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The cost of diabetes and its complications: A Review

by

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A REVIEW

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ABSTRACT

Diabetes mellitus is a disease with major long-term implications, not only for the health and well-being of affected individuals, but also for costs to the National Health Service. Treatment of the disease and its complications takes up 4 to 5 per cent of total health care expenditure in the UK. These costs are dominated by in-patient care for the complications arising from diabetes.

This paper presents a review of studies which have been carried out on the costs of diabetes and its complications. For such a chronic and potentially disabling disease with numerous complications it is surprising that costs have not been more extensively researched. A large amount of data are available about the implications of diabetes in terms of incidence and prevalence, but few costs have been collected, particularly indirect and marginal costs. Moreover, researchers have frequently failed to distinguish between insulin dependent (IDDM) and non-insulin dependent (NIDDM) diabetes, which have different etiologies and, therefore, different costs, and few studies have included diabetes as a secondary diagnosis.

The studies which are available have tended to focus on direct costs, for example, the costs of hospital care, consultations and drugs, because they are the easiest to measure. Fewer studies have included indirect costs, such as the effect of time lost from work, early retirement and premature death, because of the difficulties in assigning monetary values to these factors.

The most important contributors to the costs of diabetes are those of treating complications such as eye and limb disease, heart disease, neuropathy and nephropathy.

Individual studies have assessed methods of treating complications such as end stage renal disease and lower limb problems.

The effect of the disease on patient quality of life has not been assessed, nor have there been cost effectiveness studies of diabetes. New advances in treatment, such as new monitoring methods for home glucose measurements, and laser treatment for neuropathy all have the potential to improve patient quality of life, but have yet to be evaluated.

Primary interventions, for example dietary advice, and education, are inexpensive but are frequently less successful than secondary intervention which is aimed at preventing the development of diabetic complications.

1. INTRODUCTION

Diabetes mellitus is a disease with major long-term implications, not only for the health and well-being of affected individuals, but also for costs to the National Health Service.

There are two main forms of the disease:-

(1) Insulin dependent or juvenile onset diabetes (IDDM).

(2) Non-insulin dependent or maturity onset diabetes (NIDDM).

NIDDM is more common than IDDM with 75% of diabetes sufferers having this form of the disease. The World Health Organisation has also recognised a separate class of diabetes, with high prevalence in some tropical countries, and known as malnutrition related diabetes mellitus (World Health Organisation, 1985). Diabetes of pregnancy is also sometimes recognised as a separate form of the disease.

Diabetes mellitus is the most common of the endocrine disorders. Approximately 1-2% of the population of England has diabetes (Nabarro, 1988) (750,000 people), but 50% of those affected are unaware of this and may remain undiagnosed (500,000 people estimated) (Department of Health, 1991; Redmond and Stammer, 1990; MacLeod, 1974). Treatment of the disease and its complications takes up 4-5% of total health care expenditure in the UK (Department of Health, 1991; Williams, 1991) which represents approximately £1 billion at 1989 prices. These costs are dominated by in-patient care for complications arising from

diabetes (Williams, 1991).

Certain subgroups of the population are more likely than others to develop diabetes; for example, elderly people, and those of Asian or Afrocarribean origins in whom the prevalence of NIDDM is five times higher than in comparable European populations (Department of Health, 1991).

Age is an important factor in diabetes with approximately 3.5% of people over the age of 65 having the disease, and with more than 50% of people with diabetes being over the age of 65 years. On average, 80% of the cases in people over the age of 40 years are NIDDM.

In a population of 250,000 residents of European origins, with an age/sex breakdown as in England as a whole, there will be approximately 2,500 people with clinically diagnosed diabetes and 1,000 will be treated with insulin. 10-15% of the total will be insulin dependent (Williams, 1991). Of this population, 217 will have cataracts, 205 complex retinopathy, 470 neuropathy and 115 foot ulcers. There will be 40 deaths annually, which can be directly attributed to diabetes (Department of Health, 1991a).

The incidence of new cases in England for the age group 0-19 years is 10-15 per 100,000 population each year (Williams, 1991). The prevalence will rise in the next decade because of the increase in the elderly population. This will result in an additional 100 patients per 250,000 population with diabetes. The increased incidence in children is thought to be partly caused by environmental factors which cause IDDM in those people with a susceptible genetic make-up (Williams, 1991).

Diabetes is a chronic disease with numerous side effects which incur heavy medical costs. The aim of this paper is to bring together studies which have been carried out on the costs of diabetes and its complications in an attempt to show where there are gaps in the data, and where more well designed studies are needed. Also set out are the pitfalls and difficulties inherent in carrying out cost and effectiveness studies for a chronic disease such as diabetes.

