worldwide, it might be expected that NIDDM would dominate the indirect costs attributable to diabetes in developing countries. The former disease, however, occurs in younger age groups and is likely to cause death, so years of life lost as a result of the disease may be substantial even though it is an uncommon disease. In contrast, NIDDM is more common, occurs in older people, and is less likely to cause death if untreated; but it may lead to substantial disability as a result of the complications associated with diabetes. As the prevalence of NIDDM rises and the age of onset falls (as some evidence appears to indicate is likely), these disability costs will increase. Both forms of diabetes, therefore, have serious but not directly comparable consequences with regard to indirect costs.

DIRECT COSTS. Only Kuberski and Bennet (1979), in their study in Guam, discuss the direct costs of diabetes in developing economies. Direct hospital costs alone exceeded $600,000 in 1976, including 5,352 disability days from 435 patients admitted to the hospital (an average of 12.3 days per person admitted).[1] These costs, however, will probably not be representative of all developing economies but will reflect the

relatively high level of care offered within Guam's health system.

Simlarly, the evidence of direct costs from industrial countries reflects their more sophisticated health systems and so cannot be directly transferred to situations in developing countries. Industrial country studies do, however, indicate the main influences on these costs and may suggest future cost levels for developing countries.

The studies that are available show that the cost of diabetes treatment programs is substantial and is increasing in industrial countries (for example, rising from $1.65 billion in the United States in 1973 to $7.4 billion in 1984). This trend reflects the inflation of medical care prices, the increased prevalence of diabetes, the increased use of medical care among diabetics, and the development of new treatment technologies (Songer, in press). Direct costs are now equally important to, if not more important than, indirect costs within the overall economic burden of the disease. A high portion of direct costs (usually not estimated) are likely to be the result of the complications of, and illnesses associated with, diabetes rather than of diabetes itself. Indeed, one study demonstrated that patients with chronic complications of diabetes incurred health care costs fourteen times as high as diabetic patients without any record of complications (Gambert and others 1988). Prevention and case management programs, therefore, have the potential both to reduce the indirect costs of the disease and to reduce the costs of caring for complications. Still, the cost of such programs is itself dependent on the nature of the strategy adopted, and careful consideration of the cost and effectiveness of treatment options is important in seeking to contain costs. Songer (in press) suggests, for example, that economic evaluations techniques should be used in evaluating screening programs, insulin treatment programs (multiple as opposed to single injections as opposed to insulin pump therapy), complications treatment programs (laser surgery, dialysis, transplants, and so on), and home blood glucose monitoring programs.

In most developing countries the existing level of direct costs associated with diabetes is likely to be low. Although the true incidence of IDDM is not known, it is clear that many such patients probably do not survive long after the onset of illness and so do not obtain medical care. Those people with diabetes who do survive receive only such care as is available, which for many of these countries will be limited, leading to high case fatality in the first few years following diagnosis. The costs in Guam may suggest the upper end of the cost range for developing economies, and the lower end is probably suggested by the hypothetical costing for diabetes case management presented later in the chapter.

Lowering or Postponing Diabetes Incidence

A reduction in the incidence of new cases of diabetes will only be achieved by primary prevention strategies, whereas the incidence of diabetes complications may be reduced by improvements in case management and through earlier case detection.

Primary Prevention

Beliefs concerning the cause or causes of diabetes have recently moved away from genetic and immunological explanations to a much greater emphasis on environmental factors, thus increasing the relevance of primary preventive strategies. An eminent international study group claimed in 1987 "that at least 60 percent of IDDM worldwide, and perhaps over 95 percent, is environmentally determined and thus potentially avoidable" (DERI 1987). Even if this is true, however, the causal factors in the environment have not been clearly defined, and although it may be possible to identify some high-risk individuals, the costs and technical difficulties would prohibit this option, even in most industrial countries (Zimmet 1987). As a consequence, it is not possible to make specific recommendations for the prevention of IDDM in industrial, let alone developing, countries, and given the apparently low incidence rates in the latter, a preventive strategy would not appear to be a high priority for them. A far greater priority for diabetes in developing countries lies with further international collaborative research to establish the true incidence and the determinants of IDDM through the use of population-based studies. Although diabetes has been studied using such registers in numerous industrial countries, no successful such register yet exists in Africa or Latin America (DERI 1987).

