



Working Paper 03- 68
Economics Series 27
November 2003

Departamento de Economía
Universidad Carlos III de Madrid
Calle Madrid, 126
28903 Getafe (Spain)
Fax (34) 91 624 98 75

DIRECT HEALTHCARE COSTS OF DIABETES MELLITUS PATIENTS IN SPAIN*

Juan Oliva¹, Félix Lobo², Begoña Molina³ and Susana Monereo⁴

Abstract

Objectives. To estimate the healthcare resources spent by diabetic patients in Spain during the year 2002.

Methods. The present work is a cost-of-illness study. Direct healthcare costs were estimated using rates of DM, based on primary and secondary sources of information. A range of prevalence from 5% to 6% of the adult population was determined. The total cost was composed of six items: insulin and oral hypoglycemic agents; other drugs; disposable and consumable goods (glucose test strips, needles and syringes); hospitalization; primary care visits; visits to specialists.

Results. The estimated direct cost of DM during the year 2002 ranges from € 2.4 billion to € 2.67 billion. Hospital costs had the highest weight (€ 933 million) in the total, followed by non-insulin, non-hypoglycemic-agent drugs (€ 777-932 million). Much lower are the costs of insulin and oral hypoglycemic agents (€ 311 million), primary care visits (€ 181-272 million), specialized visits (€ 127-145 million) and disposable elements (€ 70-81 million). The per-diabetic, per-year cost ranges between € 1,290 to € 1,476.

Discussion. Despite our rather conservative approach to the issue, our findings demonstrate the high direct healthcare costs of diabetic patients. Likewise, they illustrate the magnitude of the costs of treatment of DM-related complications.

Keywords: Diabetes Mellitus. Costs of disease. Prevalence. Direct healthcare cost of patients. Acute Diabetes complications. Chronic Diabetes complications.

¹ Department of Economics, University Carlos III of Madrid, Seminario de Estudios Sociales de la Salud y los Medicamentos (SESAM). E.mail: joliva@eco.uc3m.es

² Department of Economics, University Carlos III of Madrid, Seminario de Estudios Sociales de la Salud y los Medicamentos (SESAM). E.mail: flobo@eco.uc3m.es

³ Hospital of Getafe, Madrid. Section of Endocrinology, Seminario de Estudios Sociales de la Salud y los Medicamentos (SESAM). E.mail: bmolinabaena@hotmail.com

⁴ Hospital of Getafe, Madrid. Section of Endocrinology, Seminario de Estudios Sociales de la Salud y los Medicamentos (SESAM). E. mail: smonereo.hugf@salud.madrid.org

* Acknowledgements: I. Urrutia, F. Gómez, J. L. Clua, J. López Bastida, A. Rivero, J. García Rey, J. Gervás, L. Cabello, J. Damián, B. Crespo. This study has been funded by a grant from NovoNordisk.

1. Background

Diabetes Mellitus (DM), in its two Types, 1 and 2, is a high-incidence, chronic, globally-occurring disease that increases morbidity and mortality, seriously diminishing quality of life.

The World Health Organization's (WHO) estimated that in 1995 135 million adults were suffering from the disease. WHO's forecasts for the year 2025 raise that figure to 300 million people (a 120% increase) (1). Every day more resources are allocated to DM prevention and treatment, but at the same time its prevalence grows steadily. In 1987, 2.2% of USA's healthcare expenditures were consumed by diabetic patients. Five years later, in 1992, the percentage had more than doubled (to 5.8%), and 2.8% of the population was suffering diabetes (2, 3)

A diabetic patient may suffer acute decompensations, such as diabetic ketoacidotic state. He/she may develop as well chronic complications such as cardiovascular problems, renal disease and loss of vision. The risk of suffering these conditions is higher for DM people compared to non-diabetics people in the same age group. (4, 5, 6).

About 50% of all deaths of Type 1 diabetic patients are related to acute myocardial infarction; another 15% are related to strokes (cerebrovascular disease) (7, 8). A 25% of all diabetics have foot ulcers ("diabetic foot") and peripheral vascular disease. One in 15 diabetics will suffer inferior limb amputation during his or her lifetime and among these, 30-40% will lose the other limb within the following 3 years (9, 10), placing DM as the main cause of non-traumatic amputation. On the other hand, the prevalence of diabetic nephropathy reaches 30-40% among Type 1 diabetic patients; for Type 2 diabetics it is lower (17-30%) (7), but still significant. It is estimated that 23% of people undergoing hemodialysis in Spain suffer from diabetes (11). Diabetic retinopathy is the main cause of blindness in people younger than 60, causing 20-30% of all cases of blindness in developed countries. In Spain, the prevalence of blindness has been estimated at 5-6% among diabetics, having been calculated that they are six times more likely to lose their vision than the general population. In a recent study, Morato et al (12), estimate that DM Type 2 patients have the following rates of complications: Retinopathy: 33%; Peripheral vascular disease: 21%; Nephropathy: 17%; Cerebrovascular disease: 10%; Coronary disease: 14%; Peripheral neuropathy: 40%; Autonomic neuropathy: 20%. When diabetes was diagnosed, 52% of diabetics already suffered some sort of complication.

Chronic complications are the main cause of death among diabetic patients, and are responsible for the highest costs both in hospitalization and drugs. It is estimated that the

costs of drugs for chronic diabetes complications are 2.5 times higher than those of the general population, even after adjusted by age. Moreover, even leaving aside the cost of insulin and oral hypoglycemic agents, the resources spent on other drugs are higher among diabetics than for the general population (13, 14, 15). Given the relevance of chronic DM complications, cost-of-illness studies based only on acute complications of the disease result in underestimations (3, 16-26). A key aspect of the present study is to identify not only the direct costs of treating DM itself, but also the consumption of resources to prevent and treat complications.

Despite the abundance of cost-of-illness and cost-effectiveness studies in the specialized international literature, in Spain only three studies have tried to measure the direct healthcare costs of DM. Hart et al. (27) concluded that the total costs associated to DM in 1994 were around €544.8 million, an average annual cost of €381 per diabetic. Hospitalization costs represented the main portion of all costs, accounting for 36% of the total, followed by doctor and hospital out-patient visits (14.1%), antidiabetic drugs (13.2%), lab tests (10%) and dialysis (9.4%).

The CODE-2 study (28) analyzed the direct healthcare cost of a sample of 1004 type 2 diabetes patients. The mean annual cost per patient was €1,304. This represents a total annual cost for Spain of €1.96 billion. In this case, the biggest percentage of expenditures went to drugs (42.4%, including oral antidiabetic agents, insulin and other drugs), followed by hospitalization (32%) and ambulatory care (25.6%).