2. THE CAUSES OF DIABETES

IDDM is caused by a failure of the production of insulin by the pancreas, and NIDDM is caused by impaired production of insulin and/or impaired utilisation. There is a genetic component, but both types have obesity as a risk factor (Department of Health, 1991). Environmental factors have also been implicated (World Health Organisation, 1985). The disease is chronic and affects the metabolism of carbohydrates, proteins, fats, water and electrolytes. Changes in metabolism lead to the development of well defined clinical "complications", the major ones of which affect the eye, the kidney, the arteries and the nervous system (Redmond and Stammer, 1990), and are discussed in greater detail below.

3. THE MAJOR COMPLICATIONS ASSOCIATED WITH DIABETES

The main complications of diabetes, which account for significant health service costs are (1) ketoacidosis; (2) cardiovascular disease; (3) renal disease; (4) visual problems; and (5) neuropathy.

In the USA, for the years 1979 to 1981, in the age group 20-44 years, 9.2% of the

general population had their activities limited by one or more chronic conditions, but for people with diabetes in the same age group, this applied to 36.1%. In all adults aged 20 years or more, 19.3% had some disability compared with 56.5% of those with diabetes. Diabetes imposes major costs on individuals and on society in terms of disability (Drury, 1985).

3.1 Ketoacidosis

Ketoacidosis (with the possible progression to "diabetic coma") is no longer a major cause of mortality, which has been reduced to 1% of the diabetic population. The consequence of this is, however, that many who might otherwise have died, now survive for many years with vascular, renal or visual problems, all of which imply extra medical costs (Newsholme and Leech, 1983).

3.2 Cardiovascular disease

Ischaemic heart disease accounts for 50% of deaths, and stroke for 15% of deaths in NIDDM patients in developed countries. But in IDDM patients, only 10% of deaths are from cardiovascular disease. This figure is, however, 12 times higher than in people without diabetes (World Health Organisation, 1985).

3.3 Renal disease (nephropathy)

People with diabetes have a 17 fold increased risk of end stage renal disease (ESRD) when compared with the general population. The risk of death from renal disease for IDDM

patients is 23 times greater than for people without diabetes.

Diabetic patients account for 25% of new renal cases annually, and diabetes is the second leading cause of renal disease in the USA. Approximately 11% of patients on renal dialysis in the USA also have diabetes (Herman et al, 1987).

A small UK study in 1981 showed that, of 218 people who developed diabetes before they were 31, and died before they were 50, 27% died from renal failure (Nabarro, 1988).

3.4 Visual problems

Diabetes is the commonest cause of blindness in people under the age of 60 years (Gerard et al, 1989), and approximately 2% of those with diabetes are likely to have problems with their sight because of diabetic retinopathy (Department of Health, 1991a).

In the USA, 39,500 people are blind because of diabetes, and new cases amount to 5,800 per year. People with diabetes have a six fold increased risk of developing blindness than the general population. For people with NIDDM, glaucoma and cataracts are more important than retinopathy in causing blindness (Herman et al, 1987).

There have been some local studies in the UK (Nabarro, 1988) where it has been estimated that 1100 patients per year would be registered blind as a result of diabetic retinopathy, of whom 500 would be under the age of 65. Diabetic patients under the age of 65 are 23 times more likely to become blind than people who do not have diabetes.

3.5 Neuropathy

Diabetic neuropathy encompasses a large group of syndromes so that incidence, prevalence, and costs are difficult to specify and there are no satisfactory statistics available in the UK. The most common form is diabetic peripheral neuropathy which affects the lower limbs and is progressive and irreversible (Herman et al, 1987). It causes reduced sensation in the feet which can lead to ulceration, gangrene and amputation (Department of Health, 1991). Approximately 70% of diabetic patients are reported to have some degree of neuropathy, leading to disability in up to 25% of patients (Dyck and Stiller, 1990).

In the USA in 1983, approximately 31,000 diabetic patients had leg amputations, and 50% of all lower limb amputations are performed on people with diabetes. Overall, they have a 16 fold increased incidence of amputation, when compared with the general population (Herman et al, 1987). A study of mortality among a group of 497 people with diabetes found that 92 had died between 1975 and 1987, with the commonest causes of death being myocardial infarction (39%); all cardiovascular disease (55%); neoplastic disease (25%) and diabetic neuropathy (5.4%) (Morrish et al, 1990).

