# **Metabolic Syndrome in Mexico: Situational**

# **Assessment and Some Technological Challenges**

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# Abstract

The assistance of chronic diseases represent one of the main challenges of health systems, for this reason it is important to design new proceedings assistance where new technology could improve all aspects of chronic disease care. The epidemic of chronic diseases increase in Mexico with main diseases associated to obesity as type 2 diabetes and hypertension. The Mexican National Health Register indicated that 8% of population older than 20 year suffers type 2 diabetes and approximately of 30% have hypertension; similar prevalence is found in dyslipidaemia (30%). The prevalence of Type 2 diabetes is increasing and has been associated with obesity; obesity as well as dyslipidaemia and hypertension affect 70% of the population over the age of 20-years. The economic impact of diabetes in Mexican health national system is near to 317 million dollars and for hypertension represents 6% to 8% of the total health budget. The first proposal of this document is to design health information applications that may contribute to the improvement of efficiency, cost/effectiveness, quality and safety of medical care of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in primary care; Secondly, this paper presents a proposal for self-help measures for the metabolic control of patients with Type 2 diabetes in primary care; the third proposal of this document is to early detect ocular fundus alterations in patients with diabetes mellitus and hypertension by applying teleophthalmology in primary care. These proposals are aimed at aiding and giving suggestions for the preparation of projects promoting the improvement of quality of life of people with chronic diseases, such as type 2 diabetes, obesity, hypertension and dyslipidaemia, given that these chronic diseases have already occupied a priority place regarding concerns of nationwide healthcare interest. With the results being obtained, patients will benefit while support to health professionals and health managers will be given, for a practice of excellence in the health services unit in Mexico.

## 1. Background

As per the World Health Organization (WHO), chronic conditions require to be managed over a period of years or decades; most of these conditions require a complex response for a long period of time, which involves good coordination of health professionals and access to essential drugs as well as to monitoring systems.<sup>1</sup>

Chronic diseases affect the quality of life and functional status of patients; substantially increase the use of healthcare services and secondary health care costs increase.<sup>2</sup>

The economic and fiscal costs of chronic diseases assistance are large and growing, but less effective. This evidence indicates that is necessary to develop new models focused on improving the management of chronic conditions in primary care.<sup>2</sup>

Type 2 diabetes is associated with macrovascular (myocardial infarction, stroke and peripheral vascular disease) and microvascular complications (retinopathy, nephropathy and neuropathy).<sup>3,4</sup>

These long-term vascular complications occur as a result of a combination of factors, such as hyperglycaemia, hypertension, obesity and dyslipidaemia, causing vascular impairment and having as a consequence endothelial dysfunction.<sup>5-8</sup>

The aetiology of macrovascular disease risk in type 2 diabetes is multifactorial; part of the increased risk may be explained by the presence of various factors, such as cardiovascular risk factors and cardiovascular disorders. This clinical condition is denominated metabolic syndrome and includes insulin resistance, hyperglycaemia, obesity, dyslipidaemia and hypertension, amongst others.<sup>9, 10</sup>

Micro vascular complications of Type 2 diabetes, include neuropathy, retinopathy and nephropathy, and are related to starting age, diabetes duration, and degree of metabolic control and may decrease the patients' life expectations and quality of life.<sup>11</sup>

Prevention of complications is reached with the sum of various therapeutic alternatives; however, current treatment measures have not been sufficient to diminish the rate of appearance of chronic complications despite the huge expense being aimed for their care.<sup>12,</sup> <sup>13</sup> Nearly 25% of recently diagnosed patients already have evidence of cardiovascular disease, nonetheless, there is controversy of the relationship between hyperglycaemia *per se* and the macrovascular disease.<sup>14, 15</sup>

The main objective in the management of patients with type 2 diabetes and concomitant diseases is to reach good metabolic control, evaluated by levels of optimal HbA1c (< 7%), arterial tension (< 130/85), total cholesterol (< 200 mg/dL) triglycerides (< 150 mg/dL), HDL-cholesterol (> 35 mg/dL) and weight control with the purpose of preventing or slowing micro- and macrovascular complications.<sup>16-17</sup>

Risk factors that may be potentially modified into type 2 diabetes are hyperglycaemia, hypertension, triglycerides, cholesterol, obesity and tobacco consumption, although the major objective in treating type 2 diabetes is managing glycaemia and particularly the prevention of macrovascular and microvascular complications.<sup>16, 18</sup>

