University of Southern Denmark · Syddansk Universitet

THE SOCIETAL IMPACT OF DIABETES MELLITUS AND DIABETES CARE

Type 1 diabetes in Bangladesh in year 2001

by

Anders Green, Martha Emneus, Terkel Christiansen and Stefan Björk

Health Economics Papers
2005: 5

University of Southern Denmark

FOREWORD

The present Working Paper is one in a series of three papers (WP 2005:4; WP 2005:5; WP 2005:6) on the societal impact of diabetes mellitus and diabetes care in Bangladesh. The work was initiated by Novo Nordisk A/S, Corporate Health Partnerships and conducted of a team consisting of the four authors. An external evaluation was made by an invited Critical Board. The team received a number of valuable suggestions from the board, and most of these are included. Still, the content of the final reports is the responsibility of the authors alone. The project was financed by Novo Nordisk A/S. Two reports on type 1 and type 2 by the authors are available on request from Novo Nordisk A/S when published.

Terkel Christiansen

PROJECT ORGANISATION

Project team:

Senior Adviser *Stefan Björk* (PhD), Novo Nordisk A/S

Adviser *Martha Emneus* (M Sc. (Ec)), Novo Nordisk A/S

Professor *Terkel Christiansen* (M Sc (Ec)), (Health Economics) University of Southern Denmark

Professor *Anders Green* (Dr Med Sci, MD), (Epidemiology) University of Southern Denmark

External Critical Board:

Professor, Chief Consultant *Knut Borch-Johnsen* (Dr Med Sci, MD), Steno Diabetes Center, Gentofte (Denmark)

Professor *Dorthe Gyrd-Hansen* (PhD), University of Southern Denmark, Odense (Denmark)

Professor *Torsten Lauritzen*, University of Aarhus (Dr Med Sci, MD, GP), Århus (Denmark)

Dr *Gojka Roglic (MD)*, World Health Organization, Geneva (Switzerland)

Director *Pontus Roos* (Dr Lic), Institute of Applied Economics, Malmö (Sweden)

Timetable for main phases of the project:

Calendar year 2002:	Initial planning and preparation of project protocols
	Development of epidemiological model data and cost structure
Calendar year 2003:	Using empirical data sets for validation and supplementary analyses
	First reporting of results
Calendar year 2004:	Final analyses and reporting

TABLE OF CONTENTS

EXECUTIVE SUMMARY

As part of a larger project aiming at assessing the societal impact of diabetes and diabetes care, this study presents a health economics assessment of Type 1 diabetes (T1D) in Bangladesh with reference to the calendar year 2001.

From epidemiological modelling four contrasting scenarios has been established: The *Current scenario* is assumed to reflect the real situation for T1D in Bangladesh. The *Worst scenario* that represents the hypothetical situation where no treatment for diabetes is available and likewise no access to diabetes care. The scenario "Improved" represents a situation where there is unlimited access to care and treatment at otherwise similar conditions as in the *Current scenario*. Finally, the *Ideal scenario* represents the hypothetical situation where T1D is not associated with any excessive risk of complications and mortality and access to diabetes treatment and care is unlimited.

Costs of treating T1D in Bangladesh have been estimated from available reports and ad hoc enquiries together with clinically based estimates. Cost and effects are estimated for each of the scenarios. Costs are structured in healthcare resources, non-healthcare resources, patients´ time and informal caregivers´ time. Effects have been quantified in terms of patient-years, quality-adjusted patient-years and production value (income by working) with and without the value of household production included. The reference point of the analysis is the current scenario. Gains on the cost and effect side have been estimated from contrasting each of the scenarios "Worst", "Improved" and "Ideal" with "Current". These gains are not additive, however.

The table below summarises the results. The costs of current treatment and care of T1D in Bangladesh are low, in total as well as per patient-year. This reflects that, currently, T1D is a low-prevalent disease in Bangladesh with a limited fraction (about 40% of people with type 1) having access to care and treatment, which only a part of this population segment can afford. Accordingly, the *Current scenario* is closer to the *Worst scenario* than to the *Improved scenario*. The *Improved scenario* is more costly than the *Current scenario* (total costs increase by approximately 900%), but the increase in invested resources will produce high gains in terms of patient years at an added cost of 2,559 DKK per patient year (and 2,766 DKK pr quality-adjusted life-years). This should be seen in relation to current cost per person year (compared to the worst case) which is equal to 1067 DKK per patient year. Some of the costs will be negated by increases in production value. The hypothetical *Ideal scenario* illustrates that should perfect treatment become available for all patients with T1D, the number of patients years and production value would be increased many-fold. Cost per patient year would remain more or less constant relative to the improved scenario, but the absolute cost of ideal treatment would be 36 times higher than the total cost of current treatment. This additional cost would however be mitigated by production gains. When moving from the current towards the ideal scenario production gains will increase more rapidly than the increase in costs associated with treatment. It should be underlined that these results are not net benefits because the related consumption from longer life expectancy is not taken into consideration

We conclude that the prevailing healthcare conditions for patients with T1D in Bangladesh are poor and that this results in bad health, reduced longevity, increased morbidity and associated low production value for these patients. Establishing access to care and treatment for all patients is costly but yields an increased number of patient-years and an increased production value. Considerable further gains in patient-years and production value, and

further reduction in net costs would be the case if it would be possible to make treatment for T1D perfect.

Table 1 T1D in Bangladesh, year 2001, summary of costs of treatment and effects in contrasting scenarios, mill DKK, 2001 prices

Total costs and effects	Worst	Current	Improved	Ideal
Costs Mill DKK				
Healthcare Resources	2	5	72	317
Non-Healthcare Resources	4	3	3	0
Patients´ time	0	0	3	6
Informal care-givers´ time	0,0	0	0	0
Total cost	**6**	**9**	**79**	**323**
Effects				
Patients' life years unadjusted	5.533	8.557	35.768	155.251
Patients' life years treated	0	3.578	35.768	155.251
Patients' life years quality adjusted	3.597	6.394	31.561	147.489
Production value inclusive the informal sector) Mill DKK	**0**	**12**	**121**	**805**
Registered as GDP Mill DKK	**0**	7	**67**	**443**

Numbers might not add up due to rounding.

Table 2, Socio-economic costs and gains in a comparison of scenarios, mill DKK

Total costs and effects	Socio economic gains current vs worst	Socio economic gains improved vs current	Socio economic gains ideal vs current
Costs Mill DKK			
Healthcare Resources	3	67	312
Non-Healthcare Resources	0	0	-3
Patients´ time	0	3	5
Informal care-givers´ time	0	0	0
Total cost	**3**	**70**	**314**

Effects			
Patients' life years unadjusted	3024	27211	146694
Patients' life years treated	3578	32190	151674
Patients' life years quality adjusted	2797	25167	141095
Production value inclusive the informal sector) Mill DKK	**12**	**109**	**793**
Registered as GDP Mill DKK	7	**60**	**436**

Numbers might not add up due to rounding.

Table 3 Health economic evaluation, various scenarios compared, TD1 in Bangladesh, 2001

Comparison between scenarios	Socio economic gains current vs worst	Socio economic gains improved vs current	Socio economic gains ideal vs current
Net benefits human capital approach mill DKK	9	39	480
Marginal cost effectiveness ratio DKK/patient year	1067	2559	2138
Marginal cost utility ratio DKK/QALY	1154	2766	2223

(The net benefit from the human capital approach in table 3 include both the production value from the formal sector and the informal sector (the household sector).

For comparison the figures in table 1 and 2 are shown in table 4 to 7 in purchasing power parity (DKK PPP and US$ PPP) below. The purchasing parity factor between the Bangladesh and Danish/US $ is approximately 5, and we used the following exchange rate for 2001: 100 taka = 1.7 US$ or 8.5 PPP US$ (or 100 taka=15 DKK or 75 PPP DKK).

Table 4, T1D in Bangladesh, year 2001, summary of costs of treatment and effects in contrasting scenarios, mill DKK, (PPP) 2001 prices

Total costs and effects	Worst	Current	Improved	Ideal
COSTS, Mill DKK (PPP)				
Healthcare Resources	11	27	367	1611
Non-Healthcare Resources	18	18	17	0
Patients´ time	0	1	14	28
Informal care-givers´ time	0	0	2	1
Total cost	**29**	**46**	**400**	**1640**

EFFECTS				
Patients' life years unadjusted	5.533	8.557	35.768	155.251
Patients' life years treated	0	3.578	35.768	155.251
Patients' life years quality adjusted	3.597	6.394	31.561	147.489
Production value inclusive the informal sector, Mill DKK (PPP)	**0**	**62**	**615**	**4094**
Registered as GDP, Mill DKK (PPP)	**0**	**34**	**338**	**2252**

Numbers might not add up due to rounding.

Table 5, Socio-economic costs and gains in a comparison of scenarios, mill DKK. (PPP) 2001 prices

Comparison between scenarios	Socio economic gains current vs worst	Socio economic gains improved vs current	Socio economic gains ideal vs current
COST, Mill DKK (PPP)			
Healthcare Resources	16	340	1584
Non-Healthcare Resources	0	-1	-18
Patients´ time	1	13	27
Informal care-givers´ time	0	2	1
Total cost	**16**	**354**	**1595**

EFFECTS			
Patients' life years unadjusted	3024	27211	146694
Patients' life years treated	3578	32190	151674
Patients' life years quality adjusted	2797	25167	141095
Production value inclusive the informal sector, Mill DKK (PPP)	**62**	**553**	**4033**
Registered as GDP, Mill DKK (PPP)	**34**	**304**	**2218**

Numbers might not add up due to rounding.

Table 6, T1D in Bangladesh, year 2001, summary of costs of treatment and effects in contrasting scenarios, mill US$, (PPP) 2001 prices

Total costs and effects	Worst	Current	Improved	Ideal
COSTS, Mill US$ (PPP)				
Healthcare Resources	1,4	3,2	44,2	193,7
Non-Healthcare Resources	2,2	2,1	2,0	0,0
Patients´ time	0,0	0,1	1,7	3,4
Informal care-givers´ time	0,0	0,0	0,2	0,1
Total cost	**3,5**	**5,5**	**48,0**	**197,2**

EFFECTS				
Patients' life years unadjusted	5.533	8.557	35.768	155.251
Patients' life years treated	0	3.578	35.768	155.251
Patients' life years quality adjusted	3.597	6.394	31.561	147.489
Production value inclusive the informal sector, Mill US$ (PPP)	**0,0**	7,4	**73,9**	**492,1**
Registered as GDP, Mill US$ (PPP)	**0,0**	**4,1**	**40,6**	**270,7**

Numbers might not add up due to rounding.

Table 7, Socio-economic costs and gains in a comparison of scenarios, mill US$. (PPP) 2001 prices

Comparison between scenarios	Socio economic gains current vs worst	Socio economic gains improved vs current	Socio economic gains ideal vs current
COST, Mill US$ (PPP)			
Healthcare Resources	1,9	40,9	190,4
Non-Healthcare Resources	0,0	-0,1	-2,1
Patients´ time	0,1	1,6	3,3
Informal care-givers´ time	0,0	0,2	0,1
Total cost	**2,0**	**42,5**	**191,7**

EFFECTS			
Patients' life years unadjusted	3024	27211	146694
Patients' life years treated	3578	32190	151674
Patients' life years quality adjusted	2797	25167	141095
Production value inclusive the informal sector, Mill US$ (PPP)	**7,4**	**66,5**	**484,7**
Registered as GDP, Mill US$ (PPP)	**4,1**	**36,6**	**266,6**

Numbers might not add up due to rounding.

1. INTRODUCTION

Insulin has been available in the developed world for almost 80 years. Together with a constant improvement of the knowledge of how to prevent and manage the complications of diabetes this has had a huge impact on the survival of people with diabetes and, in particular, the quality of life of people with diabetes. Despite this, diabetes still represents a serious disease. Insulin treatment is an absolute requirement for preserving life in Type 1 diabetes (T1D). In addition, insulin treatment is important for improving metabolic control in other diabetic patients (T2D) to whom alternative treatment has failed, or when access to peroral anti-diabetic agents may be limited. Thus, insulin represents an essential component in diabetes care.
In contrast to the long term availability of insulin in the developed world, insulin has not been available for the majority of the population in the developing world, not to mention the lack of medical infrastructure, healthcare, awareness, doctors, nurses etc. Thus the survival, quality of life and ability to be productive are heavily impacted by these issues.

It is generally believed that the incidence (and hence the risk) of T1D is increasing worldwide (1). Furthermore, improving prognosis will add to an increasing prevalence of T1D. As compared with the other main type of diabetes, Type 2 diabetes (T2D), T1D is quantitatively of relatively minor importance. Nevertheless, T1D represents a large burden for patients and society since the disease frequently develops early in life – with a subsequent life-long need for treatment and control. Moreover, it has fatal consequences when type 1 diabetics are untreated as the disease is mortal in the very early phase. This makes T1D a silent killer, and in some parts of the world where the availability of insulin is limited, the disease is almost considered non-existent because the understanding and awareness of the cause of death of these people is very low.

Novo Nordisk A/S has launched a project aiming at studying various aspects of the societal impact of diabetes and diabetes care. The first report in this series is dealing with the general methodological considerations behind the project. The subsequent reports concern T1D and T2D, respectively, in a developed nation, exemplified by Denmark.