4. MEDICAL CARE OF DIABETIC PATIENTS

Diabetes is rarely mentioned on death certificates as a cause of death, so the numbers of deaths directly attributable to the disease is not easy to quantify (Panzram, 1987; Department of Health, 1991), although it is generally acknowledged that people with diabetes

have a reduced life expectancy (Herman et al, 1987). In developed countries, for those with IDDM of childhood onset, life expectancy is 75% of that of people without diabetes: for those with NIDDM, life expectancy can be reduced by several years (World Health Organisation, 1985). The longer a patient has had diabetes, the greater the chances of developing complications, but, because NIDDM is more common, although of later onset, the cost to the health service of this form of the disease is much larger than for IDDM. IDDM patients are much more likely to present with nephropathy and end stage renal failure than are those with NIDDM, because the disease has been present for longer (Laing and Williams, 1989).

Much of the burden of the care of people with diabetes in the UK falls on the GP. The average GP with a list of 2,000 patients will have 15 people with diabetes on his or her list (Fry, 1988). The new GP contract (Department of Health, 1989) recently implemented in the UK, allows GPs to be paid for organising preventive clinics for their patients, and the development of diabetic clinics is included. Such clinics would be feasible for large partnerships who have sufficient patients on their list to make a diabetic clinic a worthwhile proposition, and may remove some of the burden of care from hospital diabetic clinics. However, this implies that GPs have sufficient expertise to take on a greatly increased role in this area, and it may not be feasible for small practices. It is hoped that GP clinics will be more cost effective to run than hospital clinics, but there is, as yet, no evidence to support this view. A small localised study reported in 1982, however, that general practice care cost half that of hospital care for patient and ambulance services (see Wood, 1990).

Consultation rates for diabetes are high and as far as preventive work is concerned, GPs are ideally placed for advising and monitoring diet, weight and blood sugar levels

(Department of Health, 1991). Close cooperation is, nevertheless, necessary, not only between the GP and the hospital, but also with community services and the patient and the family (Williams, 1991). Control of blood sugar levels is achieved, in IDDM, by regular insulin injections, which are usually performed by the patient on a daily basis. NIDDM is controlled by diet in conjunction, possibly, with hypoglycaemic drugs (Department of Health, 1991). Approximately 50% of new cases of diabetes can be controlled by diet alone; a further 20% will also require insulin; and 30% an oral hypoglycaemic drug. Nabarro (1988), however, noted two surveys in the UK which gave slightly different and discrepant figures (i.e. 28% and 39% on insulin injections).

Regular checks of blood pressure, urine and blood glucose, for foot problems, and for other complications, are necessary, all of which involve costs in terms of consultations, drugs and tests (Department of Health, 1991). Reducing the incidence of smoking in the population can help to reduce the frequency of diabetic complications, especially ischaemic heart disease and peripheral vascular disease (Department of Health, 1991a). A GP consultation has been costed, at current prices, at £5.85, and a glucose test at £6.75. In 1985, the average net ingredient cost per prescription for hypoglycaemic agents was £9.98 and in the same year four million prescriptions were issued for these drugs in the UK (Office of Health Economics, 1987).

People with diabetes are heavy users of hospital services. They occupy an average of 5 to 6 acute hospital bed days per person per year, compared with an average of one day for people who do not have diabetes. The frequency of diabetic episodes is 7.7 per 1,000 patients at risk per year, and the frequency of new hospital out-patient referrals is 3 per

100,000 of the total population per week, and numbers of follow-up out-patient visits are 37 per 100,000 per week. Unmet need is represented by the numbers of people with undiagnosed diabetes, and those with clinically diagnosed but inadequately treated disease (Williams, 1991).

A study of the costs of diabetes in a single UK health region (Alexander, 1988) found that diabetes accounted for 4.7% of total bed days, and that, of 11857 diabetes-related admissions in 1985, 35% had diabetes as a principle cause of admission, and the remainder as a subsidiary cause. The mean length of stay of diabetic patients at 14.4 days was twice that for people without diabetes. It was found that, although of 4156 admissions for which diabetes was the principle cause, 67% had no mention of complications, 6.2% were for ketoacidosis, 7.3% for eye problems, 5.2% for peripheral circulatory disorders, 7.5% for unspecified complications, 2.4% for neurological problems, and 1.7% for renal disorders.

The Department of Health (1991) has recently listed the targets for diabetic prevention set in October 1989 at the International Diabetes Federation, by the World Health Organisation and organisations from all European countries. These are:-

(1) To reduce new blindness due to diabetes by one third or more.

(2) To reduce by half the rate of limb amputation for diabetic gangrene.

(3) To achieve a pregnancy outcome in diabetic women that approximates that of non-diabetic women.

(4) To reduce the numbers of people entering end stage diabetic renal failure by at least one third.

(5) To cut morbidity and mortality from coronary heart disease in people with diabetes by programmes of risk factor reduction.

Much of this relates to better screening for the early detection of potential problems, and education of diabetics so that problems might be anticipated.