Finally, López Bastida et al. (29) considered DM direct and indirect costs in the Canary Islands. Their findings show that the direct healthcare costs attributable to DM were €24.02 million, or €470.23 per known diabetic patient per year (62% of the total cost of a diabetic patient). This percentage includes the costs of drugs and hospitalizations, and, lagging further behind, primary care visits, visits to specialists and laboratory tests. The indirect cost was, according to the study, €14.77 million, or 38% of the total cost.

López Bastida's work has some obvious advantages. First of all, data were provided directly by the Canary Islands Health Service and are truly primary ones. Furthermore, the study estimated the indirect costs of DM. However, since the study was conducted in a part of the country where DM prevalence is by far higher than the national average, it is difficult to extrapolate to Spain as a whole.

Only three studies of DM costs in Spain, with varying methodology, and international findings difficult to apply to our country given national differences in prevalence, healthcare systems, methodologies and relative prices, leave room for new research. This is why this paper's goal is to estimate the healthcare costs of patients with DM, including costs of chronic complications, using the primary or secondary information available.

2. Methodology and results

The study focuses on the prevalence of DM and is aimed at estimating the direct healthcare costs of diabetics during the year 2002. Both a total cost and a per-patient cost are estimated.

In order to determine the number of diabetics in Spain, we analyzed the most recent epidemiological data available for prevalence and selected the interval 5%-6% (30-43). The variety of sources, methodologies and estimations made difficult to select only one value. The minimum value we have considered, 5%, is that of the 1997 National Health Survey (Encuesta Nacional de Salud) (42) taking into account adult people (18 years and older) who reported they were diabetics, or had high blood-sugar levels, or said they used antidiabetic drugs. In other recent studies, the prevalence was near 6% or even higher (32, 40, 41, 43). The chosen thresholds of prevalence are rather conservative, in any case, given that it is well-established that a significant percentage of diabetics are not diagnosed (44, 32) and the prevalence of DM is increasing. Another assumption is that 90% of diabetics were considered Type 2 and 10% Type 1 (44).

The rate of prevalence determines the average annual cost per patient. The total cost of some important items (e.g. hospitalizations, insulins or oral hypoglycemic agents) obtained from primary sources is not influenced by the chosen prevalence.

2.1. Drugs

Figures regarding the total costs of insulin (Subclass A10A) and oral hypoglycemic agents (Subclass A10B) were obtained directly from data bases ALHAQUEM and RHAZES and other publications from the General Directorate of Pharmacy of the Ministry of Health (45,46). All National Health System outpatient prescriptions are included in these data bases. Costs for 2002 were estimated by applying the average historical growth rate to the 1992-2001 data.

Drugs consumed by diabetics are not only the above-mentioned subclasses. They consume other medications to prevent or treat complications associated with DM. Age-adjusted consumption of hypolipemians, antihypertensives and platelet antiaggregating drugs is significantly higher in diabetics than in the general population (28, 17, 19). Figures for non-insulin, non-oral hypoglycemic drugs come from the CODE-2 study (28) updated for the year 2002.

2.2. Consumable goods: test strips, needles and syringes

The costs of test-strips were calculated using data from the four available sources. The first is INSALUD (Instituto Nacional de la Salud) (primary source) the central government agency that provided health care in Spain. It has been decentralized to the regional governments. 36% of Spanish population (slightly more than 14 million people) was still cared for by INSALUD up until the end of 2001. On the first of January 2002 devolution of health care to the regions was completed. Clua et al. and Oliveira and Carral (47, 48, 18) are secondary sources of information.

The pattern of use and the costs of needles and syringes were drawn from Costa (49, 50). We assume that only Type 1 diabetic patients use these items, a hypothesis that may be somehow conservative granted that a number of DM Type 2 patients are treated with insulin and need these items as well.

2.3. Visits to specialist and dialysis

Turning to costs of out-patient (ambulatory) visits to specialists, we relied on the following information

- Expertise from the department of analytical accountancy of the Hospital of Getafe on the items to be considered.
- Secondary sources (29,51)
- Data from INSALUD (52) on cost per visit in a Section of Endocrinology

This heading includes:

- Costs of service, including personnel, rents, materials, power, water and sanitation; healthcare goods and drugs.
- Costs of other services, including infrastructure, personnel, board and catering, customer service, booking, admissions, archives of clinical records, pharmacy, blood extraction, biochemistry, hematology lab, microbiology, nuclear medicine, pathology, radiology, endoscopy and neurophysiology.
- Other structural costs.

Another cost item is expenditures on dialysis for diabetic patients. The prevalence of diabetics under dialysis was obtained from Amenaber et al. (11).

It should be noted that there is no information about visits to specialists other than endocrinologists (such as neurologists, cardiologists, ophthalmology,...). For this reason, we do not include them in our analysis.

2.4. Primary care visits

In this case, data were obtained from secondary sources. López Bastida et al. (29) found that the frequency of primary-care visits was eleven per patient, per year for diabetic patients on insulin, and nine for those on oral hypoglycemic agents or diet only. Clua et al. (47, 48) findings indicate that the frequency of visits per patient, per year was ten in the area they analyzed.

No primary data about costs per visit in primary care are available. We reviewed previous works published in Spain on the topic and found wide variation among different authors (27, 61, 62, 63, 64, 65, 66, 67). Therefore we drew on the mid-range values.

2.5. Hospital costs

To calculate hospital costs we relied on the Conjunto Mínimo Básico de Datos - CMBD (Set of Minimum Basic Data) (60). The CMBD has been developed following the recommendations of the European Minimum Basic Data Committee and it compiles useful information starting from clinical records and discharge reports from public and private hospitals. It collects the following data: clinical record number, patient's age and sex, main and secondary diagnoses, date of hospitalization and discharge, and procedures performed, using the International Classification of Diseases (ICD-9-CM), where DM has the main code 250. After the first classification, each patient is assigned to a Diagnosis-Related Group (DRG). The CMBD recovers main and secondary diagnoses - an important detail, because it improves the detection of diabetics who are hospitalized for causes other than acute DM complications. We selected all hospitalizations where the diagnosis was DM. When a diabetic patient is hospitalized due to a decompensation related to diabetes, he or she is included in either DRGs 294 or 295; if the cause of hospitalization is a chronic complication, the patient is grouped according to the primary disease, that is, DM. In this way, by grouping DRGs by disease, all chronic DM related complications are taken into account (see table 1).