The present report concerns a health economics appraisal of treating T1D diabetes with insulin in a developing nation, based on Bangladesh in the calendar year 2001. Specifically, we aim at establishing a model for a developing nation which is characterised by limitations in treatment and care for patients with T1D with estimation of patient-years (with and without adjustment for quality of life) and costs. We then establish contrasting scenarios, representing both a hypothesised alternative with no access to care and treatment at all, as well as an alternative with unlimited access to care and treatment, and – finally – a purely hypothetical scenario in which appropriately treated T1D causes no excessive mortality and morbidity. Each of these hypothetical scenarios is then contrasted with the scenario for the current (actual) situation, providing the basis for an evaluation of effects and benefits.

2. OUTLINE OF METHODOLOGY – SCENARIO BUILDING

The study focuses on T1D in Bangladesh with reference to the year 2001. In addition to the scenario representing the current situation for T1D in Bangladesh year 2001, three contrasting scenarios have been created to investigate the impact of different levels of availability of treatment and care in T1D and the clinical outcome in T1D as well as the costs related to the health states arising from such assumptions. Each scenario is related to year 2001 and outlines a specific situation, affecting the actual size of the population of people with T1D (the prevalence), which has further implications for the amount of resources consumed during the year concerned.
The scenarios of interest are characterised as follows:

Current scenario

This scenario is supposed to reflect the current situation concerning T1D in Bangladesh year 2001. This situation is characterized by restricted care both in terms of the number of people that have access to treatment and the level of insulin, medication and form of treatment offered to those that have access to some form of care. The scenario, which represents the key reference scenario, is based on estimates of patient-years actually experienced during the calendar year 2001 in Bangladesh. For the *Current scenario*, it is assumed that the population of T1D patients forms two groups. One group of patients (22.5%) with access to diabetes treatment and care; this group consists of an estimated fraction of 10% of the population who can afford to buy insulin, attend routine control visits to general practitioners and specialists and perform home glucose monitoring as needed. Another group is the 12.5% of the population that live close to some clinics where free care is offered to people without funds. The care and insulin dose offered to this group is on average not an optimal level. All remaining patients are assumed to have no access to treatment and care with accompanying higher mortality rates.

Worst scenario

This scenario is supposed to reflect the situation for T1D in Bangladesh, year 2001, if treatment and care in T1D had never been available. The scenario is based on estimates of patient-years experienced during the calendar year 2001 under this assumption.

Improved scenario

This scenario has been established to investigate the consequences of possible and realistic improvements in diabetes care (with implications for the number of patient-years and corresponding distributions by age group and complication status). The scenario is based on the same demographical model as the *Current scenario*, but based on the assumption that there is unlimited access to treatment and care for all patients with T1D on the same level as in the current scenario. Thus the scenario does not encounter optimal or sufficient care but unlimited access to a low level of care. It should be stressed that in the *Improved scenario* all rates of morbidity and mortality are kept identical with those applied to the patient segment with access to care under the *Current scenario*. The *Improved scenario* is

based on estimates of patient-years experienced during the calendar year 2001 under this assumption.

A specific cost variant of the improved scenario is presented in section 5 to illustrate, what the cost level would be in Bangladesh if the country were able to put the same level of resources (in PPP terms) in health care per patient year as currently available in a country like Denmark. This cost variant of the scenario assumes that more resources are available for diabetes treatment than current available in Bangladesh but the issues concerning organization, ability to comply and life style are not optimal; thus it is not assumed that the complications are absent. The results are presented in section 5. Results.

Ideal scenario

This scenario is supposed to reflect a situation where T1D – when appropriately treated – neither causes any excess mortality nor any excess morbidity. By implication this assumes that there is unlimited access to treatment and care for all patients. Compared to the improved scenario the treatment outcome is assumed to be perfect. All patients have a full dose of insulin (15 K pr year), access to blood glucose monitoring and routing diabetes control. Further it implies that people with diabetes have a life style that ensures optimal compliance. This may be difficult to imagine because the economic situation in Bangladesh is associated with a variety of health problems. The assumption here is that it is possible for people with diabetes through perfect self management to live with the disease without any additional complications caused specifically by diabetes. Thus people with diabetes in Bangladesh have the same probability of suffering from a number of other health problems existing in Bangladesh, but diabetes does not propose a specific cause of complications or death.

As described in the first methodology report, such improvements in diabetes care concerns a range of items including the enhancement of communication between people with the condition and their health care professionals; the improvement of communication and coordination among all healthcare professional groups; the promotion of effective self-management; the removal of patient and healthcare professional barriers to effective therapy; and, enabling improved psychosocial support for people with the condition (2). The case, though, is not as straight forward in a developing country. This is because there are so many other issues than diabetes conditions that impact the basic conditions of life. Therefore any measure focusing on a single disease will have a limited impact. This is also true for measures that rest on the existence of health care institutions, basic literacy and schooling as well as that affordability and individual surplus in every day life "to do the right thing" is available.

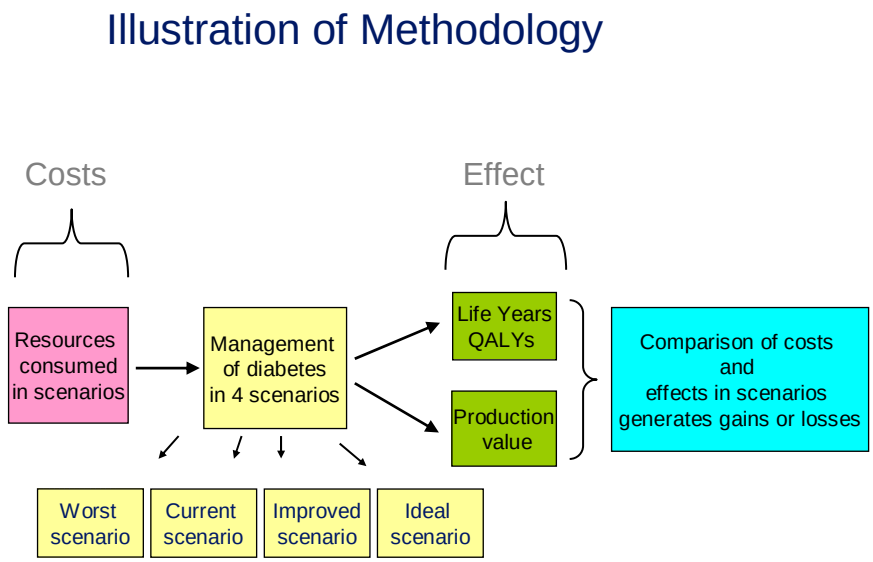
Thus, this scenario may, with due reservation, be used as a reference of what the potential is of further gains in productivity when compared with the *Current scenario*. The epidemiological modelling under this scenario uses longevity in the general population to obtain the hypothetical numbers of patient-years (all falling in the class of no complications). Thereby, the number of patient-years estimated under this scenario is adjusted for the mortality level in the general population.

It should be stressed that the current population of patients with T1D in Bangladesh has obtained its size and age composition as a consequence of various levels of access to insulin treatment as well as other types of medical treatment and care the preceding decades. Therefore, a comparison of patient-years experienced under the contrasting scenarios mentioned reflects the cumulative effect of limited access to insulin treatment over previous decades and cannot be interpreted as an isolated effect of various levels of insulin treatment during the year 2001.

Strategy of analysis

Fig. 1 illustrates the strategy of analysis for each scenario

Fig. 1. Strategy of analysis



In summary, our study is mainly based on scenarios and, for each of them, estimates of the population of people with T1D by age and complication status, and the associated costs and productivity items. Using the *Current scenario* as the reference, each of the other scenarios is evaluated with respect to

- the number of patient-years experienced with T1D
- the number of quality of life-adjusted patient-years experienced with T1D
- the cost of medical interventions in the hospital system and outside,
- the cost consequences of informal care by relatives and other informal care-givers
- the cost consequences of visits to GPs and specialist for patients and relatives,
- the foregone income from time lost due to sickness and reduced productivity by patients with T1D.

These items will be dealt with in accordance with up-to-date methodology in epidemiology and health economics, as reviewed in the first report of this series.

3. EPIDEMIOLOGICAL DATA

Epidemiological modelling

The epidemiology of T1D in Bangladesh is largely unknown, although the International Diabetes Federation has published estimated incidence and prevalence figures referring to the year 2000 and 2003 (1, 3, 4). These figures have been obtained from epidemiological modelling; using assumed incidence and mortality rates in a situation with epidemiological equilibrium, i.e. the annual number of new cases equals the annual number of deaths.

Due to shortage of reliable empirical data, a similar approach has been adopted for the purpose of the present study. For each scenario, the number of patient-years, which is estimated to be experienced during the year 2001, has been modelled using prevalence estimates by means of the key indicators shown in table 3.1. Adjustments for upgrades from one age group to the next have also been incorporated on the basis of best available clinical evidence.

Table 3.1 Key indicators by age group used in the epidemiological modelling.

	Age group				
	0-14	15-39	40-64	65+	Overall
Population size (in mill)	55	60	15	5	135
Incidence rate (per 10^5 person-years)	5.0	3.8	3.0	1.7	4.1
Mortality rates (per 100 patient-years)					
• "Worst"	100.0	100.0	100.0	100.0	100.0
• *Current*, no treatment and care	100.0	100.0	100.0	100.0	100.0
• *Current*, with treatment and care	10.0	15.0	25	40	15.5
• General population	1.0	2.0	3.0	7.5	3.6

This produces estimates of age-specific prevalence numbers referring to the year 2001. These numbers have been used as estimates of person-years experienced with T1D in Bangladesh during 2001 within each scenario.

Specifically for the *Worst scenario* of the present study, the mean duration from diagnosis to death has been assumed to take the value of 1.0 year regardless of age at onset with corresponding mortality rates at 100 deaths per 100 patient-years. Furthermore, all patient-years have been assigned to the complication state with most severe impairment, i.e. state 2 (see below).

For the *Current scenario*, it is assumed that the population of T1D patients forms two groups. One group of patients with access to diabetes treatment and care; this group includes an estimate of those (10% of the population) who can afford to buy insulin, attend routine control visits to general practitioners and specialists and perform home glucose monitoring on a daily basis, and an estimate of 12.5% of the population that live close to some clinic where free care is offered to those without funds. The care and insulin dose offered to this group is on average not an optimal level and use some form of free access to diabetes care. All remaining patients are assumed to have no access to treatment and care on a daily basis; thus the mortality rates in this group are assumed to be as high as in the *Worst scenario* (table 3.1).

The *Improved scenario* is a modification of the *Current scenario* in the sense that unlimited access to treatment and care is assumed. This scenario is therefore identical to the minority of the *Current scenario* who has access to daily treatment, care and home blood glucose monitoring as needed with identical morbidity and mortality rates.

For the *Ideal scenario*, mean duration (and hence mortality) have been assumed to follow the general population values for given age-at-onset. This ensures that the patients in this scenario have mortality levels identical with those of the general population. Furthermore, by assumption all patient-years have been assigned to the complication state without any impairment due to diabetes, i.e. state 0 (see below).

Assignment of patient-years to complication status

Both the costs of treating T1D and the quality of life are strongly associated with the presence of long-term (chronic) complications of diabetes. There is no routine data available in Bangladesh that permits a characterisation of the patient population by complication status. Therefore, attempts have been made in the present study to divide the prevalence population (stratified by age groups) of patients with T1D in Bangladesh for 2001 in three distinct categories of complication status, as indicated in table 3.2.

Table 3.2 Delineation of complication status

Complication status	Patient profile of complications
State 0: No signs of chronic complications; no impairment in daily living function	No signs of complications present
State 1: Signs of minor/early chronic complications; no or only minor (insignificant) impairment in daily living function	Retinopathy, not including proliferative retinopathy; and/or microalbuminuria; and/or light neuropathy without open ulceration;
State 2: Presence of chronic complications, with significant impairment in daily living function	Overt nephropathy, incl. end stage renal disease; and/or proliferative retinopathy and/or blindness; and/or history of stroke and/or myocardial infarction; and/or history of amputation (regardless of level)

Distribution of patient-years by scenario, age and complication status

Table 3.3 shows how the numbers of patient life-years during the calendar year have been assumed to be distributed by complication status, with reference to the various contrasting scenarios. Due to lack of available routine registration data, these distributions have been established on clinical judgment, guided by extrapolations from relevant literature. Table 3.3 consists of 5 sections, the first concerns the total number of people with diabetes in the the *Current scenario*, number two the number of people in the *Current scenario* who actually have access to diabetes care and receive some form of insulin treatment. In the *Improved scenario* it is assumed that all people with diabetes have access to the current level of treatment and some form of insulin treatment. In the *Ideal scenario* it is assumed that all people with diabetes have access to the optimal daily dose of insulin, blood glucose monitoring, treatment etc.