5. ECONOMIC FACTORS

The cost of diabetes has not been extensively researched. A large amount of data are available about the complications of diabetes in terms of incidence and prevalence, but few costs have been collected, particularly indirect and marginal costs. Moreover, researchers frequently fail to distinguish between IDDM and NIDDM which have different etiologies and therefore, different costs.

Studies have supported the view that costs of diabetic care are high and could be reduced (Williams, 1991). Most of the economic impact of the disease arises from complications so that early detection and monitoring would be expected to cut morbidity and costs. Foot and cardiovascular problems account for a high proportion of costly hospital admissions and disability, coupled with premature mortality in the case of cardiovascular disease. Educational programmes for patients and their families are cost effective and are the first approach (World Health Organisation, 1985). Local policies, possibly at the district level, could be set up in the UK so that diabetic services are well organised to reduce in-patient services and achieve early identification of potential problems. As Williams commented "there are too few ... studies available .... to provide a clear picture of the relative economic merits of specific ways of organising diabetic care .... Health economic studies ..... are accumulating, but more are required as a matter of urgency" (Williams, 1991).

6. ECONOMIC EVALUATIONS

The evaluation of the available literature on the economics of diabetes will be presented under five headings, namely, direct costs; indirect costs; psychological costs; cost of treatment of complications; and cost-effectiveness.

(1) Direct Costs

These include the costs of hospital care, consultations, drugs and therapy. Most studies of diabetes have included these costs because they are the easiest to measure.

(2) Indirect Costs

These include production losses due to short-term illness, early retirement, and death before retirement. Few studies have included calculations of these costs because of the difficulties in allocating monetary value.

(3) Psychological Costs

These include factors such as the effect of the illness on the quality of life of the patient. They are sometimes mentioned in cost analyses, but usually dismissed.

(1), (2) and (3) above can be summed to give the costing methodology known as the "cost of illness" framework (Rice, 1966).

(4) The cost of complications

These are the most important contributors to the costs of diabetes and are included in both direct and indirect costs.

(5) Cost-effectiveness studies

These studies entail looking at not only the costs of treatment, but also the effectiveness in terms of benefits to the patient. There have been no cost-effectiveness studies of diabetes.

Many studies fail to differentiate between NIDDM and IDDM (Gerard et al, 1989; McKendry, 1989), because it is frequently not possible to disaggregate data into the 2 groups. There is also the failure to include diabetes as a secondary diagnosis, although some studies have included this (e.g. Gerard et al, 1989).

6.1 Direct costs

Several studies from North America and Western Europe have involved the collection of data on the direct costs associated with diabetes.

A study conducted in the USA (Berry et al, 1981) compared the lifetime costs of diabetes with four other diseases (acute lympholytic leukaemia, breast cancer, rheumatoid arthritis and stroke). Lifetime direct costs placed diabetes in the highest position because of

the large number of cases ($ 11 billion), with the lowest cost attributed to acute lympholytic leukaemia ($ 246 million). The rankings changed when recalculated on a per capita basis with acute lympholytic leukaemia having the highest per capita cost, and diabetes falling to fourth position, reflecting the fact that costs for some conditions (e.g. acute lympholytic leukaemia) are incurred in the initial years after onset, and are discounted by smaller factors than is the case with a chronic disease such as diabetes. When indirect costs are added, diabetes remained highest for lifetime costs, but fourth on a per capita basis at $19800.

A more recent study (Huse et al, 1989) estimated costs (direct and indirect) for NIDDM and its complications at $19.8 billion in the USA in 1986. Direct costs accounted for $11.6 billion of this. Although 59% ($6.8 billion) of direct costs were for unspecific diabetic complications, including ketoacidosis, a further 33% ($3.8 billion) were for the treatment of circulatory disorders, with visual problems, neuropathy, nephropathy and skin disorders accounting together for only 7% of direct costs. Moreover, the 65 years and older age group were responsible for 63% of the direct costs, but for only 48% of total costs (direct and indirect) because they contribute less to the labour market.

Weinberger et al (1990) also estimated the economic impact of NIDDM, but this time in a population of elderly people with diabetes in the USA. They found that expenditure per patient for medical care was 50% higher than in comparable non diabetic populations. The total direct cost for this group of people was estimated at $5.16 billion in 1987, 86% of which was for hospital and nursing home costs. Comparing studies is fraught with difficulty because it is not always clear what has been included and what has been left out, but this latter figure compared favourably with those of Huse et al (72%) when it is remembered that Huse et al

calculated direct costs for all age groups, and it would be reasonable to expect that elderly people would be more extensive users of hospital and nursing home services than the general population. Entmacher et al (1985) published direct costs for diabetes in the years 1969 to 1984, the latter figure being calculated at $7.4 billion, of which approximately 75% was accounted for by hospital and nursing home costs. These figures compare favourably with other USA studies.