(INSERT TABLE 1)

From the above mentioned primary and secondary sources, we estimated the direct healthcare cost of diabetic patients in Spain. Other direct costs, like special diets, educational programs, visits to specialist nurses or emergency rooms services were not considered. All figures are updated to the year 2002 applying the annual Spanish inflation rate, unless otherwise specified.

3. Results

According to data from the General Directorate of Pharmacy of the Ministry of Health, the total cost of insulin and oral hypoglycemic agents (A10A and A10B subclasses) was € 311.43 million.

A large part of DM Type 2 expenditures are due to drugs other than insulin or oral hypoglycemic agents. These costs have been estimated at € 424.44 per patient per year (for 1999) (28). In general, age-adjusted DM Type 1 patients' drug expenditures are substantially higher than those of DM Type 2 patients. Nonetheless, the average age of DM Type 1 patients is lower, making it plausible that their average drug consumption could be similar even without age adjustment. We assumed, therefore, that the average cost of non-insulin, non-oral hypoglycemic drugs was similar in DM Type 1 and Type 2 patients. Considering a 5% prevalence in the adult population (1,675,304 people), the cost of those drugs was € 777.0 million. Assuming a 5.5% prevalence (1,842,835 people), the costs would be € 854.7 million. Finally, if prevalence in the adult population was 6% (2,010,365 people), the resulting cost would be € 932.4 million.

INSALUD's expenditures in test strips reached € 23.86 million during 2002. Extrapolating this figure for the whole Spanish population (36% of Spaniards were covered by INSALUD in 2000), the result is € 66.82 million in 2000. Updating the sum to the year 2002, the figure would be € 70.89 million (Hypothesis A). A previous study (18) estimated that 1.3% of the Spanish population, or 531,016 people, used test strips to determine blood glucose levels. The per capita annual cost in 1997 was estimated at €103.6 (48). Adjusting that figure to 2002 and assuming a constant percentage of users, the estimated cost for 2002 is € 66.87 million (Hypothesis B). If we expand the second assumption, and suppose that test-strip users have climbed to 1.5% of the population (615,593 people), the estimated cost for 2002 rises to € 77.52 million (Hypothesis C).

(INSERT TABLE 2)

According to Costa et al (49, 50), the daily cost of needles and syringes ranges between is € 0.051 to € 0.0535. Using those figures as a bottom line and applying our estimated prevalence, the total annual cost of needles and syringes for 2002 would range between € 3.22 million and € 4.04 million.

In order to estimate the costs of visits to endocrinologists, our starting assumption was that between a third and a half of all visits to endocrinologists are due to DM (51). The

subsequent-visit to first-visit ratio is 4 to 1. The cost of first visits (52) was € 79.4 (updated to 2002), whereas the cost of subsequent visits was € 47.6. In one year, first visits range between 127,691 and 191,537, and the annual number of subsequent visits range between 510,764 and 766,146. These figures would result in an estimated cost ranging from € 34.46 million to € 51.69 million.

Amenabar et al. report the prevalence of dialysis in Spain on Dec. 31, 2000 (11): 441 patients per million undergoing hemodialysis and 41 per million undergoing peritoneal dialysis. The same report identifies DM as the main cause of renal failure, responsible for 23% of patients on dialysis during the year 2000. Therefore, in Spain 17,363 patients are annually in hemodialysis and 1,614 undergo peritoneal dialysis. The total of diabetics in dialysis was 3,994 and 371, respectively, in the year 2000. The total annual cost of dialysis in diabetic patients was € 93 million in 2002, being € 21,308 the mean annual cost per treatment (61) (€ 19,500 in 1999, adjusted to 2002).

The frequency of primary care visits was estimated - rather conservatively (29, 47, 48) - at an average of nine per year. According to the prevalence rate considered, the total number of primary care visits may fluctuate between 15 and 18 million annually. Due to the wide dispersion of costs estimated for primary care visits in Spain, we used an average of the intermediate values found in recent literature. These values range between €12 (Hypothesis A) and €15 (Hypothesis B) per visit. Under these assumptions, the estimated cost ranges from a minimum of €181.24 million (prevalence: 5%; mean cost per visit: €12) and €271.86 million (prevalence: 6%; mean cost per visit: €15), finding in-between values for the other assumptions.

Finally, using the CMBD (60) we estimated hospital costs of diabetic patients. We found 285,013 hospitalizations of diabetic patients, a little more than three million stays. The total cost was estimated by applying the mean tariff per DRG per case. For 1999, the total estimated cost of stays related to patients with "Diabetes Mellitus" in their diagnoses (main or secondary), was €853.74 million. Adjusting that figure to 2002 the estimated cost rises to € 932.99 million.

The relative weight of acute DM complications was 4.7% of the total hospital costs of diabetic patients. The fraction of hospital costs due to chronic complications was 37.4% (32.2% attributable to macrovascular problems and 5.2% due to microvascular). The remaining 57.8% was caused by other hospitalizations apparently unrelated to DM.

(INSERT TABLE 3)

4. Conclusion

Aggregating the previously mentioned items results in a direct yearly healthcare cost that fluctuates between a minimum of € 2.4 billion and a maximum of € 2.67 billion. These figures, in terms of annual average costs per diabetic, are € 1,290 and € 1,476 as the lowest and highest values, respectively (see table 4). It is important to highlight that this is the first time that the CMBD and ALHAQUEM and RHAZES data bases are used to estimate the cost of patients with diabetes in Spain.

(INSERT TABLE 4)

Regarding the distribution of these costs, hospitalization and drugs are the most important items. Hospital costs fluctuate -depending on the assumptions involved- between 35% and 39% of the total. Expenditures on insulin and oral hypoglycemic agents range from 12% to 13%, while the cost of other drugs is between 31% and 36%. The cost of primary care visits trail far behind, varying from 8% to 10% of the total. The cost of visits to the endocrinologist and dialysis are 5% to 6%, whereas the cost of test strips, needles and syringes amount to 3% to 4% of the total (see figures).

(INSERT FIGURES)

5. Discussion

It has been estimated that, nowadays, the diabetic population consume at least around 5%-6% of the global health care expenditures in developed countries (3), and a diabetic patient consumes at least three times more direct resources (physicians' services, drugs, hospitalizations) than a non-diabetic.

For the prevalence interval above mentioned, the direct health care costs of DM patients in Spain for 2002 was between 5% to 5.5% of total medical expenditures. That is, between 5% to 6% of the population are diabetic patients and consume nearly € 2.4-2.7 billion. Other attempts to determine the costs of diabetic patients in Spain have not include all relevant costs. In this paper we have tried to identify and quantify the direct medical costs for 2002, capturing all available data bases in the National Health System.