At present there are also no proven intervention strategies that reduce the incidence of NIDDM. Still, many authorities believe there is now sufficient evidence that experimental community or population intervention studies should be made of lowered dietary intake of carbohydrates (including reductions in fat and sugar intakes), reduced obesity, and increased physical exercise and activity (Zimmet 1987). Considerable attention would have to be given to establishing sound methods for measuring both the successful implementation of the interventions and for evaluating the possible changes in incidence of NIDDM over time.

The links between diabetes, coronary heart disease, hypertension, and other noncommunicable diseases have led the World Health Organization to propose an integrated program for the prevention and control of noncommunicable diseases (for example, by stressing good nutrition, avoidance of obesity, increased physical activity, and reductions in smoking and alcohol consumption). A parallel has been drawn with intervention projects for coronary heart disease (WHO 1985; Zimmet and others 1986). Because no specific and modifiable causes are known to account clearly for the rise in diabetes, a broad strategy that tackles a wider range of emerging health problems makes sense for many developing countries. The strategy would need to rely heavily on modifying individual human behavior, improvements in the health services, mass health education, and government regulation and legislation.

Costs and Consequences of Preventing Diabetes

In assessing whether or not to undertake a primary preventive strategy for diabetes, it is useful to consider the possible costs

and consequences of such a program. Both costs and consequences will be influenced by the nature of the preventive strategy adopted. In particular, costs are influenced by the scale of the educational program (and by the nature of other preventive activities); the consequences, by the effectiveness of potential educational strategies.

Given the existing inadequacy of the epidemiological understanding of IDDM, such a preventive strategy is currently only a possibility for NIDDM. Prevention of NIDDM would involve mass health education in order to change the behavioral patterns that increase the risk of diabetes. Unfortunately, little is known about either the costs or the effectiveness of such education programs. Phillips, Feachem, and Mills (1987) report that the total costs of mass media campaigns have varied substantially—from less than $20,000 for a Kenyan childcare program to more than $500,000 for programs involving foreign expertise, careful audience research, and prime-time broadcasting (for example, the Tanzanian "Man Is Health" program costs about $600,000). It would appear difficult to justify similar programs for diabetes alone, because the relatively low incidence results in a small potential target population and so would generate high costs per capita of this population. The promotion of healthy lifestyles through mass media programs aimed at the entire population would be more justifiable and would, in part, seek to prevent the development of diabetes. On the basis of Phillips, Feachem, and Mills's hypothetical costings for five possible education programs (varying from cheap to "luxury"), the cost per capita might be between $0.04 and $0.96 for a population of 500,000, or between $0.02 and $0.54 for a population of 1 million.

A number of factors clearly influence the effectiveness of such programs—in particular, their coverage and the subsequent use of their messages by the general or targeted population. The author of a review of fifteen mass media health and nutrition projects in developing countries concluded that although mass media programs can quickly reach large numbers of people and up to half of those reached by the message remember it in the short term, there is only limited evidence that people actually adopt new behavioral patterns (Leslie 1987). Other studies (for example, Foote 1985 on the promotion of oral rehydration therapy in the Gambia) present a more optimistic picture of the influence of broad educational programs on some health-related behavioral patterns. The success of programs aimed at the control of cardiovascular disease and hypertension in a number of industrial countries may suggest that changes in lifestyle can be effective means of preventing noncommunicable diseases, including diabetes. Yet studies have not clearly shown that patient knowledge and patient behavior in diabetes care are correlated (Marquis and Ware 1979). In general, the evidence on the effectiveness of educational programs remains limited and contradictory, and the costs per case prevented of such programs are at present impossible to evaluate.