The assistance of chronic diseases represent one of the main challenges of health systems, for this reason it is important to design new proceedings assistance where new technology could improve all aspects of chronic disease care.<sup>19,20</sup>

Health technology has become an indispensable part of health care system, offering new forms of health assistance. Many innovations in medicine transform into applicable medical technology with potentially great benefits for patients. The emergence of new technologies could prove to be more effective and cost-effective in comparison with established practices for the health assistance of chronic conditions.<sup>21</sup>

The use of health information technology has been promoted as having tremendous promise to improve the effectiveness, safely, cost-effectiveness and quality of medical care delivery in chronic illnesses.<sup>22</sup>

# 2. Presentation of the Problem

### **2.1. Burden of disease**

Chronic diseases are now the leading causes of death and illness in Latin America and the Caribbean (LAC), accounting for 68 % of deaths in Latin America and 60 percent of disability-adjusted life years (DALYs) in the region.  $^{20}$ 

### 2.1.1. Diabetes

Type 2 diabetes is characterized by reduced levels of insulin or insulin resistance, and represents approximately 85-90 per cent of diabetic sufferers, most of who are over the age of 40 years.<sup>23</sup>

In random household survey of Hispanic populations aged >40 years in two US-Mexico border counties, the prevalence of diabetes was 20%, which is 2–2.5 times higher than non-Hispanic whites.<sup>20</sup>

In 1993, the Mexican National Chronic Disease Survey, found a prevalence of 30% of metabolic syndrome in Mexican population over the age of 20 years. In Mexico City in an adult population without diagnosis of type 2 diabetes was reported a prevalence of 43%.<sup>24</sup>

The epidemic of chronic diseases increase in Mexico, principally diseases associated to obesity as type 2 diabetes and hypertension, the Mexican National Health Register for 2000 indicated that 8% of the population older than 20 years suffers type 2 diabetes and approximately of 30% have hypertension; dyslipidaemia has a similar prevalence (30%). The National Health and Nutrition Register (ENSANUT) for 2006 indicated a prevalence of diabetes in adults of 7%, most of whom are women (7.3%) and for men was 6.5%. In the aged 60-69 years the prevalence was 13.5%, 14.2% in females and 12.7% for males. For the aged 60-69 the prevalence was 19.2%, 21.3 for females and 16.8% for males. The general prevalence of diabetes from ENSANUT 2006 will be published soon, once laboratory process of glycemia is finished. <sup>24, 25</sup>

In Mexico diabetes 2 the mortality rate over age of 65 years is increasing (4,697 for 100,000 habitants). Death in this group is mainly caused by diabetes, cardiovascular disease, stroke and hypertension.  $^{24,25}$ 

Although death causes are the same in males and females, death risk for diabetes and hypertension is larger in women.<sup>24, 25</sup>

	Males		Females	
Disease	Number of deaths	%	Number of deaths	%
Type 2 Diabetes	30,879	11.3	36,280	16.3
Coronary heart disease	29,843	10.9	23,550	10.6
Stroke	12,896	4.7	14,500	6.5

### Main Causes of Death in Mexico 2005 (age: 15-64 years)<sup>24, 25</sup>

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In Mexico, type 2 diabetes, diabetic complications, heart disease and stroke, concentrate more than 33% of deaths in females and more than 26% of deaths in males in general population. The prevalence of Type 2 diabetes is increasing and has been associated with obesity, poor nutrition and physical inactivity. Obesity as weel as dyslipidaemia and hypertension affect 70% of the population over the age of 20-years, as well as dyslipidaemia and hypertension; all these influence the development of cardiac ischemic diseases and stroke. 24, 25

Tobacco consumption, elevated cholesterol and hypertension have influence in development of coronary heart disease and stroke, prevalence of these illness in adults in Mexico are 21.5, 26.5 y 30.8% respectively. 24, 25

Type 2 diabetes is the greatest challenge of Mexican national healthcare system, being the main cause of outpatient consultation in primary care, and the greatest consumer of public health expenditures (about 20%).<sup>24,25</sup>

It is also the first cause of death and the largest consultation cause in primary care, as the main cause of hospitalization. 24, 25

It is estimated that approximately 5 million people over the age of 20 years suffer type 2 diabetes (prevalence 8%). Diabetes increase with age, persons aged up to 50 years, the prevalence is over 20%. <sup>24, 25</sup>

Type 2 diabetes mellitus increases the risk for dying by cardiovascular disease, stroke and kidney failure. It is also observed that it is the most important cause of limb amputation of non-traumatic origin and the main cause of blindness.<sup>24,25</sup>

The standardize mortality rates of type 2 diabetes in 2000-2005, was 79.9 to 89.9 per 100,000 habitants in females and 73.7-86.1 in males <sup>24, 25</sup> (see graphic).