Several limitations of this study must be recognized. The figures for prevalence and costs are estimations that need some qualifications. First, DM prevalence is probably higher than the figures we used, since a significant number of DM cases among the general population go undiagnosed (30-44). It could affect our average cost per patient, with total costs almost unchanged since they were obtained mainly from primary sources and official accounting records measuring resources spent in DM independently of the number of patients treated. Only our estimations of "cost of other drugs" and "cost per visit in primary care" depend directly on the chosen prevalence rate.

Secondly, the hospital cost figures are essentially a conservative estimation of the real cost of diabetics. The reason is that the CMBD relies upon a tariff for each DRG. In spite of this, several studies show that for identical DRG the average cost of diabetics is higher than the average costs of non-diabetic patients (62, 72, 73, 74). Therefore, the hospital costs related to non acute complications – chronic complications and other hospitalizations - of diabetic patients must be actually higher than the figures we have used. The phenomenon has a simple explanation: diabetes makes treating any other disease more expensive since it is a factor that extends hospital stays. This also makes diabetics more expensive than non-diabetic patients, independent of the episode that caused the hospitalization. The CMBD corroborates this, showing differences in the length of stay for diabetics and non-diabetics in the 590 identified DRGs, even after age is factored out. Other international studies reflect similar differences between the age-adjusted mean length of stay for identical DRGs among DM and non-diabetic patients (14, 16, 66, 67).

Finally, we did not include costs for all possible healthcare items. Specifically, the number of visits to specialists other than endocrinologists is unknown. In Spain the quality of data on drugs (insulins and oral hypoglycemic agents) and hospitalizations is solid. However, no homogeneous databases exist at present for ambulatory care (primary or specialized).

The relative weight of different items is similar to the findings of other studies (3, 6, 8, 14, 20, 21, 22), being the main item hospital costs. However, many papers omit data on drugs other than insulins and oral hypoglycemic agents. Polypharmacy is a frequent phenomenon among diabetics and becomes widespread with age and the evolution of the disease over time. Almost every DM patient requires not only hypoglycemic treatment, but also treatment for comorbidities and cardiovascular risk factors linked to DM. In fact, if we add up the aggregate costs of insulins, oral hypoglycemic agents and other drugs, plus costs of consumable goods, their total value would surpass hospital costs (49% vs. 35% for 6% prevalence) (see figures).

Expenditures for all drugs and consumable goods range between a minimum of € 1.16 and a maximum of € 1.3 billion. It represents 48-49% of the total cost, nearly 15% greater than hospital costs. It should be noted, however, that the relative incidence of each item should be considered rather cautiously, given the above mentioned information and data problems.

It also should be underlined that the present work does not include non-healthcare direct costs, neither indirect costs (productivity loss) nor informal care costs faced by patients and society as a whole. Estimations of indirect costs are not so frequent and findings diverge anywhere from 30% to 55% of total costs (2, 3, 6, 8, 13, 20, 21, 24, 26, 68, 69, 70). Similarly, intangible costs connected to DM were not included. In chronic diseases these costs are often significant, but quantifying them is very complex (they are seldom calculated and quality of life is used as a proxy).

Cost of illness studies are subject to criticism around three ideas: (71)

1. The total cost of the disease is not what really matters. The point is what can be done to mitigate or prevent and what resources are needed.
2. Estimating total costs of DM is useful as a means of measuring the benefits of prevention and treatment only if interventions really prevent or cure diseases (marginal analysis).
3. The fact that costs are larger does not imply that greater benefits will be achieved by allocating more resources to the disease with higher costs.

Resources should not be allocated according to the costs of a certain disease, but rather where interventions benefit the most. But it is true that cost of illness studies help to illustrate the real dimension of health problems. Cost of illness studies are suited to reveal the economic repercussions of a given disease, quantifying healthcare and other resources spent that could be allocated to alternative goals. They also provide society and decision-makers valuable information about the relative and absolute impact of health problems, helping, therefore, to set priorities in the use of healthcare and social resources (72).

In this article we have highlighted the relevance of prevention and treatment of chronic complications related to DM. Our more striking finding is that drugs and consumable goods, including other drugs different from hypoglycemic agents, account for 48-49% of the total health care costs of diabetic patients. In previous studies hospital costs were the largest portion, mainly due to hospital treatment of chronic diabetes-related complications. Since almost all diabetic patients will undergo treatments to prevent and to treat cardiovascular risk factors and macrovascular complications, the preventive management of diabetes and chronic complications should become an imperative. The cost of preventive treatment is insignificant compared with the downstream costs of treating inadequately or not treating the disease. Now the challenge is how to allocate resources more efficiently being the main goal to increase the life-span and quality of life of diabetics.

This study is another piece of evidence to support that well-proven effective medical procedures (73-78), good health education, appropriate self-care by patients and good coordination among healthcare levels, is the best combination to achieve high standards of cost-effectiveness and cost-utility (79-81) and ultimately extend life and improve the quality of life for diabetics.