Alternatively, or in conjunction with healthy lifestyle promotion, educational messages could be targeted at the groups known to be at high risk of developing NIDDM. Zimmet (1987), however, suggests that a population strategy is preferable for primary prevention purposes because a high-risk strategy would affect only a small proportion of all people who would subsequently develop diabetes. Targeting educational messages at specific people might, however, reduce costs and improve effectiveness (by permitting more precise messages to be delivered). Such a high-risk strategy might also go hand-in-hand with a screening program for these vulnerable groups. The World Health Organization (WHO 1985) suggests that screening programs provide the opportunity for creating public awareness and educating health professionals. Target groups should include those at high risk of glucose intolerance (for example, the obese) and those in whom even mild glucose intolerance might be a risk factor (for example, pregnant women). The costs and effectiveness of these programs are not currently known but will be influenced by the sensitivity and specificity of screening methods, the definition and size of target populations, and the level of care provided for those found to have diabetes.

The potential negative consequences of a preventive strategy that are suggested in table 22-2 could be forestalled by greater investment in existing health services, but in the short term such investment is rarely forthcoming in developing countries. It is, therefore, important to consider the total amount of resources that can be harnessed to provide health care in developing countries, how these resources should be allocated among the health needs of a country, and how to allocate responsibilities for the provision of health care among different providers. This approach will ensure more efficient use of currently available resources and will provide the basis for efficient use of investment funds available in the long term.

Table 22-2. Costs and Consequences of Undertaking a Preventive Diabetes Strategy

Bearer of costs	*Examples*	*Consequences*
Government	Education program, required strengthening of health infrastructure, screening program	Reduction in morbidity and mortality from diabetes and its complications; indirect and direct cost savings
Household	Increased visits, more medications, better diet	Household savings (for example, reduced time and monetary costs because less treatment and less loss of earnings)

Note: In addition, positive spin-offs include reduction in associated diseases, leading to indirect and direct cost savings (such as improved general knowledge and behavior). Negative spin-offs include lower quantity and quality of care for other conditions because of emphasis on diabetes.
Source: Authors.

Case Management

The case management of IDDM and NIDDM are very different and are, therefore, considered separately here.

Insulin-Dependent Patients

Case management varies between IDDM and NIDDM. For IDDM, the main requirements are the establishment of the diagnosis, stabilization of patients on daily insulin therapy, and the training of these patients to inject their own insulin and to monitor their own control on a regular basis. Patients using insulin must also lower their dietary carbohydrates and sugar intake, eat regular meals, and increase their physical activity. Good control of diabetes requires the regular monitoring of blood glucose or urinary glucose levels, or both, and the early detection of the long-term clinical complications. Because of the high incidence of diabetic complications, it is essential to maintain good case follow-up and monitoring procedures for all patients with diabetes. This follow-up can be the responsibility of primary-level care but shared appropriately with secondary and tertiary levels.

It is important to point out that insulin has been available for the treatment of diabetes for more than fifty years and that it is a highly effective treatment in saving and prolonging the lives of patients with IDDM. It is ironical, therefore, that the control of IDDM can be so difficult for patients and health workers in many developing countries (Serantes 1985). In particular, the regular supply of a suitable insulin preparation and appropriate syringes may be difficult to ensure, despite their obvious importance to survival (WHO 1985). Most of the world's insulin is produced by a few manufacturers based in industrial countries, and although there is a move to standardize both the insulin (to 100 international units per milliliter) and the syringe, there are many different strengths and types available (Bloom 1985; WHO 1985). In addition, insulin is a biological product with a limited storage life that requires appropriate cold-chain conditions. It is also an expensive drug, which is not available through the United Nations Children's Fund (UNIPAC) in Copenhagen, although it is included in the World Health Organization's list of essential drugs (WHO 1988). Because insulin availability is such a problem in many developing countries, particularly in Africa, the International Diabetes Federation has been organizing the collection and international transportation of unwanted insulin vials (IDF 1987).

Non-Insulin-Dependent Patients

People with NIDDM suffer from a less severe illness day to day and so, if the necessary equipment and specialist advice is available, can largely be cared for by general medical practitioners and trained nurses in industrial countries (Howe and Walford 1984; Burrows and others 1987). Because of the insidious onset of NIDDM, patients are commonly diagnosed only incidentally by screening procedures, such as the testing of a urine sample for glucose, or during the investigation of another illness or diabetic complication. Once diagnosed, most NIDDM patients can be stabilized as outpatients and do not require more than brief treatment with insulin. Their blood glucose or urine glucose needs to be monitored less frequently than that of IDDM patients, and they often respond well, at least initially, to a modified diet, weight reduction, and increased exercise and physical activity.