In Mexico, the states with the most important increase in type 2 diabetes from 2000-2005, (over 30%), were Campeche, Guanajuato and Nuevo León. <sup>24, 25</sup>

Heart disease is the second cause of mortality in Mexico. Coronary heart disease is has been associated with excessive consume animals fats, overweight, tobacco consumption hypertension, stress, sedentary lifestyle and diabetes. <sup>24, 25</sup>

2000-2005 indicated an standardize mortality rate for type 2 diabetes of 79.9 to 89.9 per 100,000 habitants in females and 73.7 to 86.1 in males.  $^{24,25}$ 

Standardize mortality rates for 2001 - 2005 indicated that cardiac ischemic showed a stability reduction in females (2%) and males (1%). Mexican states with more mortality were Chihuahua, Yucatán and Mexico City in females, and Baja California Sur, Sonora and Chihuahua in males.<sup>24, 25</sup>

Glycemia control in diabetics is complicated for the healthcare systems service and in diabetic patients. Antidiabetic drugs, insulin and information of glycemia become difficult.<sup>24, 25</sup>

The third cause of death in Mexico is stroke; the majority (70%) of these patients was aged over 60 years.<sup>24, 25</sup>

#### 2.1.2. Overweight and Obesity

The National Health and Nutrition Register from 2006 indicated that 7 from 10 adults have overweight and obesity.<sup>24, 25</sup>

Overweight and obesity are two of the main risk factors in the Mexican population. The prevalence in adults was increased from 34.5% in 1988 to 69.3% in 2006. Overweight and

obesity are associated with several other important causes of death in Mexico, as diabetes, heart disease, and stroke among the others. It is estimated that approximately around fifty thousand deaths per year derive form these risk factors.<sup>24, 25</sup>

According with ENSANUT 2006, 39% of adult population suffers from overweight and other 30% from obesity. <sup>24, 25</sup>

The prevalence of overweight is highest in males (42.5%), that of females (37.4%).<sup>24, 25</sup>

The prevalence of obesity is larger in females (34.5%) than in males (24.2%). The sum of these are in percentage 71.9% for overweight and obesity in females with aged over 20 years (24.9 millions of females) and 66.7% in males with aged over 20 years (16.2 millions of males).<sup>24-26</sup>



Oláiz-Fernández G, Rivera-Dommarco J, Shamah-Levy T y colaboradores. Encuesta Nacional de Salud y Nutrición 2006. Cuernavaca, México: Instituto Nacional de Salud Pública, 2006.

The prevalence of overweight and obesity in children from 5 to 11 years and in adolescents in Mexico is approximately 26% in children (4.1 millions) and 31% in adolescents (5.7 millions).  $^{24-26}$ 

#### 2.1.3. Dyslipidaemia

Diets with saturated fats, heredity and some metabolic problems as diabetes, may be manifested by elevation of total cholesterol, "bad" low-density lipoprotein (LDL) cholesterol and triglyceride concentrations, and a decrease in the "good" high-density lipoprotein (HDL) cholesterol concentration in the blood. It is estimated that dyslipidaemia produces 18% of stroke and 56% cardiac ischemic disease in the world.<sup>24</sup>

In México the prevalence of dyslipidaemia is 28.8% for females and 26.5% for males. The Mexican states with prevalence over 30% are Baja California, Baja California Sur, Chihuahua, Jalisco, Sinaloa and Tamaulipas.<sup>24-26</sup>

### 2.1.4. Hypertension

Hypertension is a risk factor for development coronary heart disease, stroke and renal failure in Mexico, there is also evidence that it is a direct cause of an important number of deaths. Causes contributing to the development hypertension are obesity, sedentary lifestyle, and salt and alcohol consumption. The prevalence of hypertension in Mexico in age over 20 years is 30.8 per cent. Over the age of 60 year, more of 50% of males and more of 60% of females have hypertension. <sup>24-26</sup>

Hypertensions in Mexico produce about 40 thousand deaths per year. The prevalence in population over the age of 20 years is 30.8%. Over the age of 60 the prevalence increases to 50% in males and 60% in females. In Mexico there is more prevalence in north of Mexico as Baja California Sur, Coahuila, Durango, Nayarit, Sinaloa, Sonora and Zacatecas (prevalence over 35%).<sup>24-26</sup>