A survey in Minnesota in 1988 (Morbidity and Mortality Weekly Report, 1991) estimated the direct costs (including hospital days, physician visits to inpatients, months of nursing home care, out patient physician visits, physician-ordered laboratory tests, prescriptions and supplies) at $189 million. Indirect costs caused by loss of productivity were $112 million giving a total cost of $301 million for Minnesota. The cost of chronic complications, such as amputations, renal, eye, nervous and cardiac complications was high ($75 million), and accounted for more than half of all days in hospital for these patients. Attempts to prevent chronic complications would therefore be expected to have a major impact on reducing the cost of diabetes e.g. if foot ulcers are detected and treated early enough, 50% of amputations could be delayed (Herman et al, 1987).

A Canadian study of 205 patients (McKendry, 1986) again considered only direct costs because of their relative ease of collection. Few Canadian data were available and problems were experienced in costing cases where diabetes was not the primary diagnosis. Total direct costs were found to average $2944 per patient, per year, of which 64% were for hospital services, 14% for treatment, 10% for physician services and 8% for testing supplies. Canada does not have the well established system for the collection of statistics on diabetes which

exists in the USA (Young et al, 1991).

A Swedish study (Jönsson and Persson, 1981) showed that diabetes had higher direct costs (43% of total costs) than neoplasms, circulatory and musculoskeletal problems. The mean for all diseases was 30%. It was concluded that each disease has its own specific profile of costs and that in Sweden, direct costs for diabetes are high. Neither of these two studies distinguished between IDDM and NIDDM.

The difficulties in comparing costs between countries have been discussed (Persson, 1989). These difficulties are partly related to the different types of care provided in different countries. For example, direct costs were found to be lower in the USA than in Sweden, because of the lower costs of institutional care in the USA, although drug costs are similar in both countries. Moreover, comparing costs collected within countries also has its problems.

A Danish study in which direct costs were collected for elderly diabetic patients for 1981-82 found that hospital services were the most expensive component, and community care and disablement pensions represented the areas of highest excess cost of diabetic people relative to those without diabetes. Among elderly diabetic patients, those treated with insulin cost most i.e. 2-3 times more for ambulatory medical care, 4-5 times for hospital care and 3 times more for community care than did other diabetic patients (Damsgaard, 1990).

A study which differentiated between NIDDM and IDDM in France in 1984 measured direct costs for 109 patients (Triomphe et al, 1988). It was found that direct costs for NIDDM patients differed little from mean population costs (FF 5892 per patient for NIDDM;

FF 6462 for France as a whole), but for IDDM patients costs were higher (FF 7711 per patient), the excess being attributed to drug costs. Indirect costs were partly excluded because, with an unemployment rate of 10%, they were not considered important.

Gerard et al (1989) estimated the UK costs of diabetes to be at least £259.5 million in 1984 but possibly being as high as £602.5 million, depending on the excess absenteeism attributable to diabetic patients. including direct and indirect costs, but excluding psychological costs, and not differentiating between different types of diabetes, although costs of diabetes as a secondary diagnosis were included. At 1987 prices, the cost increases to £484 million (Laing and Williams, 1989). The data are presented in Table 1.

From Table 1 it can be seen that, as in the USA and other countries, in-patient care is the largest single cost element (£298m), thought to be an underestimate (Laing and Williams, 1989). Excluded from the table are costs of primary care services, community nurse visits and out-patient treatment except in hospital diabetic clinics. The figures in the table imply that the 1.2% of people with diabetes in Britain consume 4-5% of all health care resources (Laing and Williams, 1989).

Another UK study (Alexander, 1988) estimated the direct hospital costs of diabetes in one UK health region serving a population of 3.58 million people. The total cost was estimated at £21.6 million (1984) for hospital in-patient and out-patient services, and supplies, but excluding the cost of treating complications (e.g. renal dialysis, amputations, etc), GP visits and indirect costs (see Table 2). These figures, when extrapolated to the UK as a whole produce similar results to those of Gerard et al and Laing and Williams.

Table 1

Direct costs of diabetes and its complications, 1986-7, England & Wales

	Diabetes Cost £ million	All Causes Cost £ million	Diabetes as % of Total
NHS			
In-patient (diabetes primary diagnosis)	81	6,375	1.3
In-patient (diabetes subsidiary diagnosis)	217	-	3.4
Out-patient (diabetic clinics only)	29	1,057	2.7
GP consultations (diabetes as a primary diagnosis only)	17	1,204	1.4
GP Prescriptions (diabetes as a primary diagnosis only)	35	1,960	1.8
Long-term residential and nursing care outside NHS hospitals (all residents reporting a disability from diabetes)	105	2,100	5.0
Total (where data available)	484	12,696	3.8

Source: Laing and Williams, 1989.