Only if these methods fail are drugs that lower oral blood glucose (hypoglycemic drugs) required. Such drugs have been available for the treatment of NIDDM for nearly thirty years. Data from a twenty-two-year analysis (1964–86) of the use of such drugs in the United States showed that chlorpropamide (a sulfonylurea) was then the most widely used, two new preparations introduced in 1984 gaining 41 percent of the market by 1986. Patients age sixty years and older received oral hypoglycemic drug prescriptions at the rate of 478 per 1,000 visits in 1986, and 35 percent of all diabetic patients were taking such drugs (Kennedy and others 1988). The inadequacy of primary-level services, poor dietary and general advice, and the lack of patient supervision in developing countries is likely to result in greater use of these drugs. For instance, evidence from a number of Pacific countries suggested that about 80 percent of NIDDM patients were using oral hypoglycemic drugs (South Pacific Commission 1978). If oral hypoglycemic drugs fail to control the diabetes, insulin is required and is costly for the health services and for patients. In industrial countries the number of NIDDM patients who finally require insulin therapy may be more than the number of IDDM patients regularly using insulin.

It appears, therefore, that providing adequate case management in developing countries is a much more feasible option for NIDDM than IDDM patients, particularly if planned primary-level health care strategies are adopted. It is important to note, however, that even though patients are classified as IDDM and NIDDM, insulin is important in the treatment of both groups.

Costs and Consequences of Diabetes Case Management

The case management strategies presented in the previous two sections have implications for the care ideally available at all levels of the health care system. The World Health Organization (1985) recommends that at the primary level the components of diabetes care offered should include self-care, home care, basic care, screening for complications, and health education (WHO 1985). Support for families should be provided by a primary care physician, a nurse, and other health professionals. Health workers must know the diagnostic, therapeutic, and preventive aspects of care. A list of essential items required for IDDM and NIDDM management, as recommended by the World Health Organization, is shown in table 22A-3. Referral from the primary level to the secondary or tertiary level will be necessary when specialized assistance is required in the management of the disease or its complications. Laboratory services will also be needed. At the tertiary level special clinics should be organized to provide diagnostic and management skills for

Table 22-3. Costs and Consequences of Diabetes Case Management Strategies

Bearer of costs	*Examples*	*Consequences*
Government	Case management (diagnosis, monitoring, treatment), patient education	Reduction in morbidity and mortality from diabetes and its complications as result of improved treatment; indirect and direct cost savings
Household	Increased visits, more medications, better diet	Household savings of time and money from improved treatment

Note: In addition, positive spin-offs include strengthened health services. Negative spin-offs include clinical side effects (for example, AIDS and hepatitis, effects of inappropriate use of hypoglycemic drugs and insulin), impact on existing health services.
Source: Authors.

the treatment of diabetic retinopathy, end-stage renal disease, and vascular disease.

Case management must include a patient-oriented educational strategy, focusing on face-to-face education of known diabetic patients concerning the dietary and behavioral changes necessary to maintain optimal metabolic control and to prevent and reduce the severity of diabetic complications.

As with preventive strategies, it is useful in decisionmaking to outline the costs and consequences of case management strategies (see table 22-3). Given the potentially large costs and unknown effectiveness of preventive strategies, the first option should be for improved case management. Developing countries will need to improve case management to ensure appropriate and cost-effective care and to reduce the likelihood of acute and chronic complications.

In broad terms, diabetes management aims to preserve the life of the diabetic patient, to relieve the symptoms of the disease, and to avoid its associated complications. The studies of direct costs indicate that there is substantial variation between countries in the treatment patterns adopted and that these differences also influence costs. The technology used is an especially important influence, and the trend toward more expensive care within industrial countries is one that developing countries can ill afford. Developing countries must assess the cost-effectiveness of standard case management practices. For example, the authors of a study in the United Kingdom stress the need for a structured clinic recall system for diabetics in order to improve clinical surveillance (Burrows and others 1987). There is, however, considerable uncertainty about appropriate practices—some patients are monitored frequently and others infrequently. In another study in the United Kingdom, Jones and Hedley (1986) showed that if follow-up times were increased by 30 percent (for example, from six to eight months) an additional 2,000 known nonattenders could be seen for a cost increase of less than 5 percent of the existing annual cost. Recommended practices must aim to be as cost-effective as possible in order to ensure that best use is made of limited available resources.