5. References

1. King H, Aubert RE, Herman WH. Global Burden of Diabetes, 1995-2025. Prevalence, numerical estimates and projections. *Diabetes Care* 1998, 21: 1414-1431.
2. Ray NF, Wills S, Thamer M. Direct and indirect costs of diabetes in the United states in 1992. Alexandria VA: American Diabetes Association, Inc., 1993.
3. American Diabetes Association. Economic Consequences of Diabetes Mellitus in the U.S. in 1997. *Diabetes Care*. Vol. 21 nº 2 .
4. Cowie CC, Eberhardt MS: Diabetes 1996: Vital Statistics. American Diabetes Association, Alexandria, 1996
5. Rubio JA, Álvarez J. Costes económicos de la diabetes mellitus: revisión crítica y valoración coste-eficacia de las estrategias propuestas para su reducción. *Atención Primaria*. Vol. 22. Núm. 4. 15 de septiembre 1998
6. Songer TJ, Ettaro L and the Economics of Diabetes Project Panel. Studies on the Cost of Diabetes. June 1998
7. Leese B. Diabetes mellitus and St Vincent Declaration. The economic implications. *PharmacoEconomics* 1995; 7: 292-307
8. MacLeod KM, Tooke JE. Direct and indirect costs of cardiovascular complications of type II diabetes. *PharmacoEconomics* 1995; 8 (Supl 1): 46-51.
9. Group TG. Epidemiology of lower extremity amputation in centres in Europe, North America and East Asia. The global lower extremity amputation study group. *Br J Surg* 2000 Mar;87(3):328-37
10. Gomis M et al. Repercusión económica de las infecciones en los pies de los diabéticos. *Farmacoeconomía*, 1995, IV: 39-48
11. Amenábar JJ et al. Informe de diálisis y trasplante de la Sociedad Española de Nefrología y Registros Autonómicos, año 2000. *Nefrología* 2002, Vol. XXII, nº 4: 310-31
12. Morato Giera J, Franch Nadal J, Carrillo Munoz R, Via Vidal M, Herrera Ruiz A, Valerio Sallent LL. Cronología de las complicaciones de la diabetes del adulto. El estudio del Raval Sur. *An Med Intern* 1995 Sep; 12(9): 431-7
13. Gray A, Fenn P, McGuire A. The Cost of Insulin-dependent Diabetes Mellitus (IDDM) in England and Wales. *Diabetic Medicine*, 1995; 12: 1068-1076
14. Kangas T, Aro S, Koivisto VA, Salinto M, Laakso M, Reunanen A. I. Structure Cost of Health Care of Diabetic patients in Finland. *Diabetes Care*, Vol 19, nº 5, May 1996.
15. O'Brien JA, Shomphe LA, Kavanagh PL, Raggio G, Caro JJ. Direct Medical Costs of Complications Resulting from Type 2 Diabetes in the US. *Diabetes Care*, vol. 21, nº 7, July 1998.
16. The Demand and Financial Cost of Hospital Care for Diabetes Mellitus and its Related Complications (editorial). *Diabetic Medicine*, 1998; 15: 449-451.
17. Evans JMM et al. Impact of Type 1 and Type 2 Diabetes on Patterns and Cost of Drug Prescribing. A population-based study. *Diabetes Care* 2000; Vol. 23, nº 6, June: 770-774
18. Oliveira G y Carral F. Costes de la diabetes: una reflexión desde la situación asistencial en España. *Avances en diabetología* 2000; 16: 121-130.
19. Rathmann W Haastert B, Roseman JM, Gries FA, Giani G. Prescription Drug Use and Costs Among Diabetic patients in Primary Health Care Practices in Germany. *Diabetes Care* 1998; Vol. 21, nº 3, March: 389-397.
20. American Diabetes Association. Economic Costs of Diabetes in the U.S. in 2002. *Diabetes Care* 26:917-932, 2003.
21. Jonsson B. Revealing the cost of Type II diabetes in Europe. *Diabetologia*. 2002 Jul;45(7):S5-12.
22. O'Brien JA, Shomphe LA, Kavanagh PL, Raggio G, Caro JJ. Direct medical costs of complications resulting from type 2 diabetes in the U.S *Diabetes Care* 1998, Vol 21, Issue 7 1122-1128.
23. Caro JJ, Ward AJ, O'Brien JA. Lifetime Costs of Complications Resulting From Type 2 Diabetes in the U.S. *Diabetes Care* 25:476-481, 2002

24. MacLeod KM, Tooke JE. Direct and indirect costs of cardiovascular and cerebrovascular complications of type II diabetes. *Pharmacoeconomics* 1995;8 Suppl 1:46-51.
25. Norlund A, Apelqvist J, Bitzen PO, Nyberg P, Schersten B Cost of illness of adult diabetes mellitus underestimated if comorbidity is not considered. *J Intern Med* 2001 Jul;250(1):57-65.
26. Thom TJ. Economic Costs of Neoplasms, Arteriosclerosis, and Diabetes in United States. *In vivo* 10: 255-260 (1996).
27. Hart WM, Espinosa C, Rovira J. El coste de la diabetes mellitus conocida en España. *Med Clin (Barc)* 1997.
28. Mata M, Antoñanzas F, Tafalla M, P Sanz P. El coste de la diabetes tipo 2 en España. *Gaceta Sanitaria* 2002; 16 (6): 511 - 520
29. López Bastida J, Serrano Aguilar P y Duque González B. Los costes socioeconómicos de la diabetes mellitus. *Atención Primaria* 2002; 29 (3): 145-150.
30. Goday A, Serrano-Ríos M. Epidemiología de la diabetes mellitus en España. Revisión crítica y nuevas perspectivas. *Med Clin (Barc)* 1994; 102: 306-315.
31. Tamayo-Marco B, Faure-Nogueras E, Roche-Asensio MJ, Rubio-Calvo E, Sanchez-Oriz E, Salvador-Olivan JA Prevalence of diabetes and impaired glucose tolerance in Aragon, Spain. (45) *Diabetes Care* 1997 Apr; 20(4): 534-6.
32. Muñiz J. Effect of the application of the new diagnostic of diabetes mellitus in the prevalence estimates and diagnostic level in the general population. *European Journal of Public health* 1999; 9: 149-151.
33. Bayo J, Sola C, García F, Latorre PM, Vázquez JA. Prevalencia de la diabetes mellitus no dependiente de la insulina en Lejona (Vizcaya). *Med Clin (Barc)* 1993; 101: 609-612.
34. Useros A. Prevalencia de la diabetes mellitus en la provincia de Valladolid. En: Serrano-Ríos M, ed. *Epidemiología de la diabetes mellitus: reflexiones sobre algunos estudios realizados en España y sugerencias para el futuro*. Jornadas Internacionales de la Fundación Valgrande 1988; 8: 115-144.
35. *Estadísticas de Salud 1978-1987. Información Sanitaria y Epidemiología*. Madrid: Ministerio de Sanidad y Consumo, Dirección General de Salud Pública, 1991.
36. Figuerola D, Castell C, Lloveras G. La diabetes en España. Análisis de la prevalencia y atención médica según el consumo de fármacos y el material de autocontrol. *Med Clin (Barc)* 1988; 91: 401-405.
37. Antó Bosqué JM, Company Serrat A, Domingo Salvany A, Clos Matheu J. Aproximació a l'epidemiologia de la diabetes a la ciutat de Barcelona. *Gaceta Sanitaria* 1985; 19: 11-16.
38. Franch Nadal J, Álvarez Torrices JC, Álvarez Guisasola F, Diego Domínguez F, Hernández Mejía R, Cueto Espinar A. Epidemiología de la diabetes mellitus en la provincia de León. *Med Clin (Barc)* 1992; 98: 607-611.
39. *Consenso para la Atención a las Personas con Diabetes en España*. Madrid: Ministerio de Sanidad y Consumo, 1994.
40. *Consell Assessor sobre la Diabetis a Catalunya. Estudi de prevalença de diabetes mellitus no insulíndependent a Catalunya*. Barcelona: III Congreso de la Sociedad Catalana de Diabetes, mayo 1995.
41. *Servicio Canario de Salud. Estudios sobre diabetes mellitus en Canarias*. Santa Cruz de Tenerife: Consejería de Sanidad y Consumo del Gobierno de Canarias, 1999.
42. *Encuesta Nacional de Salud (1997)*. Centro de Investigaciones Sociológicas. España, 1997.
43. Goday A. Epidemiología de la diabetes y sus complicaciones no coronarias. *Rev Esp Cardiol* 2002; 55 (6): 657-70.
44. Expert Committee on the Diagnosis and Clasification of Diabetes Mellitus. Report of the Expert Committee on the Diagnosis and Clasification of Diabetes Mellitus. *Diabetes Care* 1997; 26:443-74.
45. *Boletín de la Dirección General de Farmacia*. Ministerio de Sanidad y Consumo. 2000. Madrid, España.
46. *Boletín de la Dirección General de Farmacia*. Ministerio de Sanidad y Consumo. 2001. Madrid, España.