Direct costs appear to be superficially simple to collect, but difficulties arise when comparing individual studies because it is frequently unclear what has been included and what has been left out. Data, of necessity, have to be collected on a small number of patients, and

extrapolated nationally, compounding errors and making comparison between studies difficult. NIDDM and IDDM patients are distinct groups with different medical needs and prognoses and should wherever possible, be considered separately. Now that costs have to be collected more extensively in the NHS (Department of Health, 1989a) it would be helpful for protocols to be devised to facilitate collection of costs and aid comparisons.

Table 2

Direct costs of diabetes in one UK health region (1984)

Outpatient Costs (OP)	£
(a) Visits: 35,800 x 2 at £20 (£40 per patient) =	1,432,000
(b) Supplies: Insulin treated = £165 per person =	1,772,100
Tablet treated = £80 per person =	1,145,600
Diet alone = £13 per person =	139,620
Total for supplies =	3,057,320
Total outpatient costs =	4,489,320

Inpatient Costs (IP)	
(a) All admissions of people with diabetes = 11,857 x £100 x 14.4 days =	17,074,080
(b) Diabetes as a primary cause of admission = 4,185 x £100 x 14.4 days =	6,026,400

Source: Alexander, 1988.

6.2 Indirect costs

There have been fewer studies in which the indirect costs of diabetes have been measured. One study showed that indirect costs associated with diabetes are higher than those acute conditions with high premature death rates, such as acute lympholytic leukaemia and breast cancer, because of the chronic nature of the disease (Berry et al, 1981). However, Jönsson and Persson (1981) found that indirect costs for diabetes in Sweden (at 57% of total costs) were lower than for conditions such as neoplasms (78%), but this could be because direct costs for diabetes in Sweden are particularly high.

Identifying the indirect costs due to diabetes becomes particularly difficult when the disease is a subsidiary diagnosis only. Gerard et al (1989) estimated a cost of £86 million in the UK at 1984 prices, but this figure was thought to be an over estimate.

Herman et al (1987) estimated that people with diabetes in the USA were 2.3 times more likely to require hospital treatment than the general population and Gerard et al (1989) used estimates of 3 times. In terms of days off work, diabetic people were estimated to have an average of 10.8 days/person/year, twice as high as the general population.

The direct and indirect costs of diabetes in the USA in 1980 were estimated by Herman et al (1987). However, indirect costs were not expressed in money terms, but as thousands of person years lost, making comparisons difficult. Another study which used the "cost of illness" approach to estimate the costs of diabetes in the USA in 1984, found indirect costs of $6.3 billion out of a total cost of $13.7 billion (Entmacher, 1985).

An Argentinian study (Olivera et al, 1991) compared diabetic patients with and without chronic complications with non-diabetic people in terms of absence from work. It was found that absences were similar for the controls and for diabetic patients without chronic complications, but were higher for those with chronic complications.

The difficulties inherent in calculating indirect costs have meant that this has rarely been attempted for diabetes. Estimating such costs for a chronic disease such as diabetes poses additional problems since it might be regarded as a subsidiary diagnosis only and data might be lost because of this. Taking together studies in which attempts have been made to estimate both direct and indirect costs, approximately 55% of total costs can be attributed to direct costs and 45% to indirect costs. There can be no doubt that diabetes is a disease which has long term economic effects in terms of days lost from work, with diabetic patients averaging twice as many days off as the general population. Elderly people who are not employed contribute less to indirect costs, but they may need long term care at home which would have an economic impact on the family as a whole.

6.3 Psychological costs

These costs have rarely been considered in economic analyses because of the difficulties involved in assigning costs to factors such as the major alteration in lifestyle which might be necessary for people with diabetes. Such changes can lead to emotional problems and stress, and to anxiety associated with having to live with a life threatening disease (Herman et al, 1987).

6.4 Costs of complications

The complications of diabetes may require expensive medical interventions and treatment costs for these will be included in estimates of direct costs.

In Sweden, gangrene was found to be the single most important complication. Costs for permanent disability mainly related to early retirement are dominated by retinopathy. Using various assumptions, Jönsson calculated that costs for the control of diabetes accounted for less than 25% of the total costs of diabetes. Improvements in the control of diabetes have the potential to reduce direct costs for the treatment of complications (Oliviera et al, 1991; Jönsson, 1983), as well as decreasing indirect costs, and improvement in the treatment of complications can also reduce indirect costs (see Table 3).