More is known about the effectiveness of patient education as a part of case management than the effectiveness of other educational strategies, but the evidence is not conclusive. In one hospital, patient education led to a reduction in occupancy by diabetic patients from 5.6 days per year to 1.4 days (Miller and Goldstein 1972). Similarly, patient education in self-care led to a 78 percent decrease in hyperglycemic coma (Davidson 1983) and a 75 percent decrease in below-knee amputations (Assal and others 1982). In contrast, the long-term (more than one year) effect of nutrition education on weight loss was disappointing (Foreyt and others 1981; Wing and others 1985). Studies show that education provided in the outpatient setting can be effective for diabetes (for example, intensive outpatient education was associated with lowered plasma glucose levels [Mazzuca and others 1986]), but it is also often undermined by attrition rates. A review of such studies showed that in the five in which attrition rates were reported, up to 90 percent of the patients failed to complete the educational program (Kaplan and Davis 1986). This emphasizes the importance of motivation and of linking education to follow-up visits.

The key resource required for such an education program is appropriately trained personnel, although literature, equipment, and facilities are also necessary (WHO 1985). Education can take place in the hospital or in the outpatient setting; unfortunately there is little cost data for either strategy. The authors of a study in Australia in which the outpatient initiation of insulin therapy was assessed showed that this strategy is feasible where the facilities for education about diabetes exist; they also showed that it is safe, achieves satisfactory metabolic control, is acceptable to most patients, and, compared with inpatient care, reduces costs by Aus$1,857 per new patient stabilized (Bruce and others 1987).

In order to estimate the annual costs of treating IDDM and NIDDM patients in a low-income developing country, data from Malawi on inpatient and outpatient costs and from international essential drugs lists (WHO and the nongovernment Dutch organization [IDA]) were used. In the absence of developing country data on hospitalization rates for diabetes patients, the analysis used estimates based on data from the United States. Despite the limitations of the available data, it is clear that the cost of treating IDDM patients will be dominated by their need for insulin and the equipment for its administration, at an estimated cost of $191 per diabetic per year (1987 prices), approximately 90 percent of total costs. The finding reflects the high cost of insulin in developing countries in relation to that of hospitalization, and the relatively low probability of hospitalization. It is more difficult to estimate the costs associated with NIDDM patients, but it seems likely that the biggest cost is for oral hypoglycemic drugs at an estimated $20 per diabetic per year. If we assume no hospitalizations, this represents nearly 90 percent of the total cost per patient.

It is possible that as case management improves and case fatality is reduced, the cost of hospitalizations for complications will rise and eventually dominate the total cost of institutional care for diabetic patients. These rising treatment costs theoretically increase the potential benefits (with respect to cost savings) of primary and secondary preventive strategies and also stress the importance of improved case management of the complications of diabetes to reduction of the direct costs associated with them.

In practice, diabetes case management (and preventive) strategies must balance what is feasible in each developing country situation against the potential benefits. Feasibility is related to the cost of the strategy, to the coverage and quality of care achieved, to the availability of trained health workers in existing health systems, to the pool of available health resources, and to the range of other compelling health needs that exist. For example, although recall systems are a relatively cheap and very cost-effective method of protecting the health of diabetics, existing recall systems (for example, those for tuberculosis patients) often do not function effectively: health staff have too many other "priority activities" to give adequate attention to patient monitoring, and patients either do not understand the benefits of monitoring systems or judge that the costs of regular check-ups outweigh the potential benefits. In addition, record systems are frequently poorly maintained in health facilities, and health cards are not always kept by patients. Remedying this situation requires patient and provider education and additional resources (additional health or clerical personnel, card index systems, and so on).