47. Clua JL, Puig, J, Queralt ML, Palau A. Análisis coste-efectividad de la automonitorización de la glucosa sanguínea en diabéticos tipo 2 *Gaceta Sanitaria*, 6 2000 ; 14: 442-448
48. Clua Espuny JL, Puig Junoy J, Queralt Tomas ML, Palau Galindo A. Automonitorización de la glucosa sanguínea (MGS): evaluación de su prescripción y resultados en la diabetes tipo 2. *Atención Primaria* 1999; 24 (6): 316-325.
49. B. Costa Pinel.M. Belmonte Serrano.F. Páez Vives.A. Sabaté Obiol.À. Estopá Sánchez.J. Borrás Borrás. Conversión de la terapia intensiva con insulina rápida a insulina lispro en la diabetes tipo 1. Análisis farmacoeconómico de coste-efectividad. *Revista Clínica Española*, 08 2001 ; 201: 448-454.
50. Costa B, Arroyo J, Sabaté A. The economics of pharmacotherapy for diabetes mellitus. *PharmacoEconomics* 1997; 11: 139-158.
51. Monereo Megías S, Alameda Hernando C, Molina Baena B, Pavón de Paz I et al. Análisis de las patologías que originan la demanda de atención endocrinológica especializada extrahospitalaria. 43º Congreso de Endocrinología y Nutrición de la SEEN. Santiago de Compostela, mayo 2001. *Endocrinología*, 2001; vol 48 (suppl 2): 50.
52. Instituto Nacional de la Salud (INSALUD). Memoria Económica 2000. Madrid, España.
53. INSALUD. Informe económico-funcional de las Instituciones Sanitarias. Madrid: Ministerio de Sanidad, 1996.
54. Gisbert R, Brosa M. Costes y evaluación económica. SOIKOS. Barcelona, España, 1997.
55. Diari Oficial de la Generalitat de Catalunya. Nº 3726. 25.9.2002.
56. A. Joyanes Romo.M.I. Fuentes Galindo.V.R. Plasencia García.S.R. González-Casanova González.B. Marrero Pereyra.J.F. Reyes Rodríguez.. Implicaciones asistenciales y económicas de prestación sanitaria al turista en atención primaria. *Cuadernos de Gestión*, 4 2000 ; 6: 184-189
57. Garcia Latorre FJ, Dolsac Espinosa JI, Cebrian Martin C, Lorente Valero F., Bastarós García JC. Indicadores económico-asistenciales en dos áreas sanitarias: el coste del "producto consulta" en equipos de atención primaria *Atención Primaria* 1994;14(3):655-660.
58. Comas Fuentes A, Suarez Gutierrez R, Lopez Gonzalez ML, Cueto Espinar A. Coste-efectividad del consejo sanitario antitabaco en atención primaria de salud. *Gac Sanit* 1998 May-Jun;12(3):126-32
59. Plans P. Coste-efectividad de la vacunación antineumocócica 23-valente en Cataluña. *Gaceta Sanitaria* 2002; 16 (5): 392-400.
60. Conjunto Mínimo Básico de Datos hospitalarios (CMBD). Ministerio de Sanidad y Consumo, 1999.
61. J. Lamas, M. Alonso, J. Saavedra, G. García-Trío, M. Rionda y M. Ameijeiras. Costes de la diálisis crónica en un hospital público: mitos y realidades. *Nefrología* 2001; Vol. XXI. Núm. 3. Mayo-Junio.
62. Monereo S. Complicaciones de la diabetes mellitus: impacto sobre los costes hospitalarios. *Endocrinología* 1999. Vol. 46, nº 2: 55-59.
63. Pascual JM et al. Impacto de la diabetes en los costes de hospitalización. *Med Clin (Barc)* 1996; 107: 207-210).
64. González M., Galíndez A. Estudio del coste de hospitalización de las complicaciones de la diabetes.
65. Carral F, Oliveira G, Salas J, Garcia L, Sillero A, Aguilar M. Care resource utilization and direct costs incurred by people with diabetes in a Spanish hospital. *Diabetes Res Clin Pract* 2002 Apr;56(1):27-34
66. Van Houtum WH et al The Cost of Diabetes-related Lower Extremity Amputations in the Netherlands., *Diabetic Medicine*, 1995.
67. Norlund A, Apelqvist J, Bitzen PO, Nyberg P, Schersten B. Cost of illness of adult diabetes mellitus underestimated if comorbidity is not considered *J Intern Med* 2001 Jul;250(1):57-65.
68. Henriksson F, Jönsson B. Diabetes: the cost of illness in Sweden. *J Intern Med* 1998; 244: 461-8.