Table 3

The economic costs of diabetes divided into control and complications
(Swedish Kroner, millions)

	Management or control	Complications	Total
Direct costs	313	255	568
Indirect costs	-	749	749
Total costs	313	1,004	1,317

Source: Persson, 1989

Improvements in the control of diabetes can therefore be seen as an investment which hopefully results in fewer complications, better health and reduced costs (Jönsson & Persson, 1981).

A serious complication of diabetes is end stage renal disease (ESRD), with almost 25% of such patients in the USA also having diabetes. Diabetic patients were found to be more expensive than non-diabetic patients for ESRD treatment (Smith et al, 1989). Overall, diabetic patient treatment costs were $4695 more per year than non-diabetic patient costs, most of the additional costs being for in-patient services, and the remainder for physician services and medical supplies. However, whilst charges for transplant were higher for diabetic patients, so also were the cost savings. The extra costs were recovered by future savings in five years (Smith et al, 1989).

Hospitalisation costs of diabetic complications in the USA for 1987 are shown in Table 4. The largest single cost was for heart disease, which accounted for 47% of the total hospitalisation costs for diabetic complications. It has also been calculated that, in the USA, the total hospitalisation cost for lower limb amputation in 1983 was approximately $302 million, excluding rehabilitation, premature mortality and disability costs (Entmacher, 1985).

If at least some of these complications could be prevented or reduced in severity, there is potential for large cost savings to the health service and to the individual. Prevention is the key to this, possibly by relatively simple measures such as adequate control of blood sugar levels, dietary advice, regular check ups, chiropody and general advice to the diabetic person and his or her family.

Table 4

Hospitalisation costs of diabetic complications in the USA for 1987

	Attributable hospitalisations	Mean costs per day ($)	Mean LOS (days)	Total costs ($ millions)
Neuropathy	35,859	596	8.6	184
Diseases of the veins	5,798	510	7.7	23
Diseases of the arteries	68,567	884	14.4	873
Cardiovascular accident	71,863	639	10.8	496
Heart disease	355,521	891	7.5	2,376
Renal disease	72,743	703	10.0	511
Opthalmic disorders	20,574	1066	3.4	75
Other and unspecified diabetic complications	155,978	507	7.0	554
Total	786,903			5,091

LOS = length of stay

Source: Jacobs et al, 1991.

6.5 Cost effectiveness studies

New advances in treatment, such as the new insulins, new monitoring methods for home glucose measurements, pumps to replace syringes, and laser treatment of retinopathy all have the potential to improve patient quality of life, and possibly reduce costs, but have yet to be evaluated.

Persson (1989) asked the question "why are there so few cost effectiveness studies of diabetes?". One reason put forward was that chronic conditions are less well documented than acute conditions such as heart attack, for which studies exist, and patients have to be

followed up for a long time. This would require well organised clinical trials or special studies to measure effectiveness (Gerard et al, 1989). Also, because diabetes often exists with other diseases, there is a risk of double counting of costs.

Berry et al (1981) suggested that one solution would be to calculate the expected annual cost per patient in each age/sex group. This assumes that the level of utilisation of health care is more strongly correlated with current age than with age of onset, but is probably valid for chronic diseases. Another method is to consider only patients with a primary diagnosis of diabetes, which means making the assumption that non-primary diabetes contributes to the cost of care of other primary conditions at the same rate as those conditions (when not primary), contribute to the cost of care of primary diabetes. It might be possible, but difficult, to estimate the cost of "excess" disease.

Although cost effectiveness and cost-benefit analyses of diabetes have been limited (Songer, 1990), there have been some studies evaluating services or procedures associated with the treatment of diabetes. Studies of education and nutrition programmes have been shown to reduce the number of hospitalisations (Songer, 1990). Techniques for treatment of retinopathy in IDDM patients have been found to be cost effective in reducing blindness and improving quality of life (Javitt et al, 1990). A similar study comparing different methods of screening for retinopathy was carried out by Buxton et al (1991) (see also Sculpher et al, 1991). If diabetic retinopathy is detected early enough then treatment can be effective, so, if a screening programme is initiated then the most cost effective method should be used.

A further study (Gupta and Veith, 1988) has compared the cost effectiveness of arterial

reconstruction and amputation in which most of the patients had diabetes. Total charges/costs for the revascularisation group were $26,194 and for the amputation group $27,255. The authors concluded that choice of treatment should be based on patient factors and quality of life, and not on cost alone. The introduction of specialised foot clinics have been found to halve amputation rates (Edmonds et al, 1986).

Kaplan et al (1988) showed that diet and exercise programmes to reduce obesity in NIDDM patients were competitive with other medical interventions in terms of cost-utility (see Table 5 for comparisons between interventions). Education programmes were also found to be cost effective (Connor, 1984). Research on secondary prevention has typically not incorporated an economic component and no attempt to use cost utility analysis (cost per QALY) has been made (Laing and Williams, 1989).