In the last years Mexican Ministry of Health has been promoting self-help group for overweight, obesity, hypertension, diabetes and dyslipidaemia, in 2005 about 300 thousands persons participated in the IMSS however the results are poor. The effective cover of treatment in Mexico is only about 23.2%.<sup>24-26</sup>

### 2.1.5. Diabetic Retinopathy

Studies report that, in Mexico, approximately 10-15 percent of newly diagnosed Type II diabetes patients, have symptoms of Diabetic retinopathy.<sup>24-26</sup>

Diabetic retinopathy has become a greater problem in the Type 2 diabetes population due to the rapidly increasing prevalence of Type 2 diabetes, and delays associated with it is diagnosis. The prevalence of Diabetic retinopathy was found to increase dramatically with the length of duration of diabetes showing a prevalence of 7.4 per cent for people who have diabetes for 0-4 years, 25.6 per cent in those with diabetes for 5-9 years, 33.8 per cent in those with diabetes for 10-19 years and 60.5 per cent in people with diabetes for 20 or more years.<sup>24-26</sup>

Diabetic retinopathy is the most frequent cause of new cases of blindness amongst the adult population (age 20-74 years) in developed countries. <sup>24-26</sup>

### 2.1.6. Avoided Deaths

Among the main diseases producing lost of healthy life years (AVISA) are cardiac ischemic and diabetes.  $^{\rm 24}$ 

Females		Males		
Disease	%	Disease	%	
Diabetes mellitus	6.3	Diabetes mellitus	4.5	
Coronary heart disease	2.8	Coronary heart disease	3.5	
Stroke	2.2			
Total (millions of AVISAs) 6.9		Total (millions of AVISAs) 8.4		

Main causes of lost Healthy Life	Years (AVISAs) Mexico	2005
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DGIS, Secretaría de Salud

In Mexico the indicator more common is lost of Healthy Life Years (AVISAs for its acronym in Spanish); this indicator allows measuring the damages to health problem without death.  $^{24}$ 

According with this indicator the most important diseases in females are depression and diabetes, in males are diabetes and coronary heart disease.<sup>24</sup>

### 2.2. Costs

#### 2.2.1. Financial Burden

In the US, the economic burden of cost-related diabetes has been estimated in US \$65 billion annually.<sup>27</sup>

In developed countries it is estimated that care of chronic pathologies may account for 75% of Health care expenditures and more than 80% of pharmaceutical expenditures.<sup>28</sup>

#### 2.2.2. Total Expenditure in Mexican Health

Gross Domestic Product (GDP) in Mexico for Health is 6.5%, is below that for other Latin America countries.<sup>24</sup>

Expenditure in Mexico was increased from 2000 (5.6%) to 2005 (6.5%). The expenditure per cápita in health was increased from 3,664 to 4,981 pesos in the same period. From total health expenditure, 46% is for public expenditures and 54% correspond to private expenditure. In 2005 the health public expenditure was 243,812 millions of pesos.<sup>24</sup>

#### 2.2.2.1. Diabetes

Arredondo et al. in 2005 estimated economic impact of diabetes in Mexican health national system, near to 317 millions of dollars<sup>29</sup> (See next table).

They estimated economic impact of diabetes in Mexican health national system for 2005 in \$317,631,206 (U.S. dollars) as total amount for diabetes, including \$140,410,816 in direct costs and \$177,220,390 in indirect costs. The total direct costs, representing financial requirements to provide health care for expected cases of type 2 diabetes and its main complications in the three main public institutions in Mexico, expend in 2005, \$37,079,587 for the Ministry of Health (or Secretaría de Salud [SSA], serving the uninsured population) and \$103,331,235 for the Mexican Social Security Institute, or Instituto Mexicano del Seguro Social (IMSS), and the Institute for Social Security and Services for State Workers, or Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (ISSSTE), both of which serve the insured population.<sup>29</sup>