Table 3.3 Estimated patient-years by current age and complication status in contrasting scenarios

3.3.1 Current scenario					
Complication status	0-14	15-39	40-64	65+	Total
State 0	770	1,132	253	34	2,189
State 1	220	472	152	29	873
State 2	2,585	2,308	506	96	5,495
Total	3,575	3,912	911	159	8,557

3.3.2 Current scenario PATIENTS WITH ACCESS TO CARE AND INSULIN					
Complication status	0-14	15-39	40-64	65+	Total
State 0	770	1,132	253	34	2,189
State 1	220	472	152	29	873
State 2	110	283	101	21	515
Total	1,100	1,887	506	84	3,578

3.3.3 Worst scenario					
State 0	0	0	0	0	0
State 1	0	0	0	0	0
State 2	2,750	2,250	450	83	5,533
Total	2,750	2,250	450	83	5,533

3.3.4 Improved scenario					
State 0	7,698	11,320	2,532	336	21,886
State 1	2,200	4716	1,519	294	8,729
State 2	1,100	2,830	1,013	210	5,153
Total	10,998	18,866	5,063	841	35,768

3.3.5 Ideal scenario					
State 0	15,710	56,719	43,883	38,940	155,251
State 1	0	0	0	0	0
State 2	0	0	0	0	0
Total	15,710	56,719	43.883	38,940	155,251

4. COSTS STRUCTURE, EFFECTS AND METHODS OF VALUATION

Overview

There are several types of costs involved in the care and management of T1D for both the individual and the healthcare system. Moreover, survival may involve need of treatment for later complications. These types of costs are automatically included in the present study, as we have chosen a one-year window, and thereby included patients who may be at all possible stages in the life-course of their illness.

With regard to costs of treatment we follow the US Panel (5) and distinguish between costs of using:

- healthcare resources
- non-healthcare resources
- patients´ time
- informal care-givers´ time

Concerning effects we use three approaches:

- patient life years gained
- quality of life gained
- production value gained (both from the formal as well as the informal sector), measured in monetary units

The three approaches should be seen as alternative ways of expressing the effects rather than additive measures as there may be overlaps between them.

It should be stressed that all cost items have been estimated as those additive costs that may be considered attributable to the condition of diabetes. Thus, costs that would have been incurred by other diseases and conditions have not been included.

Before reviewing the establishment of the specific costs structure and its corresponding valuation, it is appropriate to comment upon some particular issues of relevance for health economics studies in a developing country like Bangladesh, such as the necessity of including economic activity that is not registered in a monetary market economy.

Economic conditions

The economic relations in a developing country are quite different from a well developed industrialised market-based economy. A substantial part of production is not fully registered in monetary terms. One reason is that the institutional framework for registering production activities, for instance a universal income tax system, does not exist. Another reason is that a large part of the basic production and consumption activities takes place in a barter economy without monetary transactions and finally that the household sector plays an important economic role. In order to neither over- nor underestimating the socio-economic consequence of healthcare improvement two different concepts for production value are used, a narrow concept based on production registered as GDP and a broader concept in which the value of household production and other production in the informal sector is included.

To take account of such characteristics of the economy in a developing country we distinguish between the:

- formal and informal production sectors
- workforce and unemployment
- productivity and income levels for formal and informal workers
- cash income and barter economy
- distribution and valuation of time for working and nursing (distinguishing between formal and informal caregivers).

Access to healthcare is characterised by:

- urbanisation/rural areas
- physical access to healthcare
- financial affordability.

Still, the methods used in valuation of costs are basically the same as in the report on Denmark and as described in report no 1 on methodology.

Living standard

Statistics show that the richest 20% of the population has an average income which is 5 times that of the 20% poorest group. (Income ratio of highest 20% to lowest 20%= 4.9 (6). Approximately 83% of the population live on less than 2 $ a day and approx 35% live below the national poverty line (7).

This study is based on the current average level of income in Bangladesh and, as far as possible, on local Bangladesh price data, sometimes expressed in US $. The average GDP is 350 US$/capita when converted to US $ by the official exchange rate. When expressed in purchasing power parity (PPP) (see below), it is equivalent to 1750 $ PPP GDP per capita (or 4.8 $ per capita a day) in 2001 (7b, 8).

To make the results more comparable with international data and, in particular, healthcare costs in the developed world, selected prices and results are also shown in PPP. All price

data and results in this study which are not explicitly denominated PPP are in local price levels. When expressed in PPP $, the Bangladesh income and price level should be increased by approximately 5 (7). When further converted to DKK, the official exchange rate of 8.32 DKK/US $ should be corrected to 8.42 DKK/US $ to take into account that the purchasing power of US $ was about 2% higher in Denmark than in the US in 2001 (9).

Thus, 100 taka =1.7 US $ (2001 exchange rate) = 8.5 PPP-US$, 100 taka = 15 DKK (2001) = 75 PPP-DKK.

(A table summarizing the unit price and cost data in US$, US$ (PPP), DKK, DKK (PPP) can be found in Appendix 1.)

Access to healthcare

Our model differentiates between those who can afford to pay for healthcare and those who receive free healthcare. The analysis is based on the assumption that 22.5% of the total population with type 1 and type 2 diabetes has real access to diabetes care. The estimated figures consist of 10% who can afford to pay for healthcare and 12.5% who have access to free healthcare. The background for the assumption is as follows: Only 10% are assumed to have an income that enables them to pay for healthcare services and medication at the current prices in Bangladesh (7c). They pay for healthcare provided by a private or public hospital. The rest of the population cannot afford to pay for healthcare and only receive treatment if there is a free (public or private) healthcare centre. A number of free clinics primarily in the urban areas and in the districts around Dhaka are offering treatment for people without means to pay. These clinics (10) estimate that they are in contact with approximately 50% of the people with diabetes in the urban areas. Approximately 25% (7d) of the population live in urban areas, and consequently an estimate of 12.5% (50% of people in the urban areas) of the total population with diabetes has physical access to a diabetes clinic. People living in rural areas do generally not have access to clinics or healthcare.

The formal and informal sector of economic activity

Two different economic sectors are assumed to exist side by side: the formal sector based on monetary flows where people are working for wage income, and an informal sector based on barter and household production. Besides household production like subsistence farming and care-giving the large informal sector includes trading and small-scale production. A large part of the average consumption is based on production from the informal sector and is therefore not registered as contribution to GDP.

About 45% the population is assumed to be working in the informal sector with household production, which is essential for the survival and basic needs of the family. The background is as follows: An estimate of the size of the formal versus the informal sector is made by looking at the age distribution of the population (population below 15, between 15 and 65, and above 65), and combining this with the official figures for the workforce and for unemployment. The classical way of looking at the workforce can be problematic in a developing country because people above 65 years and some children between 10 and 15 years, are probably part of the workforce. In contrast, some of the richest 10% are non-productive because domestic servants do all the housework.

The official figure of 64.1 m people registered in the ***official workforce*** in 1998 (8) (scaled to 67 m in 2001) amounts to 50 % of the population in Bangladesh and to 90% of the group between 15-65 years (75 mill people (7)). The total population of 135 m people is distributed as follows: people aged 15-65 (75 m people) amounts to 56% of the population; those below 15 and above 65 amounts to approx 41% (55 m people) and 4% (5 m people), respectively (11, 7). We assume that the ***real workforce*** includes people registered in the official workforce, the majority of those above 65 years who are physically able to work (all in complication group 0) and a share of those below 15 years (10% of those in complication group 0).

Although unemployment officially is registered to 35% of the workforce (8), there is no general unemployment benefit as well as no general old-age pension. Consequently, survival demands some kind of productive activity of the unemployed and old aged people with no other income. Assuming that the unemployed workforce (the unemployed population constitutes 35% of the official workforce or some 23 m people) work in the informal sector together with people above the age of 65 (5 m) and an arbitrary selection of 10% of the population under 15 (6 m), the result is an ***informal workforce*** of 34 m people. The ***formal workforce*** amounts to 44 m people (the 65% employed of the official workforce). The total ***real workforce*** is therefore assumed to amount to 78 m people. Thus 57% of the 135 m population is assumed to be productive.

Level of income in the formal sector and informal sector

In the following sections we distinguish between the per capita income in the population and the per capita income of productive people. The average income level in the formal sector has been set equal to the average GDP per active person in the formal sector equivalent to US$ 1056 (GDP for year 2001 Bill US$ 46/44 m persons in the formal workforce). This is based on the assumption that the value registered in the GDP is the result of economic activities in the formal sector.

It is assumed that the productivity in the informal sector is lower than in the formal sector and consequently the income is lower. An underlying assumption is that the productive population in the informal sector is equivalent to the poorest 45% of the population and that all income is used to cover basic needs.

We have not been able to find hard core data to estimate the income level in the informal sector. Instead we have looked at different sources of information about living standard, poverty and income inequality in Bangladesh to find a benchmark for the income level in the informal sector. We decided to use a study made by the World Bank and the Asian Development Bank (12) (see appendix 3 for two additional examples). According to the World Bank/Asian Development Bank study "one of the major differences distinguishing the income earning strategies of the poor from the rich is their tremendous high reliance on daily wage income". Data from the study shows that 50% of the population in year 2000 was poor measured by an upper poverty line based on cost of basic needs (CBN) of approx 719 taka per person per month. (based on geographic regions ranging from 582-971 taka per person per month). Measured by a lower CBN poverty line of approx 580 taka per capita per month (based on geographic regions ranging from 510-694 taka per person month) 34 % of the population was extremely poor. These statistics indicate an available per capita income in the informal sector between 580 and 719 taka per month (the average is 650 taka) equivalent to the cost of basic needs for 35-50% of the poorest part of the population. To be applicable as a measure for the average income for the productive part of the population in the informal sector this level must be scaled. As each of the 78 m people in the workforce supports 57 m people outside the workforce the average per capita figures must be divided with a factor 0,57 to find the average income of the productive population. Dividing 650 with 0,57 is equivalent to 1140 taka per month. This level is equivalent to 2/3 of the GDP (US$ 233 pr year).

Informal care-giving

An important non-healthcare cost is nursing. There are almost no formal nursing facilities in Bangladesh to take care of people in complication group 2. This places a large burden on the informal care-givers to care of people with high levels of complications, disabilities and dying patients. Especially low income informal care-givers are assumed to be burdened as they provide nursing for people who cannot afford to pay for healthcare, thus assumed to be in a highly disabled state. An important element in the *Improved scenario* compared to the current is the reduction of non healthcare resources as the number of people in need of nursing is reduced. This has significant implications for the time resources released for essential household production in the informal sector.

Relation between healthcare improvements and economic growth

Studies show that there is a relation between improved health and economic growth. There is a growing consensus that investments in health pays off productively leading to an assumption that improved economic activity from better healthcare will reinforce the ability to fund healthcare systems.

The WHO (13) has estimated that each 5 years improvement in life expectancy is associated with a increase in economic growth of about 0.3-0.5% per year providing other growth factors are equal. We have used these results to calculate the size of the increase in GDP which could be achieved in Bangladesh as a consequence of the increased survival in the *Improved scenario*.

Assuming that improvement of the life expectancy is general for the whole population, between 0.3% and 0.5% increased growth will accumulate to 6% to 10% over a period of 20 years. The period of 20 years has been selected because the assumed improvement in life expectancy in the *Improved scenario* is achieved during a period of 20 years. For our study we have only calculated the effect on the production value of the diabetes population as a sensitivity.

Costs structure and valuation

The details of the valuation of items of costs and production value applied to the scenarios are shown in table 4.1. The resulting costs structure and its application to the various categories of patient-years are summarised in table 4.2, referring to the *Current scenario*. Specific comments to the individual items are given below together with information on data sources.

Table 4.1 Valuation of costs items and productive value, with applications to scenarios

	Unit cost	*Current*	*Worse*	*Improved*	*Ideal*
Healthcare resources					
Hospitalisation (DKK per admission day	US$ 18.9 DKK 158	Access: 42%	Access: 0%	Access: 100%	Access: 100%
Treatment with insulin (1000 units) (100% of treated patients)	US$ 7.9 DKK 66	Access: 42%	Access: 0%	Access: 100%	Access: 100%
Treatment with other drugs (DKK per year)	US$ 6 DKK 50	Access: 42%	Access: 0%	Access: 100%	Access: 100%
Visits to GP/specialist (DKK per visit)	US$ 2 DKK 17	Access: 42%	Access: 0%	Access: 100%	Access: 100%
Home monitoring (DKK per year)	US$ 117 DKK 976	Access: 10%)	Access: 0%	Access: 100%	Access: 100%
Non-Healthcare resources					
Nursing by informal caregivers (1/3 of their productive value/time per year)	US$ 77 US$ 391 (PPP) DKK 641 DKK 3,257 (PPP)	Patient-years in complication state 2	Patient-years in complication state 2.	Patient-years in complication state 2	Not applied
Patients' time					
Loss of production value during routine controls (½ day)	US$ 0.9 US$ 5 (PPP) DKK8 DKK40 (PPP)	all productive persons	NA	all productive persons	Not applied
during hospital admissions (pr day)	US$ 1.9 US$10 (PPP) DKK 16 DKK79 (PPP)	all productive persons	NA	All productive persons	
10% related to discomfort during 50% of work time	US$ 0.2 US$ 1 (PPP) DKK 1,6 DKK 8 (PPP)	All productive persons in complication group 1.	NA	All productive persons in complication group 1	Not applied
Informal caregivers' time					
Loss of production for relatives during routine control and admissions of children (DKK per day)	US$ 0.32 US$1.6 (PPP) DKK 2.66 DKK 14 (PPP)	Applied to patient-years in age 0-14 and for people in complication group 2	Not applied	Applied to patient-years in age 0-14 and for people in complication group 2	Applied to patient-years in age 0-14

Production value/socio-economic data					
GDP : US$ income per capita (formal sector)	US$ 686 US$ 3,487 (PPP) DKK 5,707 DKK29,015 (PPP)	25% of type 1 patients are productive (ages above 15 except in compli-cation state 2)	No productive patients in type 1	60% of type 1 patients (ages above 15 except in complication state 2)	91% type 1 patients (ages above15 years)
US$ income per capita (informal sector) 2/3 of GDP/capita:	US$ 233 US$ 1,167 (PPP) DKK 1,941 DKK 9,870 (PPP)				

In appendix 1 a table showing the cost units in US PPP and DKK PPP can be found.