There has, however, been one study which attempted to measure the outcome of diabetes retrospectively using hospital discharge data (Macleod et al, 1989). It was found that such statistics were not accurate or complete enough to give a realistic picture of the outcomes of patients with diabetes. The findings, in a group of 230 diabetic people provided over a 10 year period ending in 1985, were that there were 29 admissions for ketoacidosis in 20 patients, one case of ESR failure, and 36 lower limb amputations.

It has been argued that resources spent on diabetes research are inadequate in relation to the burden the disease imposes on society. In 1985, only £3.3m was spent on diabetes research in the UK compared with £130m in the USA (Laing and Williams, 1989).

Table 5

Comparison of cost-utility ratios for various care interventions

Programme	Estimated cost-utility ratio
Pneumococcal vaccine, older adults	1,500
Phenylketonuria screening	7,000
Screening for severe hypertension	9,200
Behavioural intervention in NIDDM	10,870
Screening for mild hypertension	18,600
Estrogen replacement in post-menopausal women	23,500
Rehabilitation in chronic obstructive pulmonary disease	24,600
Coronary artery bypass graft two-vessel disease	32,700
Pneumococcal vaccine, young children	114,900
Coronary artery bypass graft one-vessel disease	516,500

* All US$ values have been adjusted to the 1987 value.

Source: Kaplan et al, 1988.

Intervention with preventive measures can reduce the impact of diabetes. Primary intervention, aimed at preventing people from developing diabetes tends to be less successful than secondary prevention which is aimed at preventing the development of complications of diabetes. The main example of primary prevention is reduction of obesity, which in turn may affect glucose tolerance (Herman et al, 1987).

Education is an important and inexpensive form of secondary prevention but frequently lacks coordination. It is aimed at teaching patients how to manage their disease, and about diet and lifestyle, including smoking. If people with diabetes stopped smoking, stroke could be reduced by 5%, coronary artery disease by 10% and peripheral vascular disease by 30% (Kannell and McGee, 1979).

Regular blood pressure checks are also important since cardiovascular problems are a major cause of death of people with diabetes. Similarly, regular checks for diabetic retinopathy can reduce the incidence of this complication, and regular chiropody can be effective in reducing the numbers of patients who need costly amputations. Table 6 sets out the estimated impact of interventions on diabetes in the USA.

7. CONCLUSION

Diabetes imposes significant direct and indirect costs on society and numerous attempts have been made to identify, measure and value these costs, with varying degrees of success. Outcomes of diabetic care initiatives cannot be directly measured, and until they are,

Table 6

Estimated potential impact of interventions for diabetes, United States

Problem	Intervention	Preventable (%)	Preventable cases/year
Type I diabetes	-	-	-
Type II diabetes	Obesity control	50	293,000
Gestational diabetes	Obesity control	33	28,000
	Primary interventions		
Peripheral vascular disease	Hypertension control	60	24,000
Stroke	Hypertension control	85	19,000
Coronary heart disease	Hypertension control Smoking cessation Lipid control	45	38,000
	Secondary interventions		
Ketoacidosis	Glycemic control Education	70	52,000
Serious congenital malformation	Glycemic control Education	70	500
Blindness	Education Laser photocoagulation	60	3,480
End-stage renal disease	Hypertension control	50	2,000
Amputations	Education Hypertension control Smoking cessation Glycemic control	50	15,000

Source: Herman et al, 1987.

their impact cannot be directly measured either (Department of Health, 1991a). Most studies have been carried out in the USA, where health care provision is very different to that in the UK, making comparisons unreliable. Studies have also suffered from a lack of suitable retrospective data. Moreover, the difficulty in setting up prospective studies which would be long term in nature and expensive to run has meant that there has been reliance on secondary data. There is also a lack of evidence in the literature on the efficacy and cost effectiveness of interventions. Up to date figures for the costs and effectiveness of the organisation of care either in hospital clinics or GP clinics, are needed now that GPs are being encouraged to care for more of their diabetic patients.

The total cost of a disease is not, however, a suitable basis for either investment in research or the funding of prevention and treatment. The relevant information needed to substantiate such investments is whether the benefits (in terms of enhancements to the length and quality of life) at the margin of investing in the diabetes field per unit cost are greater than the marginal benefit/cost results achieved elsewhere. Kaplan et al (1988) are one of the few groups of researchers who have tried to address this issue. This study indicates that, relative to other treatment, investment in diabetic prevention programmes gives relatively good economic results.

Cost effectiveness studies of diabetic interventions are essential to provide a basis for attempts to reduce the costs of the disease, and to ensure that people with diabetes are treated with efficiency and equity.

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