69. Dawson KG, Gomes D, Gerstein H, Blanchard JF, Kahler KH. The economic cost of diabetes in Canada, 1998. *Diabetes Care*. 2002 Aug;25(8):1303-7.
70. Persson U. The indirect costs of morbidity in type II diabetic patients. *Pharmacoeconomics*. 1995;8 Suppl 1:28-32.
71. Donaldson C, Venkat-Narayan KM. The cost of diabetes. A useful statistic? *Diabetes Care*, vol. 21, n° 8, August 1998
72. Jonsson B. The Economic Impact of Diabetes. *Diabetes Care*, vol. 21, suppl 3, December 1998
73. The Diabetes Control of Complications Trial Research Group. The effect of intensified insulin treatment on the development and progression of long term complications in insulin dependent diabetes mellitus. *N Engl J Med* 1993; 329: 977-986.
74. The Diabetes Control and Complications Trial Research Group. Lifetime Benefits and Costs of Intensive Therapy as Practiced in the Diabetes Control and Complications Trial. *JAMA*, November 6, 1996- Vol 276, n° 17.
75. CDC Diabetes Cost-Effectiveness Study Group. The Cost-Effectiveness of Screening for Type 2 Diabetes. *JAMA*, November 25, 1998 – vol. 280, n° 20.
76. Sculpher MJ, Buxton MJ, Ferguson BA, Spiegelhalter DJ, Kirby AJ. Screening for diabetic retinopathy: a relative cost-effectiveness analysis of alternative modalities and strategies. *Health Econ* 1992; 1: 39-51.
77. Vijan S, Hofer TP, Hayward RA. Cost-utility analysis of screening intervals for diabetic retinopathy in patients with type 2 diabetes mellitus. *JAMA* 2000; 283: 889-896.
78. Niefeld MR, Braunstein JB, Wu AW, Saudek CD, Weller WE, Anderson GF. Preventable hospitalization among elderly medicare beneficiaries with type 2 diabetes. *Diabetes Care*. 2003 May;26(5):1344-9
79. Klonoff DC, Schwartz DM. An Economic Analysis of Interventions for Diabetes. *Diabetes Care* 2000; Vol. 23, n° 3, March: 390-404.
80. Monereo S. Coste de la diabetes: ¿podemos optimizarlo? *Endocrinología* 1998. Vol. 45, n° 8: 279-282.
81. Rubio JA, Álvarez J. Costes económicos de la diabetes mellitus: revisión crítica y valoración coste-eficacia de las estrategias propuestas para su reducción. *Atención Primaria* 1998. Vol. 22. Núm. 4.

Table 1

Clinical classification	International Classification of Diseases (ICD-9-CM)	Diagnosis-Related Group (DRG)
Hyperglycemic episode	250.0-250.2	294-566
Ketoacidosis	250.1-250.3	295
Neuropathy	250.6	6-18-19
Nefropathy	250.4 (581.81-583.81)	304-305-315-316-317-320-321- 322-331-332-556-568-569
Ophthalmopathy	250.5 (362.01-362.02)	36-37-39-42-45-46-47
Peripheral Vascular Disease	250.7 440.9-443.8-785.4	113-114-124-130-131-209-225- 269-270-285-292-796
Cerebrovascular Disease	250.7 430-437-438	5-14-15-16-17-532-533
Cardiovascular Disease	250.7 410-411-412-413-414- 414.8	106-107-112-120-121-122-123- 124-125-127-132-133-134-140- 141-142-144-145-478-479-544- 546-549-550-808

Table 2. Cost of test strips

	Hypothesis A	Hypothesis B	Hypothesis C
Cost of test strips (millions of €)	70.89	66.87	77.52
Hypothesis A: INSALUD data extrapolated to the whole Spanish population Hypothesis B: (18) and (48) Hypothesis C: (18) and (48) plus increase in percentage of users.			

Table 3. Synthesis of Hospital Activity

	Hospitalizations	Stays	Estimated Cost
1. Acute complications	6.8%	5.4%	4.7%
2. Chronic complications	38.1%	36.9%	37.4%
2.1 Microvascular complications	8.1%	4.9%	5.2%
2.2 Macrovascular complications	30.0%	32.0%	32.2%
3. Other hospitalizations	55.2%	57.7%	57.8%

Source: CMBD

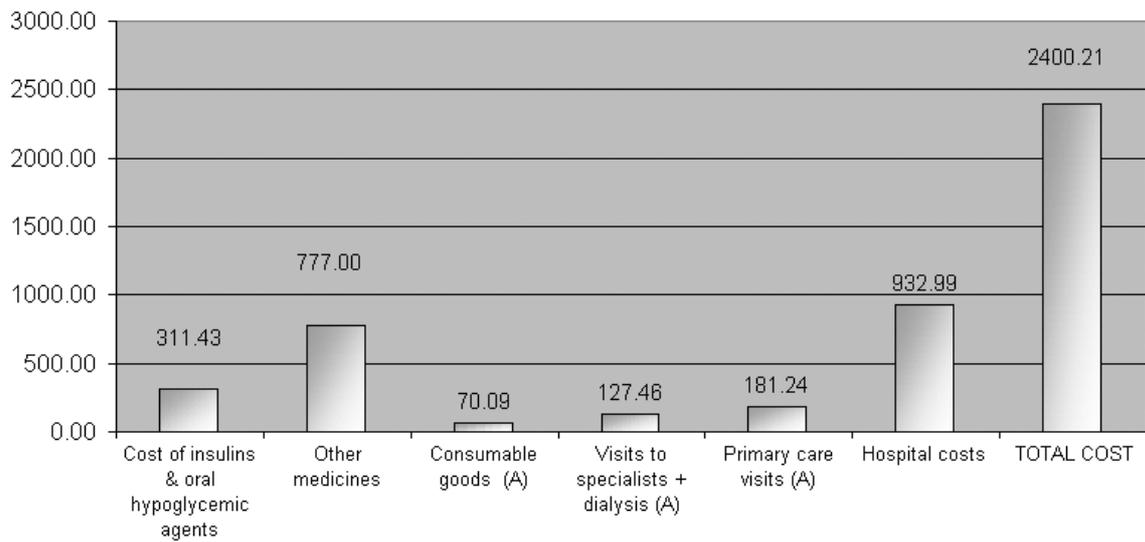
Table 4
Synthesis
Costs of Diabetes Mellitus Patients In Spain, 2002

	Prevalence: 5% of adult population	Prevalence: 5.5% of adult population	Prevalence: 6% of adult population
Number of people with DM	1,675,304	1,842,835	2,010,365
Cost of insulins (A10A) and oral hypoglycemic agents (A10B) (*)	311.43	311.43	311.43
Other drugs	777.00	854.70	932.40
Consumable goods (test strips + needles and syringes)	70.09-80.74	70.41-81.06	70.73-81.38
visits to specialists + dialysis (*)	127.46 -144.69	127.46 - 144.69	127.46 - 144.69
Primary care visits	181.24- 226.55	199.36 - 249.20	217.49-271.86
Hospital costs (*)	932.99	932.99	932.99
Total cost			
Minimum total cost	2400.21	2496.35	2592.49
Maximum total cost	2473.40	2574.07	2674.75
Minimum per-patient cost	1432.70	1354.63	1289.56
Maximum per-patient cost	1476.39	1396.80	1330.48