Table 4.2 Overview of costs structure and its application to categories of patient-years. Cost and productivity per patient-year

COSTS and PRODUCTIVITY *per patient-year*

			Number of units *per patient-year* by current age group and complication state:											
			0 - 14			15 - 39			40 - 64			65+		
Item	Unit	Cost per unit (DKK)	0	1	2	0	1	2	0	1	2	0	1	2
Healthcare Resources														
Hospitalization	Cost pr day	158	0	5	10	0	5	10	0	5	10	0	5	10
Medication with insulin	1000 units of insulin	66	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5
Medication with oral antidiabetics	One day´s treatment	0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Medication with other drugs	One year´s treatment	50	0,00	0,00	1,00	0,00	0,00	1,00	0,00	0,00	1,00	0,00	0,00	1,00
Routine diabetes controls	One average visit	17	5	10	15	5	10	15	5	10	15	5	10	15
Home monitoring	One year´s activities	976	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Non-Healthcare Resources														
Annual cost for nursing assistance in the home, full-time (1/3 of an informal care giver's time)	One year´s cost	641	0,000	0,000	0,994	0,000	0,000	0,994	0,000	0,000	0,994	0,000	0,000	0,994
Patients´ time														
Loss of production value during routine controls. Abseenteism	Cost per day of visit	3	1	0	0	5	10	0	5	10	0	5	0	0
Loss of production value during admissions	Cost per working day	7	0,00	0,00	0,00	0,00	5,00	0,00	0,00	5,00	0,00	0,00	5,00	0,00
Loss of production value related to discomfort during work (-10%)	Cost per working day	0,65	0	0	0	0	115	0	0	115	0	0	0	0
Informal care-givers´ time														
Loss of production value during routine controls. Abseenteism	Cost per day of visit	2,66	5	10	15	0	0	15	0	0	15	0	0	15
Production value														
Income by working	One year' s aver. income	2.378	0,10	0,00	0,00	1,00	1,00	0,00	1,00	1,00	0,00	1,00	0,00	0,00
Income by working (informal sector)		1.941												

Healthcare resources

Healthcare resources consist of costs of hospitalisation, treatment with insulin and other drugs, and visits to general practitioners and specialists.

Hospitalisation costs

It has not been possible to find any average costs data based on aggregated data on total national hospitalisation costs divided by the actual days in hospital and number of actual treatments carried out. Instead costs data from various sources has been gathered and used to check the validity of the estimates that we have created. The activities only apply to the subset of the population with access to care and treatment (assumed 22.5%).

The different figures are listed as follows:

- First part of a Health Facility Efficiency study (14) undertaken by the Ministry of Health in Dhaka found the following average costs (in 1999) : 66 taka per outpatient day visit in Thana Health Complexes and 55 taka in District hospitals; 521 taka per inpatient day in Thana health complexes and 182 taka in district hospitals
- Data gathered from Mirpur general hospital (see appendix 2) show that the cost of a hospital bed is between 72 taka for a bed in ward and 615 taka for a VIP cabin while a bed in a private hospital range between 300 and 2.500 taka. The median of the information from the private hospital is 1400 taka pr bed (see appendix 2). The study also shows that approximately 1/3 of the cost is covered by income from patients' fees,.
- A third study from Gonoshastathaya Kendra Hospital, Savar (15), presents a cost pr patient day of 525 taka (Gynecology and Obstetrics). The cost of hospital activities related to gynecology and obstetrics is considered less costly compared to treatment of diabetes related hospitalisation.

This illustrates that the cheapest bed in a ward (72 taka or 1.26 $) costs more than the available income for 34% of the population who live on less than 1 $ a day and 60% of the available income for 83% of the population who live on less than 2 $ a day.
Our model differentiates between those who can afford to pay for healthcare and those who receive free healthcare. Statistics show that the richest 10% of the population has an average income which is 6-7 times that of the poorest group (7).
It should also be noticed that typically a share of the hospital beds is reserved for patients who cannot afford to pay. Two important issues must be mentioned. The price may be underestimating the real cost of the service provided because only a share of the patients cover the full cost from their pay thus the government is providing the missing funds or it could illustrate that the service provided is very limited and basic.
Based on the frequency of hospital admission across patient groups (see table 4.2) used in this study, 980 hospital beds are assumed to be occupied by type 2 patients on a yearly basis. The total number of hospital beds in Bangladesh is approx 37,000 (11).

On the basis of the above cost information we (rather arbitrarily) use a cost of a hospital bed of 521 taka in 1999 prices scaled to 600 taka in 2001 prices equivalent to 10.5 US$ for free hospital admissions, and 1.400 taka (2001) for those that can afford to pay equivalent to approximately US $ 24.7 for hospital admissions covered by a patient fee. This results in an average price of 960 taka or US$ 16.8 when the weights for patients that can afford to pay/cannot afford to pay is applied. 15% is added to take account of the depreciation and capital cost of healthcare facilities leading to an average price of 1103 Taka or 18.9 US$ pr hospital day (158 DKK (2001).

Other Healthcare costs

The estimates have been based on local assessments as reviewed in internal reports (16). Furthermore, specific 'ad hoc' enquiries have been performed in Bangladesh by consultant companies (see Appendix 2).

Cost of insulin consumption

From inquiries from Birdem and private pharmacies (see appendix 2) the following insulin prices have been obtained. The table shows that the prices vary substantially.

Table 4.3 Cost of insulin consumption

	US$	*units*	*per year*	*US$ per KU*	*DKK per KU*	*Source *)*
Disposable Syringes with needles/pc	0.11	364	40.0	2.7	22.2	Novo internal data
Disposable Syringes with needles/pc	0.03	364	10.9	0.7	6.1	3 -5ml Birdem
Disposable Syringes with needles/pc	0.09	364	32.8	2.2	18.2	1-10 ml pharmacies
Disposable Syringes with needles/pc	0.12	364	43.7	2.9	24.2	1-10 ml pharmacies
Disposable Syringes with needles/pc	0.26	364	94.6	6.3	52.5	20 ml pharmacies
Human Insulin/day (40 iu/day)	0.37	364	134.7	9.0	74.7	Novo internal data
Human Insulin/day (40 iu/day)	0.13	364	47.3	3.2	26.2	pharmacies 1
Human Insulin/day (40 iu/day)	0.18	364	65.5	4.4	36.3	pharmacies 2
Human Insulin/day (40 iu/day)	0.21	364	78.1	5.2	43.3	Average
Human Insulin/day (40 iu/day) plus disposable syringer with needles/pc	**0.32**	**364**	**118.1**	**7.9**	**65.5**	**Average including syringes**

*) See appendix 2 for background. pc: piece and iu: international units, 40 iu is the average dose per day.

Depending on the patients' income the cost of insulin and hospitalisation range from free of charge to 100%. The cost of insulin varies considerably in Bangladesh. The highest prices from pharmacies are on a level that limits the affordability even among the 10 % that is assumed to be able to pay for their own health care. Prices from pharmacies range from US$ 0.13-0.18 for a daily dosis of 40 iu to US$ 4.2 for 40 iu. Internal Novo Nordisk price information points to a price level of 0.37 US$/40 iu. Table 4.3 shows that an average price based on the lower-end information is 0.32 $ inclusive syringes. This price is equivalent to 66 DKK/KU.

To verify this, another calculation was performed on the basis of an estimated market value data as follows: According to IMS the total market of insulin in Bangladesh has a value of approximately 50 Mill. DKK. The total market in units is estimated to approx 800 MU (16). The average value of this gives 63 DKK/KU which is very close to the above mentioned lower end average of 66 DKK/KU.

Our estimate is based on an average of 66 DKK (7.9 US$) per K-units insulin (1000 units). Only the 10% richest part of the population (approximately 44% of people with access to healthcare) is assumed to use insulin on a regular basis. The share of patients assumed to visit free clinics use insulin only if they receive it in a free clinic. Using this average price and assuming a consumption of 7.5 K-units of insulin per patient-year (on average 20 units per day) the annual cost of insulin for a patient-year is DKK 491 (59 US$). In the *Improved scenario* it is assumed that every body in need has access to a low level of insulin (7.5 K-units per patient-year). In the *Ideal scenario* it is assumed that all diabetic patients consume 15 K-units per patient-year, which is considered the optimal level of insulin consumption.

Routine visits at General Practicians (GP) and specialists

Table 4.4 Cost of visits to GP and specialists

Consultations	US$	Source*)
GP consultations pr visit	0.86	Mirpur General hospital, Dhaka
GP consultations pr visit	1.75	Mirpur General hospital, Dhaka
GP consultations pr visit	2	Novo internal data
Specialists pr visit	5.18	Mirpur General hospital, Dhaka
Specialists pr visit	6.9	Mirpur General hospital, Dhaka
Specialists pr visit	6	Novo internal data
Average		**Distribution of visits**
Average GP consultations	1.5	90%
Average specialist consultations	6.0	10%
Costs per visit	**2**	

*) See appendix 2

The data used for estimating the cost of a routine visit to the general practitioners was obtained through various enquires by consultants (Appendix 2) and supplemented by internal Novo Nordisk information (16). The items included:

- Cost of GP visits
- Cost of specialist visits.

An average has been calculated on the basis of available data and is based on 10% specialist visits and 90% GP visits. The average cost is 2 US$ or 17 DDK. Visits to GPs also cover the cost of outpatient visits in hospitals (free visits as well as visits covered by fees). On average each patient visits an outpatient health facility 8-9 times a year. This is a result of irregular access to insulin and other treatment that lead to acute complications like coma and other illness. The average figures cover larger variations in visit frequency between different age and complication groups.

Home blood glucose monitoring

Prices related to consumption and costs of strips/meters have been obtained through a survey performed by consultants (Appendix 2) and supplemented with internal Novo Nordisk data (16).
The approximate annual costs are presented in table 4.5

Table 4.5 Selected costs of blood glucose meter and strips.

	US$	Life time (years)	Per year	Source*)
Blood glucose meter	60.8	3	20.27	Novo Nordisk internal data
Blood glucose meter	60.47	3	20.7	Birdem
Blood glucose meter	69.11	3	23.0	Birdem
Blood glucose meter	65.65	3	21.9	Pharmacies
Blood glucose meter	69.11	3	23.0	Pharmacies
	US$	Units	Per year	
Blood glucose strip/pc	0.48	200	96	Novo Nordisk internal data
Blood glucose strip/pc	0.47	200	94	Birdem
Blood glucose strip/pc	0.35	200	70	Birdem
Blood glucose strip/pc	0.41	200	82	Pharmacies
Blood glucose strip/pc	0.48	200	96	Pharmacies
Urine Strip/pc	0.04	200	8	Novo Nordisk internal data

*) See appendix 2, Pc: piece

Table 4.6 Average cost of blood glucose meter and strips

Average	US$	DKK
Average blood glucose meter	**21.7**	**180.3**
Average blood glucose strip/pc	**87.6**	**728.8**
Urine strip/pc	**8**	**66.6**
Price per patient per year	**117.3**	**975.7**

The average cost of using a glucose meter per year has been calculated to US$ 117.3 (DDK 976) based on an expected life-time of the glucose meter of 3 years. It is assumed that only 10% of the population (44% of those treated with insulin) performs home monitoring on a regular basis and – on average – such patients perform a blood glucose measurement 4 times a week (200 strips pr year). In the *Ideal* and *Improved scenario* all type 1 patients are assumed to perform home glucose monitoring on a regular basis.

The cost of time resources and production value

The valuation of time is based on the human capital approach. Thus, the production value and use of time resources are measured by the average income from working. No hard national statistical income data are available from Bangladesh why an estimate is made from two income levels shown in the table below. Table 4.7 summarises the income elements from the formal sector and the informal sector. In the formal sector it is assumed that the income level is equivalent to GDP per active person in the formal sector (US$ 1056). The weight of the formal sector is 55%. In the informal sector the income level is assumed to be

2/3 of the GDP per capita (US$ 350) and based on a 45% weight. The reasons for choosing these are described in the section "Formal and informal economic activity". The average income level is calculated to US$ 686 or US$ 3,487 (PPP).
Every time a productive person with diabetes in complication group 0 and 1 visits a doctor or is admitted to a hospital there will be a loss in terms of the value of time in paid or unpaid production. This loss is included in the calculation as described below. It is assumed that visiting a clinic or a doctor takes half a working day both for a patient and for relatives who accompany a child, an elderly person or a disabled person (typically complication group 2).

- Average daily income (formal sector): DKK 24 (3 US$)
- Average daily income (informal sector): DKK 5 (0.64 US$)
- Loss of income during admission: a full day's income pr admission day
- Loss of income during routine control (DKK pr day): 50% of a day's income.

Table 4.7 Level of income, Bangladesh 2001.

	Formal sector	**Informal sector**	**Average income by working**
Distribution by sector	55%	45%	100%
2001 DKK	DKK 8,788 (24 DKK/day) DKK 44,680 (PPP)	DKK 1,941 (5.3 DKK/day) DKK 9,870 (PPP)	DKK 5,707 (16 DKK/day) DKK 29,015 (PPP)
2001 US$	US$ 1,056 (3 US$/day) US$ 5,370 (PPP)	US$ 233 (0.6 US$/day) US$ 1,186 (PPP)	US$ 686 (1.9 US$ (3,487) (PPP)
Assumptions	GDP per active person in formal sector	2/3 of GDP per capita	Average

Productive persons in complications group 1 are assumed to suffer from 10% reduced productivity during 50% of the working time as a consequence of discomfort from the diabetes condition.