The broad case management strategy presented here must therefore be adapted to the country-specific situation through consideration of the needs of existing diabetic patients and the level of available resources. Important issues will include whether basic care can be offered at health centers or only at local hospitals on an outpatient basis and whether drugs or insulin can be made widely available, possibly dispensed through the private sector. A growing trend is to recommend district diabetes centers, which can offer routine care and education and ensure the adequacy of supplies and drugs.

In many developing countries, a diabetes case management strategy will be based on primary care facilities, the regular supply of essential drugs and equipment, and the setting of appropriate clinical priorities, such as standard diagnosis and treatment protocols. After these have been achieved, consideration should then be given to the additional resources needed for the development of secondary and tertiary levels of care.

The cost of treating an IDDM patient can be used to estimate the cost per disability-adjusted life-year gained by a case management strategy. A similar estimate is not made for NIDDM patients because of the uncertainty about the number of years of life saved by treatment.

Treatment of an IDDM patient is lifesaving; thus each year's treatment saves a year of life. There is marginal reduction in the quality of life because of the inconvenience of treatment and lifestyle limitations. Assuming that 0.9 of a disability-adjusted year of life is obtained for the $213 annual cost of treatment, then the cost per disability-adjusted life-year gained is $237.

Priorities

In any consideration of future priorities, there is an inevitable trade-off between investing resources in primary prevention and in better management of patients. In addition, there are major equity and ethical questions to be considered.

Priorities for Resource Allocation

Resource allocation plans need to take into account questions of public health policy and equity.

PUBLIC HEALTH CONSIDERATIONS. The current evidence about the public health significance of diabetes worldwide is limited. It would seem that IDDM is numerically the lesser problem, but its recognition and management requires the use of relatively specialized and more costly techniques. By contrast, NIDDM is relatively more common and with changing conditions is of growing significance, particularly in the Pacific, China, Asia, and the Middle East. This is probably also true for Latin American and African countries, although there is less clear evidence for these two continents. In the United States more deaths are attributed to diabetes than to lung cancer, breast cancer, motor vehicle accidents, cirrhosis of the liver, or infant mortality (WHO 1985). Improved case recognition and management is, therefore, important and can be justified for industrial countries simply on the grounds of its potential to reduce both the future indirect (morbidity and mortality) costs of the complications associated with the disease and the future direct costs of caring for patients suffering with such complications. It is also probable that emphasizing the preventive strategy could reduce the costs of the disease and its complications. Given this situation and the changing health patterns of developing countries, it seems clear that the burden of diabetes and the predictable potential costs of the disease for developing countries cannot be ignored as they undergo development.

The position faced by developing countries concerning the broad policy options of primary prevention and case management is as follows:

- In general, primary prevention has the potential to reduce both the indirect and direct costs of diabetes but only at substantial expense
- Primary prevention is not, currently, a realistic option for IDDM
- Primary prevention has more potential for NIDDM, but prevention would need to rely on interventions and educational programs of unknown effectiveness
- In general, case management has the possibility of reducing the potentially large indirect and direct costs of the complications of diabetes, except in its most developed forms, when medical care may be beyond the level affordable by many developing countries
- Only a small number of IDDM patients will require case management, but it will be potentially expensive because

such patients need regular insulin throughout their lives and most patients eventually suffer from at least one complication. Still, because treatment postpones death for many years, it may well be cost-effective in comparison with interventions for some other chronic diseases

- Case management is very important for NIDDM patients and should be based on patient education, behavior modification, and appropriate use of oral hypoglycemic drugs.

The diversity of manifestations of diabetes makes it difficult to suggest universally appropriate policy strategies. Each country needs to determine for itself how it will tackle the potential problems of the disease, within the primary care framework proposed by WHO (1985). In table 22-4 we summarize some policy options for discussion and indicate that the options differ between developing countries as a result of the differing income levels, the differing health infrastructure, and the differing relative significance of diabetes as a health problem. Within policies, the differences between IDDM and NIDDM must also be recognized. In the table we assume the incidence of both forms of diabetes taken together is either high or low. The distributional issues discussed next must also be considered and should feed into policy discussions about how to finance diabetes case management activities and what levels of care can be afforded.