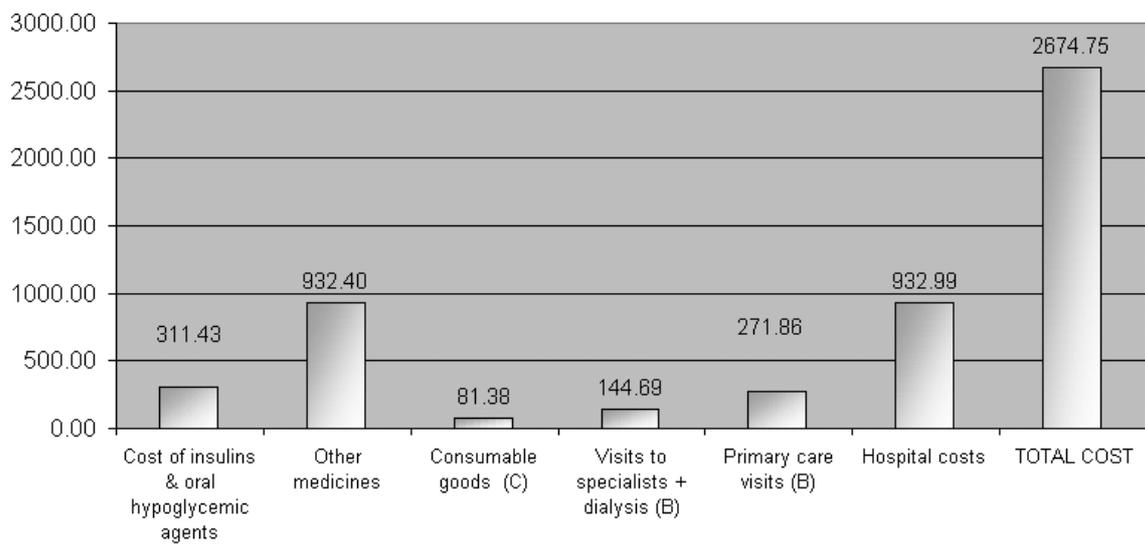
In millions of euros, except population and per-patient figures

(*) In these items, estimated costs do not depend on DM prevalence, because they come from records and primary sources (see methodology).

Costs of DM patients: minimum cost (prevalence = 5%)

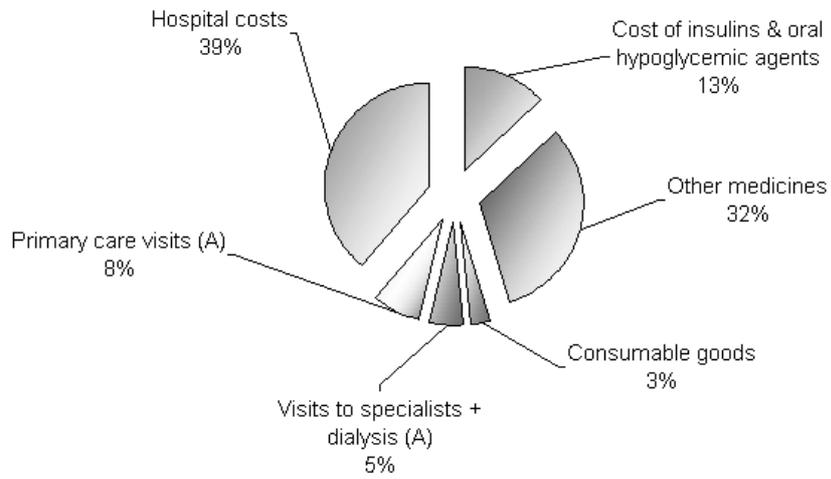


Costs of DM patients: maximum cost (prevalence = 6%)

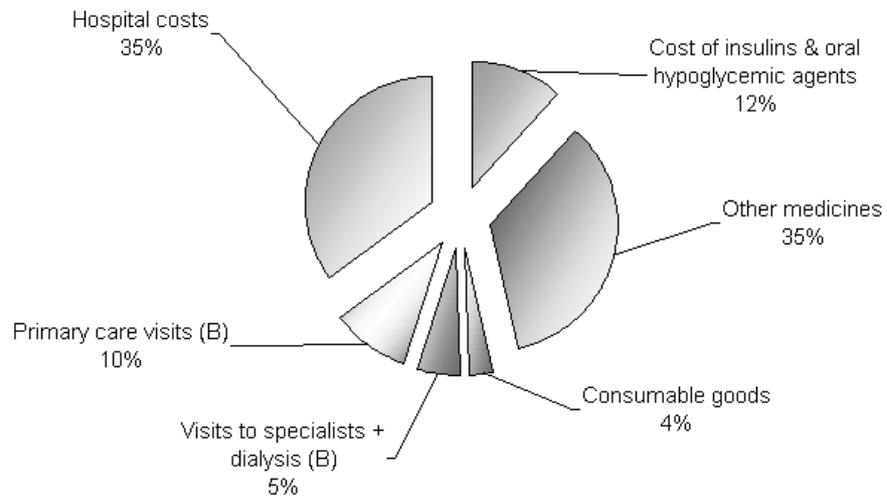


Costs unit: millions of euros

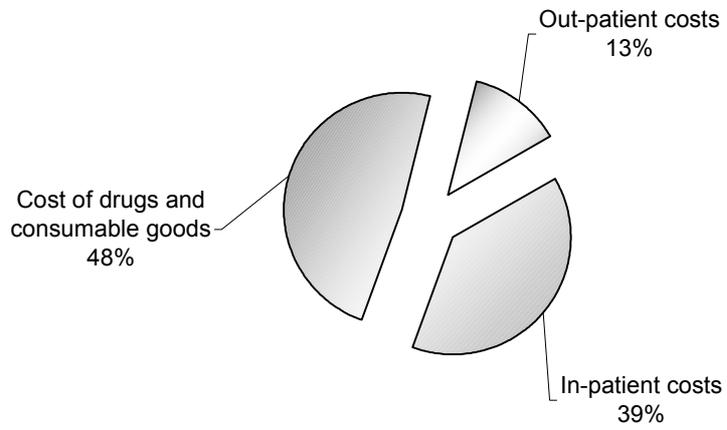
Costs of DM patients: minimum cost (prevalence = 5%)



Costs of DM patients: maximum cost (prevalence = 6%)



Costs of DM patients: minimum cost (prevalence = 5%)



Costs of DM patients: maximum cost (prevalence = 6%)