Non-healthcare resources - costs of nursing

Formal nursing in public institutions of patients with severe complications is not typical in Bangladesh. Nursing of patients primarily takes place in the home through the efforts of relatives and family. The cost of nursing is measured by the value of time of people in the informal sector. In a household with a severely disabled diabetic person (complication group 2) it is assumed that 1/3 of the productive time of a homemaker has to be dedicated to assisting the patient in need.

- Value of informal time per year: (2/3 of GDP per capita US$ 350 = 233 (or 1,186 PPP-US$), or 1,941 DKK = 9,870 PPP-DKK.
- Informal care-givers time allocated to nursing : 1/3
- Cost of informal nursing pr year: DKK 641 (US$ 77) or in PPP-DKK 3,257 (US$ 391)

Assessment of quality of life effects

The effect from having T1D is expressed on the basis of numbers of patient-years experienced under the contrasting scenarios. We have furthermore attempted to perform an adjustment of the patient-years by using a generic (non-disease specific) quality of life (QoL) questionnaire; the EQ-5D (17). The reason for choosing EQ-5D is that it has been extensively validated in a wide range of countries with acceptable results, although at the present moment we do not know to which extent it is valid in Bangladesh. Yet another reason for choosing the EQ-5D is that the instrument yields an index (in contrast to profiles). This makes it possible to directly generate Quality-adjusted Patient Life Years (QALYs), a measure that makes it possible to include changes in QoL into health economic calculations. This is not possible from profiles as they only present QoL in different categories and not as a single number, which is necessary in order to adjust patient-years for quality.

EQ-5D identifies the quality of life of a person on a preference based scale between 0 (death/worst imaginable health state) and 1 (best imaginable health state). Thus, any kind of health state can be translated into a numerical value between 1 and 0. This number can then be used to adjust the length of a person's life with this health state into a health status measure which is a number of quality-adjusted patient-years (QALYs). An effect measure is the gain in QALYs. In practice the number of patient-years or months lived in this state will be multiplied by the number representing the health state. If a person has a reduced health state, e.g. limited mobility due to a car accident, the value of this health state may be e.g. 0.64. The quality-adjusted value of one year lived in this state is then 1 x 0.64 = 0.64 i.e. 64% of 1 year lived with full health.

Specifically EQ-5D operates in five dimensions; mobility, personal care, ordinary daily activities, pain/discomfort, and anxiety/depression. For each dimension score 1 means no problems at all while score 3 means severe problems. By means of regression analysis, as suggested by Greiner et al. (17), all possible compound scores have been assigned a value between 0 and 1 with the value 0 indicating lowest possible level of QoL and the value 1 indicating maximal QoL.

A group of selected diabetes nurses have translated a number of typical diabetes health states into the descriptive health states as used in the EQ-5D questionnaire. This way we obtained EQ-5D weights to a number of health states that are typical for diabetes patients.

According to these results we have used the QoL-coefficients of 0.95, 0.85 and 0.65 for patient-years experienced in complication states 0, 1 and 2, respectively. This approach is discussed in the methodology report and in the discussion section of this paper.

The coefficients obtained for quality-adjustment of diabetic patient-years in Denmark have been applied without further adjustment to the patient population of Bangladesh.

5. RESULTS

Costs

Tables 5.1, 5.2, 5.3 and 5.4 show the detailed estimates of costs in the four scenarios *Current*, *Worst*, *Improved* and *Ideal*, respectively.

Particularly for the *Current scenario*, key results are summarised below in fig. 5.1 and fig. 5.2.

Fig. 5.1a T1D in Bangladesh, year 2001, Current scenario, total costs (mil. DKK) by main categories according to age groups

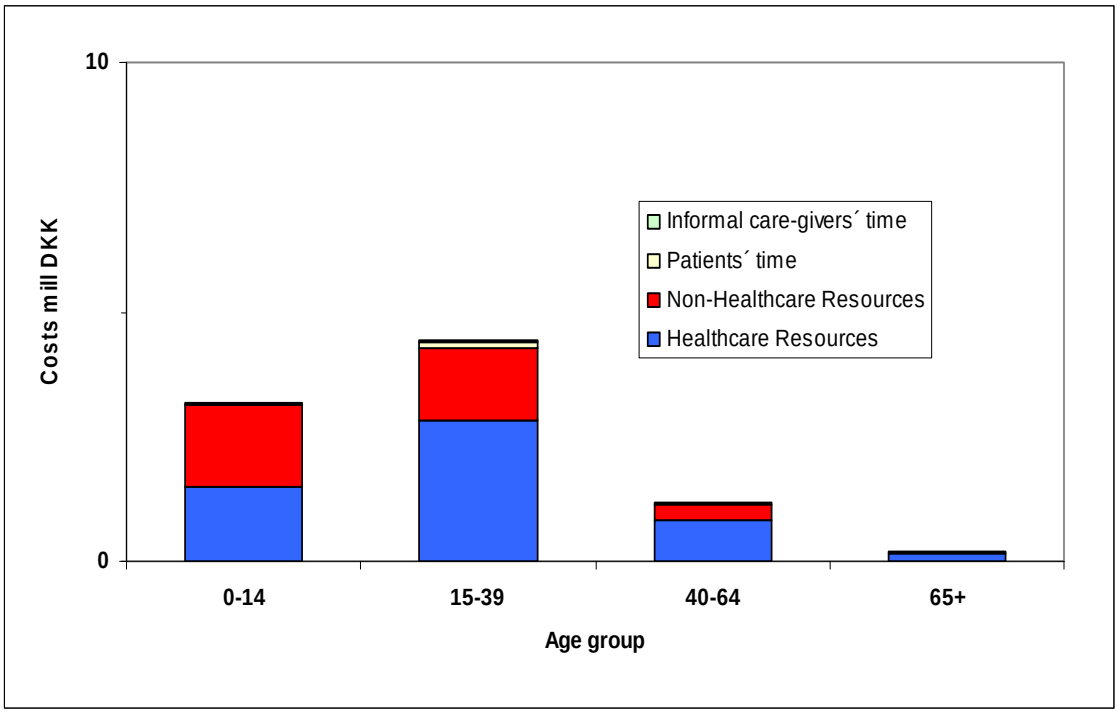


Fig. 5.1b T1D in Bangladesh, year 2001, Current scenario, total costs (mill. DKK) by main cost drivers among health care costs according to age groups

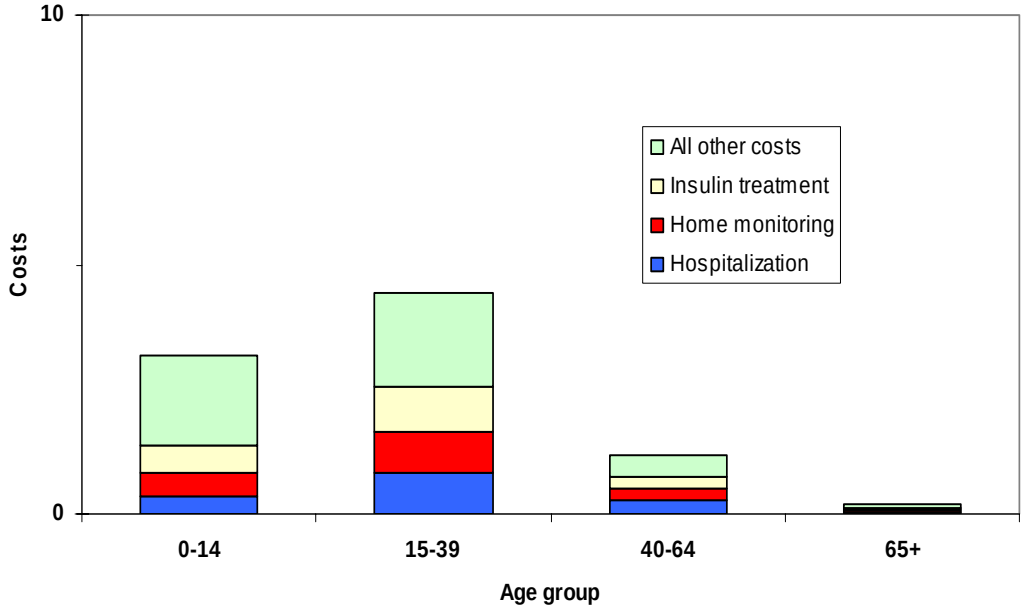


Figure 5.1a The age group 15-39 years has the highest total cost as a consequence of the largest number of patient lives in this age group. The low level of costs in the 65+ group reflects that very few patients are alive in this group. In relative terms health care resources are the most important cost item growing with growing age. The overall relative minor importance of non health care costs is a consequence of the informal character of the care-taking and the low cost attached to this item. The non health care costs are largest for the young groups as a consequence of the number of surviving people in complication group 2 is relatively larger than among the older age groups.

Figure 5.1b shows that overall hospitalisation costs are between 11 and 27% of the total costs, relatively largest for the age group above 64 years. Both insulin and home monitoring are as heavy cost items as hospitalisation. The relative large share of home monitoring is not a reflection of wide spread application of blood glucose monitoring but only that monitoring appliances are expensive The cost item "all other cost" consisting primarily of informal nursing of people in complication group 2 is dominating in the youngest age group only.

Fig. 5.2a T1D in Bangladesh, year 2001, Current scenario, total costs (mill DKK) by main categories according to complication status.

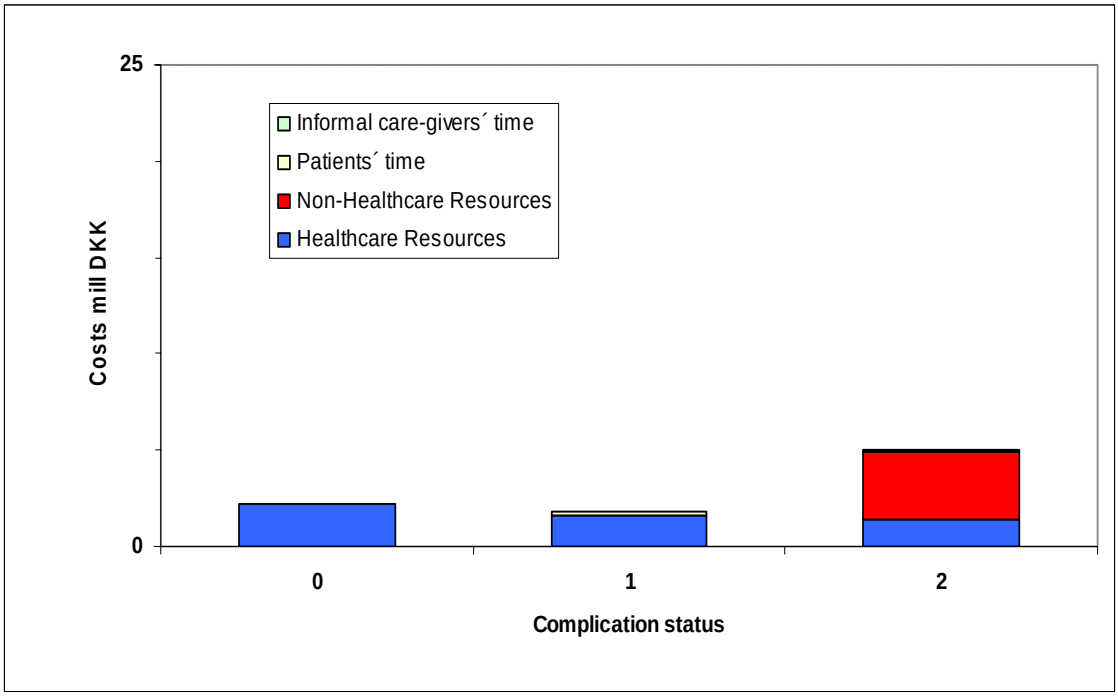


Fig. 5.2b T1D in Bangladesh, year 2001, Current scenario, total costs (mill DKK) by main cost drivers among health care costs according to complication status.

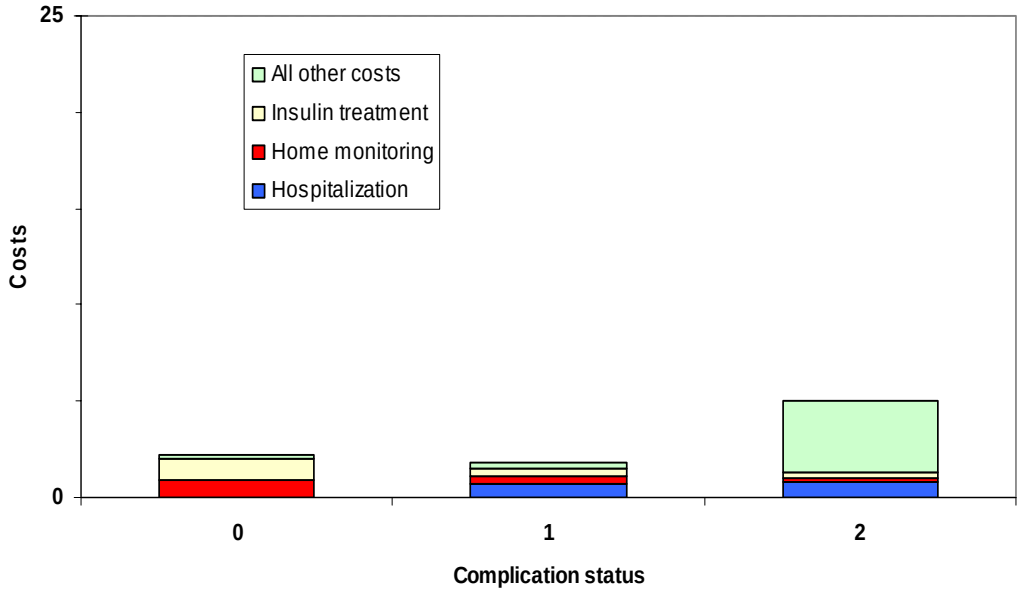


Fig. 5.2a and b illustrate the total costs by complication status. The patient-years experienced in complication group 2 (with severe impairment) carry the highest costs. Because of the low level of access to diabetes treatment and care in the *Current scenario*, complication group 2 represents also the highest number of patient-years (64%) and the heaviest burden on informal caregivers in this group (non health care cost in 5.2a and "all other costs" in 5.2b).