EQUITY CONSIDERATIONS. Considerations of distribution and equity can have an important influence on investment priorities. Discussion of the equity implications of diabetes prevention and case management programs must be based on who suffers from the disease and therefore who will gain from prevention and treatment, as well as on the sources of finance for the programs.

Non-insulin-dependent diabetes mellitus is often characterized as a disease of the rich, because it is clearly associated with environmental changes reflecting increased wealth. Within developing countries, for example, the urbanized population is generally deemed to be more affluent than the rural population and may be more at risk of developing NIDDM. Insulin-dependent diabetes mellitus, however, is less clearly associated with such environmental factors, and so patients suffering from this type of diabetes may be of high or low income. The country-specific situation must obviously be assessed before the relative status of diabetics can be judged.

What would these characterizations suggest about the effect on equity of diabetes prevention and case management programs? One argument might be that late-onset NIDDM patients are not only more wealthy but probably in the productive years of life, possibly in responsible and influential jobs, and that they are an important economic asset which must be protected. It can also be argued that the existing bias of many developing country health systems is already set against lower socioeconomic groups and in favor of wealthier patients and further state expenditure on upper-income groups cannot be justified.

This latter argument does not imply that little or no provision should be made for diabetes but rather that it cannot be viewed as a priority for state health services alone. It might be possible to consider, for example, the provision of drugs and insulin on a means-tested basis in the public sector or on a fee-for-service basis in the private sector. Such a strategy has many practical difficulties, however, and the possible benefits may exceed the costs of implementation. For example, it would promote the development of dual health standards: high-quality private care for the more wealthy diabetics and low-quality or inadequate public care for the less wealthy. This strategy would also probably conflict with ethical considerations. Since insulin has been available for more than fifty years and it is an essential, life-sustaining drug for IDDM patients, many people would consider it unethical to adopt a health policy which fails to guarantee adequate supplies of insulin. This is the implicit policy in many countries, however; because they cannot afford to provide the drug, the way is left open to the private sector to supply unregulated care for those who can afford to pay. Inequities already exist, and countries must consider the effect on them of possible policy changes.

Resolution of distributional problems is not easy, especially when resources are scarce and policy choices often have unwanted consequences. Future health care investments in developing countries, however, must seek to reflect both existing resource constraints and such distributional concerns. The production and distribution of insulin as a life-preserving drug is an important part of the broader considerations involving its usage, such as patient monitoring and health education.

Table 22-4. Policy Options for Control of Diabetes Mellitus

Incidence of DM	*Higher-income developing countries*	*Lower-income developing countries*
Low	Focus on primary and secondary care only, especially face-to-face education of known diabetics Develop standard case management protocols for IDDM and NIDDM Have appropriate drugs available	Do nothing Consider minimum case management requirements
High	Consider tertiary provision Screen high-risk patients Strengthen preventive and case management efforts (for example, through broader education programs) Secure regular supplies of insulin and oral hypoglycemic drugs, and ensure delivery to patients Stimulate epidemiologic, clinical, and laboratory research	Focus on primary and secondary care only, especially for NIDMM Face-to-face education of known diabetics Develop standard protocols Make insulin and oral hypoglycemic drugs available on demand only Form links with international research efforts

Source: Authors.

There is a clear need to bring together the interested parties worldwide, including the manufacturers, the International Diabetes Federation, the World Health Organization, and other international agencies, to develop more effective and acceptable strategies for developing countries.

Priorities for Operational Research

Specific international actions can assist the development of appropriate strategies, and the International Diabetes Federation and the World Health Organization are active in these areas (King and Mitrofanov 1988). For example, there is an urgent need for operational research to find ways of facilitating the purchase of insulin and oral hypoglycemics at reasonable prices (for example, through UNIPAC) and to guarantee their availability in developing countries in order to improve case management strategies and to reduce the cost per case. Moreover, international support for diabetes research is necessary, and more international collaborative research centers are needed in the developing world. Such research should aim to clarify the importance of diabetes and the options available for its prevention and case management. The following are the preliminary research priorities that we have identified in this chapter for national and international action:

- Assessment of the incidence and prevalence of both IDDM and NIDDM in developing countries, particularly in Asia, Sub-Saharan Africa, and Latin America, through a greater support to epidemiological studies
- Large-scale evaluation studies of possible interventions and strategies to prevent NIDDM, including studies of the cost and effectiveness of a broad strategy of noncommunicable disease control
- Assessment of the costs and effectiveness of alternative case management procedures (IDDM/NIDDM)
- Case studies to assess what resources are currently consumed by IDDM and NIDDM
- Operational research to improve the quality of case management within existing health services, such as the development of standard treatment protocols for primary care
- Consideration of appropriate financing mechanisms for expanding the management of diabetes patients, particularly within secondary and tertiary health care facilities.

Appendix 22A. Diagnosis and Self-Care of Diabetes

The tables that follow show the blood glucose levels of both diabetics and nondiabetics and the glucose concentrations they produce during the glucose tolerance test, as well as the equipment essential to self-care for diabetics.

Table 22A-1. Blood Glucose Levels for Diagnosis of Diabetes Mellitus

	DM likely		*DM uncertain*		*DM unlikely*	
Sample	*mmol/l*	*mg/dl*	*mmol/l*	*mg/dl*	*mmol/l*	*mg/dl*
Whole blood						
Venous	> 10.0	> 180	4.4–10.0	80–180	< 4.4	< 80
Capillary	> 11.1	> 200	4.4–11.1	80–200	< 4.4	< 80
Plasma						
Venous	> 11.1	> 200	5.5–11.1	100–200	< 5.5	< 100
Capillary	> 12.2	> 220	5.5–12.2	100–220	< 5.5	< 100

Note: Unstandardized (casual, random) blood glucose values.
Source: WHO 1985.

Table 22A-2. Diagnostic Glucose Concentration Values in the Oral Glucose Tolerance Test
[mmol/l (mg/dl)]

	Diabetes mellitus		*Impaired glucose tolerance*	
Sample	*Fasting*	*Two hours after glucose load*	*Fasting*	*Two hours after glucose load*
Whole blood				
Venous	≥ 6.7 (120)	≥ 10.0 (180)	< 6.7 (<120)	6.7–10.0 (120–180)
Capillary	≥ 6.7 (120)	≥ 11.1 (200)	< 6.7 (< 120)	7.8–11.1 (140–200)
Plasma				
Venous	≥ 7.8 (140)	≥ 11.1 (200)	< 7.8 (< 140)	7.8–11.1 (140–200)
Capillary	≥ 7.8 (140)	≥ 12.2 (200)	< 7.8 (< 140)	8.9–12.2 (160–220)

Note: For epidemiologic or population screening purposes, the two-hour value after 75g oral glucose may be used alone or with the fasting value. The fasting value alone is considered less reliable because true fasting cannot be assured.
Source: WHO 1985.

Table 22A-3. Basic Equipment for Self-Care of Diabetics

Self-management of IDDM	*Self-management of* NIDDM	*Primary health care center*
Urine testing materials for glucose and ketone bodies and/or blood glucose testing materials	Urine testing materials for glucose and ketone bodies and/or blood glucose testing materials	Urine testing materials for glucose and ketone bodies and/or blood glucose testing materials
Book or chart and pencil for recording results	Book or chart and pencil for recording test results and body weight	Book or chart and pencil for recording results
Insulin as prescribed and cool place for storage	Oral hypoglycemic agents, when applicable	Insulin, plus cool place for storage
Syringe, needles, and carrying case	Sugar lumps or other readily absorbed carbohydrates	Syringe and needles
Sterilization facilities		Sterilization facilites
Cotton wool		Cotton wool
Sugar lumps or readily absorbed carbohydrates		Cleansing agent
		Sugar lumps or readily absorbed carbohydrates
		Oral hypoglycemic agents
		Materials for testing the presence of protein in urine
		Weighing machine
		Blood glucose monitors or meters and test-strips
		Glucose for intravenous use (glucagon, if available)
		Simple printed education materials and teaching aids
		Place for storing patients' records

Source: WHO 1985.

Notes

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1. All dollar amounts are current U.S. dollars unless otherwise indicated.

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