Table 5.1 Details of costs under the Current scenario, by age group and complication status. All values in mill. DKK, 2001.

	TOTAL	0 - 14			15 - 39			40 - 64			65+		
		0	1	2	0	1	2	0	1	2	0	1	2
TOTAL	***9,0***	***0,8***	***0,4***	***2,0***	***1,2***	***1,0***	***2,3***	***0,3***	***0,3***	***0,6***	***0,0***	***0,1***	***0,1***
Healthcare Resources	***5,3***	***0,8***	***0,4***	***0,3***	***1,1***	***0,9***	***0,8***	***0,3***	***0,3***	***0,3***	***0,0***	***0,1***	***0,1***
Hospitalization	1,5	0,0	0,2	0,2	0,0	0,4	0,4	0,0	0,1	0,2	0,0	0,0	0,0
Medication with insulin	1,8	0,4	0,1	0,1	0,6	0,2	0,1	0,1	0,1	0,0	0,0	0,0	0,0
Medication with oral antidiabetics	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Medication with other drugs	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Routine diabetes controls	0,5	0,1	0,0	0,0	0,1	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Home monitoring	1,6	0,3	0,1	0,0	0,5	0,2	0,1	0,1	0,1	0,0	0,0	0,0	0,0
Non-Healthcare Resources	***3,5***	***0,0***	***0,0***	***1,6***	***0,0***	***0,0***	***1,5***	***0,0***	***0,0***	***0,3***	***0,0***	***0,0***	***0,1***
Annual cost for nursing assistance in the home, full-time (1/3 of an informal care giver's time)	3,5	0,0	0,0	1,6	0,0	0,0	1,5	0,0	0,0	0,3	0,0	0,0	0,1
Patients´ time	***0,1***	***0,0***	***0,0***	***0,0***	***0,0***	***0,1***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***
Loss of production value during routine controls. Abseenteism	0,0	0,0007	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0003	0,0	0,0
Loss of production value during admissions	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Loss of production value related to discomfort during work (-10%)	0,1	0,0	0,0	0,0	0,0	0,0848	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Informal care-givers´ time	***0,1***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***
Loss of production value during routine controls. Abseenteism	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Production value	***12,1***	***0,4***	***0,0***	***0,0***	***6,5***	***2,7***	***0,0***	***1,4***	***0,9***	***0,0***	***0,2***	***0,0***	***0,0***
Income by working	12,1	0,4	0,0	0,0	6,5	2,7	0,0	1,4	0,9	0,0	0,2	0,0	0,0

Table 5.2 Details of costs under the Worst scenario, by age group and complication status. All values mill. DKK, 2001

	TOTAL	0 - 14			15 - 39			40 - 64			65+		
		0	1	2	0	1	2	0	1	2	0	1	2
TOTAL	***5,8***			***2,9***			***2,3***			***0,5***			***0,1***
Healthcare Resources	***2,2***			***1,1***			***0,9***			***0,2***			***0,0***
Hospitalization	2,0			1,0			0,8			0,2			0,0
Medication with insulin	0,0			0,0			0,0			0,0			0,0
Medication with oral antidiabetics	0,0			0,0			0,0			0,0			0,0
Medication with other drugs	0,3			0,1			0,1			0,0			0,0
Routine diabetes controls	0,0			0,0			0,0			0,0			0,0
Home monitoring	0,0			0,0			0,0			0,0			0,0
Non-Healthcare Resources	***3,5***			***1,8***			***1,4***			***0,3***			***0,1***
Annual cost for nursing assistance in the home, full-time (1/3 of an informal care	3,5			1,8			1,4			0,3			0,1
Patients´ time	***0,0***			***0,0***			***0,0***			***0,0***			***0,0***
Loss of production value during routine controls. Abseenteism	0,0			0,0			0,0			0,0			0,0
Loss of production value during admissions	0,0			0,0			0,0			0,0			0,0
Loss of production value related to discomfort during work (-10%)	0,0			0,0			0,0			0,0			0,0
Informal care-givers´ time	***0,0***			***0,0***			***0,0***			***0,0***			***0,0***
Loss of production value during routine controls. Abseenteism	0,0			0,0			0,0			0,0			0,0
Production value	***0,0***			***0,0***			***0,0***			***0,0***			***0,0***
Income by working	0,0			0,0			0,0			0,0			0,0

Table 5.3 Details of costs under the Improved scenario, by age group and complication status. All values in mill. DKK, 2001.

	TOTAL	0 - 14			15 - 39			40 - 64			65+		
		0	1	2	0	1	2	0	1	2	0	1	2
TOTAL	***78,6***	***12,1***	***5,4***	***4,4***	***18,0***	***13,0***	***11,4***	***4,0***	***4,2***	***4,1***	***0,5***	***0,7***	***0,8***
Healthcare Resources	***72,3***	***11,9***	***5,3***	***3,7***	***17,5***	***11,4***	***9,5***	***3,9***	***3,7***	***3,4***	***0,5***	***0,7***	***0,7***
Hospitalization	15,0	0,0	1,7	1,7	0,0	3,7	4,5	0,0	1,2	1,6	0,0	0,2	0,3
Medication with insulin	17,6	3,8	1,1	0,5	5,6	2,3	1,4	1,2	0,7	0,5	0,2	0,1	0,1
Medication with oral antidiabetics	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Medication with other drugs	0,3	0,0	0,0	0,1	0,0	0,0	0,1	0,0	0,0	0,1	0,0	0,0	0,0
Routine diabetes controls	4,5	0,6	0,4	0,3	0,9	0,8	0,7	0,2	0,3	0,3	0,0	0,0	0,1
Home monitoring	34,9	7,5	2,1	1,1	11,0	4,6	2,8	2,5	1,5	1,0	0,3	0,3	0,2
Non-Healthcare Resources	***3,3***	***0,0***	***0,0***	***0,7***	***0,0***	***0,0***	***1,8***	***0,0***	***0,0***	***0,6***	***0,0***	***0,0***	***0,1***
Annual cost for nursing assistance in the home, full-time (1/3 of an informal care	3,3	0,0	0,0	0,7	0,0	0,0	1,8	0,0	0,0	0,6	0,0	0,0	0,1
Patients´ time	***2,7***	***0,0***	***0,0***	***0,0***	***0,4***	***1,6***	***0,0***	***0,1***	***0,5***	***0,0***	***0,0***	***0,0***	***0,0***
Loss of production value during routine controls. Abseenteism	1,1	0,0	0,0	0,0	0,4	0,4	0,0	0,1	0,1	0,0	0,0	0,0	0,0
Loss of production value during admissions	0,5	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,1	0,0	0,0	0,0	0,0
Loss of production value related to discomfort during work (-10%)	1,1	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,3	0,0	0,0	0,0	0,0
Informal care-givers´ time	***0,4***	***0,1***	***0,1***	***0,0***	***0,0***	***0,0***	***0,1***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***	***0,0***
Loss of production value during routine controls. Abseenteism	0,4	0,1	0,1	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Production value	***120,9***	***4,4***	***0,0***	***0,0***	***64,6***	***26,9***	***0,0***	***14,4***	***8,7***	***0,0***	***1,9***	***0,0***	***0,0***
Income by working	120,9	4,4	0,0	0,0	64,6	26,9	0,0	14,4	8,7	0,0	1,9	0,0	0,0

Table 5.4 Details of costs under the Ideal scenario by age group and complication status. All values in mill. DKK, 2001.

	TOTAL	0 - 14			15 - 39			40 - 64			65+		
		0	1	2	0	1	2	0	1	2	0	1	2
TOTAL	***322,6***	***32,3***			***118,0***			***91,3***			***81,0***		
Healthcare Resources	***316,9***	***32,1***			***115,8***			***89,6***			***79,5***		
Hospitalization	0,0	0,0			0,0			0,0			0,0		
Medication with insulin	152,6	15,4			55,8			43,1			38,3		
Medication with oral antidiabetics	0,0	0,0			0,0			0,0			0,0		
Medication with other drugs	0,0	0,0			0,0			0,0			0,0		
Routine diabetes controls	12,8	1,3			4,7			3,6			3,2		
Home monitoring	151,5	15,3			55,3			42,8			38,0		
Non-Healthcare Resources	***0,0***	***0,0***			***0,0***			***0,0***			***0,0***		
Annual cost for nursing assistance in the home, full-time (1/3 of an informal care	0,0	0,0			0,0			0,0			0,0		
Patients´ time	***5,5***	***0,1***			***2,2***			***1,7***			***1,5***		
Loss of production value during routine controls. Abseenteism	5,5	0,1			2,2			1,7			1,5		
Loss of production value during admissions	0,0	0,0			0,0			0,0			0,0		
Loss of production value related to discomfort during work (-10%)	0,0	0,0			0,0			0,0			0,0		
Informal care-givers´ time	***0,2***	***0,2***			***0,0***			***0,0***			***0,0***		
Loss of production value during routine controls. Abseenteism	0,2	0,2			0,0			0,0			0,0		
Production value	***805,3***	***9,0***			***323,7***			***250,4***			***222,2***		
Income by working	805,3	9,0			323,7			250,4			222,2		

A summary of costs is presented in table 5.5. The costs in the *Current scenario* are the same level as the estimated costs in the *Worst scenario*, i.e. the hypothetical situation without access to treatment and care. However, the costs under the *Improved scenario* are much higher than under the *Current scenario*. This illustrates that the current situation for T1D in Bangladesh is closer to the *Worst scenario* than to the *Improved scenario*. The very low level of costs involved treating type 1 diabetes reflects that only a fraction of T1D patients survive and receive treatment. The costs under the *Ideal scenario* are substantially higher than the estimated costs in the *Current* and *Improved scenario*. This illustrates that the level of treatment in the *Improved scenario* is far from ideal. The *Ideal scenario* results in 4 times more patient-years as a result of improved survival compared to the *Improved scenario* and more than 18 times more patient-years compared to the *Current scenario* (se table 5.6). It should also be stressed that in the *Worst* and *Current scenarios*, respectively, the non-healthcare costs (primarily informal nursing) are two and half the size of the healthcare costs while both in the *Improved* and *Ideal scenario* the non-healthcare costs are diminutive. The assumption of lack of sufficient treatment in the *Worst* and *Current scenarios* results in high level of patients in complication group 2 in need of nursing.

Table 5.5 Summary of costs of treating T1D in the contrasting scenarios, 2001

	Worst	*Current*	*Improved*	*Ideal*
COST				
Healthcare resources mill DKK	2	5	72	317
Non-healthcare resources mill DKK	4	3	3	0
Patients´ time, mill DKK	0	0	3	6
Informal care-givers´ time, mill DKK	0,0	0	0	0
Total cost mill DKK	**6**	**9**	**79**	**323**

.

Effects

Table 5.6 summarises the estimated numbers of patient-years and QALYs, as well as the productivity (income by working) under each of the scenarios entertained.

Table 5.6 Summary of effects (patient-years and production value) in the contrasting scenarios

	Worst	Current	Improved	Ideal
EFFECTS				
Patients' life years unadjusted	5,533	8,557	35,768	155,251
Patient' life years treated unadjusted	0	3,578	35,768	155,251
Patients' life years quality-adjusted	3,597	6,394	31,561	147,489
EFFECTS Mill DKK				
Production value (including the informal sector)	**0**	**12**	**121**	**805**
Registered as contribution to GDP	**0**	7	67	443

In the table a distinction is made between the patient life years (unadjusted) and patients' life years treated (unadjusted). The distinction is created to highlight the number of people in the *current and worst scenarios* that do receive treatment versus those that do not receive treatment.

More patient-years are estimated for the *Current scenario* compared with the *Worst scenario*. This is accompanied by a positive production value in the *Current scenario* compared with 0 in the "*Worst" scenario*, reflecting that access to treatment results in a shift from all patients being in complication group 2 in the *Worst scenario* to 36% of the patients being in complication group 0 and 1 in which the productive people are found. The number of patient-years, QALYs and the production value are very much higher in the *Improved scenario* as compared with the *Current scenario*. It is also noteworthy that under the *Ideal scenario* (assuming T1D diabetes is a disease completely without specific complications if treated appropriately) considerable more patient-years – with accompanying higher production value – would be experienced because these patients have no complications.

Health economics assessment

The estimated costs and effects, as reviewed above, have been summarised in a simple health economics evaluation as shown in table 5.7. Each of the hypothetical scenarios *Worst*, *Improved* and *Ideal* has been contrasted with the *Current scenario* in terms of differences.

Table 5.7 Summary results of various scenarios compared

	Socio-economic gains, current vs. worst	**Socio-economic gains, improved vs. current**	**Socio-economic gains, ideal vs. current**
COSTS			
Healthcare resources, mill DKK	3	67	312
Non-healthcare resources mill DKK	0	0	-3
Patients´ time, mill DKK	0	3	5
Informal care-givers´ time	0	0	0
Incremental costs mill DKK	**3**	**70**	**314**
EFFECTS			
Patients' life years (unadjusted)	3,024	27,211	146,694
Patients' life years treated (unandjusted)	3,578	32,190	151,674
Patients' life years quality-adjusted	2,797	25,167	141,095
EFFECTS Mill DKK			
Production value inclusive the informal sector)	**12**	**109**	**793**
Registered as contribution to GDP	7	**60**	**436**

Similarity of the gains in patient life years (unadjusted) and treated patients' life years (unadjusted) between the *current* and *the worst scenario* is a reflection of the need to receive treatment (primarily insulin) for people with type 1 diabetes to survive more than one year. The lower level of quality adjusted patient-years compared to patient life years reflect that those treated still receive insufficient treatment and survive and develops complications.

It is evident that the increased costs for the *Current scenario* compared with the *Worst scenario* must be seen against a substantial gain in patient-years.

Under the assumptions specified, the gains in patient-years, QALYs and production value, respectively, are substantial in the *Improved scenario* compared to the *Current scenario* but the gains from the improved production value is not sufficient to cover the additional healthcare resources needed to accomplish these gains.

The difference between the *Current scenario* and the *Ideal scenario* may be viewed as the potential further gains that might be expected, if the treatment of diabetes should reach perfection. According to the estimates, a higher level of costs yield substantial further gains in patient-years and accompanying production When seen from the rest of the society, it should be noticed however, that the increased number of patient years also entails higher consumption by the patients. The cost per patient-year is at the same level in the *Worst* and *Current scenarios*, highest in the *Improved scenarios* and lower in the *Ideal* compared to the *Improved scenario*.

A summary of various types of health economic evaluations of different scenarios compared is shown in table 5.8. Net benefit of the *Current scenario* compared to the *Worst scenario*, based on only productive gains are 12 minus 3 mill DKK = 9 mill DKK (indicating net gain when the human capital approach is applied to value the gains in years). The figure 12 mill DKK includes the value of household production.

Applying the human capital approach implies that benefits are measured in terms of productive gains only, disregarding the value of life per se. When the *Improved scenario* is compared to the *Current scenario*, the net benefit increases to 39 mill DKK. The corresponding figure increases to 480 mill DKK when the *Ideal scenario* in compared to the *Current scenario*. Positive Cost-Benefit figures imply that the productive gains from gains in patient-years do outweigh the cost increase when contrasting each of the alternative scenarios with the "*Current" scenario*. As described in the methodology report and discussed in the discussion section non of these measures take into consideration the issue of increased consumption as a derived effect of an improved health outcome.

The marginal cost-effectiveness ratios are calculated as costs per added patient-year gained. The ratios for the three comparisons are 3,2 mill/3,024 = 1067; 2,559 and 2138 DKK/year, respectively.

Finally, the cost-utility ratios show the added cost of obtaining an added quality-adjusted patient-year. The ratios for the three comparisons are 3,2mill/2,797 = 1154; 2766 and 2223 DKK/QALY, respectively. As the gains of patient-years are quality-adjusted, the gains in QALYS are lower than the gains measured in pure patient-years and, consequently, the costs per QALY are higher than the cost per patient-year.

Table 5.8 Health economic evaluation, various scenarios compared, TD1 in Bangladesh, 2001

Key Evaluation Figures	**Socio economic gains current vs worst**	**Socio economic gains improved vs current**	**Socio economic gains ideal vs current**
Net benefits human capital approach mill DKK	9	39	480
Marginal cost effectiveness ratio DKK/patient year	1067	2559	2138
Marginal cost utility ratio DKK/ QALY	1154	2766	2223

(The net benefit from the human capital ratios in table 5.8 include both the production value from the formal sector and the informal sector (the household sector.)

Relation between life expectancy and economic growth

Following the study by WHO (13) estimating that each 5 year improvement in life expectancy is associated with an increase in economic growth of about 0.3-0.5% per year other growth factors being equal, the increase in GDP which could be achieved in Bangladesh as a consequence of the increased survival in the *Improved scenario* is between 6% and 10% over a period of 20 years. If we calculate the effect on the production value of the diabetes population, this is equal to 128-134 mill DKK. This should be compared to the production value of 121 mill DKK in the *Improved scenario* in table 5.6. It should be underlined that since diabetes in the improved scenario still is a chronic disease added patient-years amongst these patients will not entail the same level of productivity gains as for persons whose life-expectancy is prolonged in a state of perfect health.

Sensitivity analysis: 25% higher average income.

In the base case of this study the average level of GDP pr capita of US$ 1,056/233 in the formal/informal sectors respectively (on average US$ 686) have been used to calculate the production value of people with diabetes. This level may be on the conservative side. A sensitivity based on 25% higher average income level is presented below (US$ 1,320/291 in the formal/informal sectors on average US$ 831). The results are presented in the table below for the key evaluation figures and can be compared to the key evaluation figures in table 5.8 above.

Table 5.9 Sensitivity Analysis (+25% higher average income)

Key Evaluation figures	**Socio economic gains current vs worst**	**Socio economic gains improved vs current**	**Socio economic gains ideal vs current**
Net benefits human capital approach Mill DKK	11	62	646
Marginal cost efficiency ratio DKK/patient year	1077	2578	2146
Marginal cost utility ratio DKK/ QALY	1165	2788	2231

(The net benefit from the human capital ratios in table 5.9 include both the production value from the formal sector and the informal sector (the household sector.)

In particular the net benefits are impacted in this sensitivity. The rise in production value with 25% impacts the net benefit ratios to rise substantially especially in the ideal versus the current case where the net benefit rises from Mill DKK 480 to Mill DKK 646. 25% higher average income results in a 34% increase in the net benefit because the survival rate as well

as ability to work in the ideal scenario are higher than in the current scenario. The cost side of the calculation are impacted only slightly through the impact on the value of non health care cost (informal nursing). Thus the cost effectiveness and cost utility ratios are only impacted marginally through increased value of informal nursing. This example illustrates that the base case is quite robust.

Sensitivity analysis: Consideration in relation to the level of costs in *the improved scenario*.

Two c*osts variants of the improved scenario* are presented in the following to illustrate the diabetes health care cost level in Bangladesh if the country where able to put up the same level of resources (in PPP terms) in diabetes health care per patient year as currently available in a country like Denmark. The current Danish cost level represents an advanced version of the *improved scenario* for Bangladesh based on a higher level of technology and treatment opportunities and adequate medication/insulin, but organization, ability to comply and life style are not optimal (thus it is not an ideal scenario).

The purpose of the *variants* is to show what level of health care cost [1] that the different levels of estimated diabetes population in the improved and ideal scenario in Bangladesh would generate if conditions were closer to the current Danish health care system.

It should also be emphasized that the figures shown below in table 5.10 in this *cost variant of the improved scenario* cannot be compared to the level of production value in the improved and ideal scenarios because they are dependant on the economic conditions, number of survivals and the physical condition of these people.

The "*variant of the improved scenario"* assumes more adequate treatment levels to be available in Bangladesh than assumed in the original improved scenario. It is important to underline that this variant of adequate medication would have an immense impact on the estimated number of people surviving because type 1 diabetes patients need a certain minimum of treatment, in particular insulin, to survive. Therefore the number of patient-years in a "*variant of the improved scenario"* would be much closer to that of the *ideal scenario (*155,251 patient-years) *than of the improved scenario* (37,768 patient-years), but we do not know more precisely where and therefore we calculate a range within which the number of patient-years in the *variant of the improved scenario* will be.

The average level of current health care costs per patient year in Denmark is calculated to DKK 25,500 (see Report 2 of this series (18). This level include cost of hospitalization, treatment of complications, medication with insulin and other drugs, blood glucose monitoring, routine visits to GPs and specialists and physiotherapy. If this level is adjusted to the local level of costs in Bangladesh with a PPP factor of 5 the annual cost pr patient is DKK 5,100. Applied for the *variant of the improved scenario* this cost level for 37,768 patient-years would generate a total health care cost of Mill DKK 182 or 2.5 times higher than the Mill DKK 72 in *the improved scenario* as shown in table 5.10..

[1] The non healthcare cost and patient time lost in the *improved scenario* as presented earlier in this study is not considered in this sensitivity analysis because it is a function of the insufficient level of treatment assumed in the *improved scenario*

Table 5.10 Sensitivity analysis : Health Care Costs

	Improved Scenario	**Ideal scenario**
Number of patient treated	35,768	155,251
Scenario health care cost Mill DKK	72	317
Sensitivity using Danish level of health care cost (DKK 5,100 equivalent to local Bangladesh level) Mill DKK	182	792

By doing this a comparison can be made to the ideal scenario that assumes that a perfect treatment and life style is available in Bangladesh on the basis of provision of a level of medication and treatment so that diabetes do not incur complications or cost of hospitalization. The ideal scenario represents an outer limit for what maximum socio economic gains that could be reached if people with diabetes had the opportunity and ability to comply with the recommendations for keeping the disease at an absolute minimum.

Total health care costs associated with the number of patient-years (155,251 patient years) in the ideal scenario is shown in table 5.10 to be Mill DKK 792 if the current Danish level of health care costs of DKK 5,100 are applied.

The cost level in the *cost variant of the improved scenario* would then range between DKK 182 Mill and 792 Mill depending on the number of patient-years assumed (ranging from 35,768 to 155,251).

This illustrates that the more patient-years achieved in an "*improved treatment"* (without becoming an ideal scenario), the more cost savings will be generated from the ideal treatment and life style as assumed in the Ideal scenario (DKK 317 Mill for 155,251 patient years). The maximum achievable savings would be DKK Mill 792 - 317 = 475.

6. DISCUSSION

Overall considerations

In the present study many assessments have been based on assumptions, and information of less than optimum reliability. We have studied available information on healthcare expenditure, number of hospital clinics, hospital beds, income levels and any health sector information that was available to ensure that our assessments was made as realistic as possible. We believe that the final results provide a realistic picture within the frameworks and scenarios considered. Our experiences also underline that studies of the present kind are developed in a continuous process with the need for further development and validation in the future.

The study design

This study presents a health economic analysis of the standard types of evaluation - cost-effectiveness analysis (CEA), cost-utility analysis (CUA) or cost-benefit analysis (CBA). Some of the controversial issues related to either of the standard types of evaluation are relevant to our study, and therefore some of our reservations are discussed in the following.

First, the comparison of the present situation to *Worst scenario* involves a rather big change in the society whilst most economic evaluations - at least of the CEA type - are made for smaller changes. Second, whereas the *Worst scenario* is not totally irrelevant for a developing country, the *Ideal scenario* may seem somewhat artificial, particularly in the context of a developing country.
It was discussed whether it would be relevant explicitly to split the model into the 10% richest, the 10% poorest with free access and the remaining 80% without access to care and to analyze these groups in two separate models. We chose to model these aspects through implicit distinction between the rich and poor but in one model. It might be relevant in a further analysis to make two distinctly different models.

The results demonstrate that the current conditions for managing T1D in Bangladesh are poor, partly due to lack of access to basic treatment, incl. insulin, for a substantial part of the population. Improvements yielding equal access to treatment and care for all patients with T1D is costly but will be accompanied by a gain in production value of the same order of magnitude. It is conceivable or likely that as a consequence of such improvement, some adjustments will take place at a macro level in the society, but any conclusion would be rather speculative.

Funding of healthcare system improvements

The economic analysis of the "improved" and *Ideal scenario*s is assuming 100% access to (two different) healthcare systems for everybody in the country at current prices. The study has not taken into account that financing of such healthcare systems would require large economic adjustments and funds. Instead it is (rather unrealistically) assumed that a lump-sum is available for funding of the system. Further, an estimate regarding the impact on GDP growth from health improvements has been included in the study. We perform a sensitivity analysis where we asses the situation if the economy had experienced 0.3-0.5% annual growth for every 5 year extra in average survival. A development of this (as a next

step) is obviously to look into what the constraints there are for expanding coverage and make an assessment of what investments are necessary.

Cost structure and valuation

To obtain cost estimates of the various medications and appliances used by patients in treatment and healthcare providers we have gathered data from hospitals and pharmacies selling insulin and devices, appliances for blood glucose monitoring, anti-diabetic tablets etc. Such data are based on the companies' assessment of the daily dose of tablets, on internationally agreed norms for daily doses of insulin and yearly consumption for instance of strips for blood glucose monitoring. We have critically investigated the figures and, when necessary, amended the level of consumption to a level that we find realistic.

Gains and losses in production value

A major effect of treatment of T1D patients with insulin is gain in patient-years. A derived effect may be in terms of productive time, and use of time by informal care-givers. The valuation of these gains is controversial, and the issue is discussed in the following section as well as in the methodology report 1 of this series (19).

Productivity in the informal and formal sector

Bangladesh has experienced economic growth since the nineties. Whether this growth is reflected in a rising living standard is still to be documented as it would depend on many factors. If the economic growth has lead to increased population growth, the average living standard may not have improved markedly. In the long term, though, a continued reduction of infant mortality (as has happened in other parts of the world) will probably lead to lower fertility pr women and eventually to higher average living standard.

The GDP is used as an approximation due to lack of data on Gross National Income. In a developing country this is not a major problem because the difference between Gross Factor Income, GFI and gross National Product, GDP is probably minor. The average income level in the formal sector has been set equal to the average GDP per capita and to 2/3 of the per capita GDP in the informal sector. This is based on an assumption that the best educated with access to modern technology is working in the formal sector and, consequently, their productivity is higher. Based on a monetary valuation of the market value of labour and its contribution to the production, it is assumed that the productivity in the informal sector is lower than in the formal sector.

The shadow price of time spent in home production is based on the assumption that there is a free choice between working in the formal sector or in household production at the margin. This implies that the monetary value of the informal production from working in the household sector as a minimum has the same value as working in the labour market because time spent in home production was the preferred choice. The value of production in the household sector (the informal sector) then becomes higher than in the formal sector because it involves an active choice between a monetary reward through income and the reward through utility from working in the household sector. But the labour market is definitely not perfect in the developing world, however, and even in industrialised modern economies the choice between homemaking and wage earning is not free.

As it appears we have simplified our analyses by using the human capital approach but extended the measurement of productive outcome to include the value of household production.

Derived consumption

An effect derived from increased number of patient years are the added consumption that these patients have. The issue is discussed in the methodology report (19). Such derived consumption effects are not included in this study.

7. OVERALL CONCLUSION

We conclude that the prevailing healthcare conditions for patients with T1D in Bangladesh are poor and that this results in bad health, reduced longevity, increased morbidity and associated low production value for these patients. Establishing access to care and treatment for all patients implies extra costs, but with the benefit of more patient years. Considerable further gains in patient-years and production value and further reduction in costs would be the case, should it be possible to make treatment for T1D perfect.

8. REFERENCES

(1) International Diabetes Federation. Chapter 2 in *Diabetes Atlas (second edition).* Brussels: The International Diabetes Federation, 2003

(2) DAWN (2002); Practical Diabetes International, Vol. 19 (6), pp. 187-192, 2002 The Oxford International Diabetes Summit: Implications of the DAWN study: 7-8 April 2002, Oxford, UK

(3) International Diabetes Federation. *Diabetes Atlas 2000.* Brussels: The International Diabetes Federation, 2000

(4) Data on Bangladesh from WHO/Dr G. Roglic.

(5) Luce BR, Manning WG, Siegel JE, Lipscomb J. Estimating cost in cost-effectiveness analysis. Chapter 6 in: Gold M, Siegel JE, Russel LB, Weinstein MC (eds.): *Cost-Effectiveness in health and Medicine*. NY and Oxford: Oxford University Press, 1996

(6) Asian Development Bank, (2000), (ADB 2000),

(7) UNDP Human Development Report 2003 on Bangladesh section 3, Note (7b) section 1 and 12). Note (7c) section 13. Note (7d), section 5 (HDR 2003)

(8)The World Fact book (WFB) 2002.

(9) OECD Health Data, 2003, (OECD 2003)

(10) Personal Communication with staff at Birdem

(11) Evidence for Health Policy (WHO, 2002) W3.whosea.org/eip/annexban.htm

(12) World Bank and Asian Development Bank (December 2002), Poverty in Bangladesh: Building on Progress Report No 24299-BD (WB and ADB 2002)

(13) WHO 2000, Ministerial Round Table: Health and poverty page 4 (WPR/RC51/10) (WHO 2000)

(14) Health Facility Efficiency study undertaken by the Ministry of Health in Dhaka

(15) McCord & Chowdhury (2003), International Journal of Gynaecology and Obstetrics 81 (2003) (83-92).

(16) World Partner Programme (WPP) – Bangladesh 2002, (Internal Novo Nordisk Report and data)

(17) Greiner et al. A single European currency for EQ-5D health status. Results from six-country study, in: The European Journal of Health Economics; 2003, 4' (3): 222 – 231

(18) Green A, Emneus M, Christiansen T, Bjørk S. Socio economic impact of diabetes in Denmark Type 1, report 2. Novo Nordisk 2004.

(19) Green A, Emneus M, Christiansen T, Bjørk S. The societal impact of diabetes and diabetes care. Methodology report 1. Health Economics Papers 2005:4, University of Southern Denmark.

APPENDIX 1

Table A1. Valuation of costs items and productive value, US$ and DKK in local value and PPP

Item	Unit	(Unscaled DKK	Scaled DKK (PPP)	(Unscaled US	Scaled US$ (PPP)
Healthcare Resources					
Hospitalization	Cost pr day	**158**	**801**	**19**	**96**
Treatment with insulin	1000 units of insulin	**66**	**333**	**8**	**40**
Treatment with oral antidiabetics	One day's treatment	**0**	**0**	**0**	**0**
Treatment with other drugs	One year´s treatment	**50**	**254**	**6**	**31**
Routine diabetes controls	One average visit	**17**	**84**	**2**	**10**
Home monitoring	One year´s activities	**976**	**4.961**	**117**	**596**
Non-Healthcare Resources					
Annual cost for nursing assistance in the home, full-time (1/3 of informal care givers time)	One year´s cost	**641**	**3.257**	77	**391,5**
Patients´ time					
Loss of production value during routine controls. Abseenteism	Cost per day of visit	**8**	**40**	**0,94**	**4,8**
Loss of production value during admissions	Cost per working day	**16**	**79**	**1,88**	**9,6**
Loss of production value related to discomfort during work (-10%)	Cost per working day	**1,56**	**8**	**0,19**	**1,0**
Informal care-givers´ time					
Loss of production value during routine controls. Abseenteism	Cost per day of visit	**2,66**	**14**	**0,32**	**1,6**
Production value					
Income by working (formal + informal sector)	One year's aver. income	**5.707**	**29.015**	**686**	**3.487,4**
Income by working (informal sector)		**1.941**	**9.870**	**233**	**1.186,3**

APPENDIX 2

TABLE 1 SHOWING SELECTED PRICES IN BANGLADESH RELATED TO DIABETES		
Item	Source: BIRDEM (non-government hospital run by an autonomous body). Largest diabetic hospital in Bangladesh. Total beds are 720	Source: pharmacies (where nothing else is indicated)
Human insulin/day (40 iu/day)	250 taka ($ 4.32) (see table 3 below)	7.50 ($ 0.13) to 10.5 ($ 0.18) depends on the manufacturing company and country
Disposable syringes with needles/pc l	3 ml: 1.75 taka ($ 0.03) 5 ml: 1.80 taka ($0.03)	1-10 ml: 5 taka ($0.09) to 7 taka ($0.12). Market varies from place to place 20 ml: 15 taka ($0.26) to 25 ($0.43). 50 ml: 10 taka ($0.17) to 15 ($0.26).
Blood glucose strips/pc	Two types of products with corresponding monitor meters: 27 taka ($0.47) -The cost of this machine is taka.3,500 ($60.47) 20 taka ($0.35) - The cost of this machine is taka 4,000 ($69.11).	Prices vary from 24 taka ($0.41) to 28 taka ($0.48)
Blood glucose monitor meter	taka 3,500 ($60.47) taka 4,000 ($69.11)	Prices vary from 3,800 taka ($65.65) to 4,000 taka ($69.11)
Lancettes	taka 5 ($0.09)	One pack with 100: 1,300 taka ($22.46) (made in Germany) One pack with 100: 800 taka ($13.82) (made in India).
Urine strips/pc		1.80 taka ($0.03)
General Practician pr visits		Prices vary from 50 taka ($0.86) to 100 ($1.73) (source: Mirpur General Hospital, Mirpur 10, Dhaka)
Specialist pr visit		Prices vary from 300 taka ($5.18) to 400 taka ($6.91) (Source: Mirpur General Hospital, Mirpur 10, Dhaka)
Average cost of a public hospital bed pr day		A bed in a ward 72 taka ($1.24) VIP cabin 615 taka ($10.63) Single cabin 515 taka ($8.9) The average is 400 taka ($6.91) (source: Mirpur General Hospital, Mirpur 10, Dhaka)
Average cost of a private hospital bed pr day	All BIRDEM: General ward bed taka.370 ($6.39). Two bedded air-conditioned cabin taka.850 ($14.69) Cabin A taka 1,100 ($19) Cabin B taka 1,300 ($22.46) Single cabin taka 1,500 ($25.92) VIP cabin taka 2,500 ($43.19) Thus average taka 1,270 ($21.94)	Prices in other private hospitals vary from 300 taka ($5.18) to 1,200 taka ($20.73) and thus average is 750 taka ($12.96)

These data have been collected by Cowi consult for Novo Nordisk in Bangladesh
Pc: piece

TABLE 3 SHOWING SELECTED MACRO ECONOMIC INDICATORS FOR BANGLADESH		
Item	Source: World Bank (2002, where nothing else is indicated)	Source: various
Total healthcare budget Total healthcare budget (PPP)	USD 266,34 mio (02/03, source: Ministry of Finance and Planning)	USD 410,85 mio (2000, Asian Development Bank)
Healthcare budget/capita Healthcare budget pr capita (PPP)	USD 1.96 (calculated based on Ministry of Finance and Planning)	USD 3.03 (calculated based on Asian Development Bank)
GDP GDP (PPP)	USD billion 47.3 USD million 235,613	
GNI pr capita GDP pr capita GDP (pr capita) (ppp)	USD 360 - population 135.7 million USD 349	USD 1,483 (1999, source: UNDP)
GDP (pr capita) pr day GDP (pr capita) (ppp) pr day	USD 0.96 (calculated) USD 3.94 (calculated)	
Average wages income among the riches 10% of the population[2]		Income ratio of highest 20% to lowest 20%= 4.9 (Source: ADB, 2000)
Estimate of population that can afford to pay for healthcare[3]	Less than 20 percent of total population (average 22.2 percent of the population with diarrhoea is brought to a health facility. For Acute Respiratory Infection, the figure is 32.9 percent. For the richest 20 percent of the population corresponding figures are 23.8% and 50.6%)	
Share of population with less than 1$/day (ppp)[4]		29.1 percent (1992 PPP US$, source: UNDP)
Share of population under national poverty line	34 percent	

[2] Figure not available The ratio reported can be used for approximation.
[3] Figure not available. The figures reported can be used for approximations.
[4] Note that the international standard is less than one dollar/day.

Table 3 Price documentation collected in Bangladesh by COWI consult October – December 2003.

Item	Name of the product	Name of the producer	Price
Human insulin (40 iu/day)	Mixtard 30HM	Novo Nordisk A/s, Denmark	250/=
	Actrapid HM	Novo Nordisk A/s, Denmark	250/=
	Insulatard HM	Novo Nordisk A/s, Denmark	250/=
	Humulin N	Lilly France S.A. France	350/=

Item	Name of the product	Name of the producer	Price
Disposable Syringes with Needles/ Pc	Dispovan	Hundustan Syringes & Medical Device Ltd. India	7.50/=

Item	Name of the product	Name of the producer	Price
Blood glucose strips/ pc	Glucomen Glyco	A. Menarini Diagnostics, Italy. www.menarini.com	27.60/=
	One Touch Basic Plus	Johnson & Johnson, USA	20.80/=

Item	Name of the product	Name of the producer	Price
Blood glucose monitor meter	Glucomen Glyco	A. Menarini Diagnostics, Italy. www.menarini.com	3,800/=
	One Touch Basic Plus	Johnson & Johnson, USA	3,500/=

Item	Name of the product	Name of the producer	Price
Lancettes /pc	Glucomen Glyco	A. Menarini Diagnostics, Italy. www.menarini.com	6/=
	One Touch Basic Plus	Johnson & Johnson, USA	4/=

Urine strips- no more used.

Hospitals: Prices ranging from Tk. 300 - Tk 1200. Both Mirpur General Hospital, Mirpur 10, Dhaka and Al-shafi hospital, Rokeya Sharoni, Dhaka offer this price range.

APPENDIX 3

Alternative information on income levels in the informal sector.

Approximately 83% of the population live on less than 2 $ a day, 36% live on less than 1$ a day – and 34% below the national poverty line (UNDP, Human Development Report 2003 on Bangladesh (HDR 2003)) (17). Using the average GDP of US$ 350 together with the above information about the living standard it is possible to estimate the average per capita income in the poorest 45% of the population result to an average of US$ 99 per capita (477 taka pr month) and in the richest 55% an average of US$ 646 per capita. To be applicable as a measure for the average income for the productive part of the population in the informal sector this level must be scaled. As each of the 78 m people in the workforce supports 57 m people outside the workforce the average per capita figures must be divided with a factor 0,57 to find the average income of the productive population. 99 and 646 US $ per year in per capita income becomes 174 and 1134 US$ per productive persons in the respective groups.

Another statistics show that the richest 20% of the population has an average income which is 6 times that of the 20% poorest group (6). If we use the average per capita income of US$ 350 in combination with this income distribution (see table 1) we find that the poorest 45% of the population have an average of US$ 193 pr capita and the top 55% have US$ 479 per capita. Scaled to the income level of the productive population this results in 338 and 840 US$ per productive person in the two respective groups.

Table 1

Income attributed to the richest 20%	43%
20%	21%
20%	15%
20%	13%
Income attributed to the poorest 20%	8%

(Source: Asian Development Bank (ADB), 2000)