ltem	SSA	IMSS	ISSSTE	Total cost		
DIRECT COSTS						
Consultations/diagnostic	6,455,557	14,571,899	3,409,364	24,436,820		
Drugs	14,375,755	32,499,886	7,592,250	54,467,891		
Hospitalization	4,316,064	9,742,498	2,279,437	16,337,999		
Treatment of Complications	11,932,212	26,934,156	6,301,740	45,168,106		
Retinopathy	1,312,543	2,962,757	693,191	4,968,491		
Cardiovascular     disease	1,193,223	2,693,415	630,174	4,516,810		
Nephropathy	8,710,514	19,661,936	4,600,272	32,972,322		
Neurophaty	429,559	969,629	226,862	1,626,050		
<ul> <li>Peripheral vascular disease</li> </ul>	286,373	646,419	151,241	1,084,033		
TOTAL DIRECT COSTS	37,079,587	83,748,439	19,582,796	140,410,816		
INDIRECT COSTS						
Mortality cost	2,061,476	4,842,457	1,106,427	8,010,360		
Cost of permanently disabled patients	42,898,783	100,770,247	23,024,472	166,693,502		
Cost of temporarily disabled patients	647,632	1,521,302	347,594	2,516,528		
TOTAL INDIRECT COSTS	45,607,891	107,134,006	24,478,493	177,220,390		
TOTAL COSTS						
Direct and indirect costs	82,687,477	190,832,445	44,061,284	317,631,206		

Direct, indirect, and total costs attributable to diabetes in three main public institutions of the Mexican health care system (in U.S. dollars, year of estimation 2005). Data were calculated using 95% CI with the Box-Pierce statistical test (P\_0.05). The exchange rate was 1 U.S. dollar\_9.35 Mexican pesos, corresponding to January 2003. The source for the data was Arredondo A, et al.: Costos y Consecuencias Financieras del Cambio en el Perfil Epidemiologico en Me´xico. INSP-Universidad de Montreal-Internacional Development Research Centre, 1999. Actualizacio ´n de Modelos Probabilisticos, January 2003.Arredondo a, zuniga A. Economic consequences of epidemiological 800 changes in diabetes in middle income countries. Diabetes care 2004:881 27:104-109.802.

#### 2.2.2.2 Hypertension

In the Healthcare Mexican System, the amount allocated for hypertension in 2007, was 6% to 8% of the total health budget, and is US\$ 2,486,145,132. Of these, US\$ 1,178,725,132 will be direct costs and US\$ 1,307,420,000 will be indirect costs. <sup>30</sup>

#### 2.2.2.3. Obesity

The Policy and Epidemiology National Center had reported that the costs for obesity were over 3,578 millions dollars, equivalent to 10.8% of health general costs in 2000.<sup>24</sup>

#### 2.3. Challenges

The prevalence of diabetes Obesity, Hypertension and Dyslipidaemia are particularly relevant in Mexico.

The benefits and costs of implementing of Health Information Technologies In Primary Care for improve the evolution clinic and decreased risk for developing complications of cardiovascular (i.e., heart, cerebrovascular and peripheral vascular) disease including neuropathy (leading to limb amputation), retinopathy (leading to blindness) and nephropathy (leading to dialysis and transplant), required an integrated strategy training, it would be includes modernization of the health information system, knowledge technical of health care providers, project management skills, financial situation, systematic evaluation of coverage and effectiveness; reorganization of primary care services and associated cost saved from the Mexican Healthcare System and societal point of view.

The variables of interest are diabetes (with and without complication); hypertension; overweight; Obesity and Dyslipidaemia.

# **3. Current Solutions**

## 3.1. Proposal 1

Design and Implementation of a network data base in primary care for medical treatment evaluation in patients with Type 2 Diabetes, Obesity, Hypertension and Dyslipidaemia.

# 3.1.1 Introduction

Many factors may directly or indirectly influence both adherence to treatment and metabolic control of patients with type 2 diabetes mellitus, obesity, hypertension and dyslipidaemia. In addition to individual variables (biological and psychological factors), the patient's behavior is influenced by the inter-relationship of family environment, cultural/socioeconomic and healthcare system support aspects.<sup>31-32</sup>

Approximately 70% of patients with type 2 diabetes who concomitantly exhibit obesity, hypertension and dyslipidaemia are uncontrolled and an important number of mistakes have been found in their management, such as inadequate nutritional recommendations, lack of timely identification of acute and chronic complications and inappropriate utilisation of available drugs.<sup>33-34</sup>

In diabetic patients in whom the control of glycaemia is not obtained with the maximum combination of oral hypoglycemic drugs, there are different options, such as: adding insulin in combination with oral treatment. If oral treatment fails, the option is to switch to insulin.<sup>33, 34.</sup>

Physicians play an important role in the patients' behavioural and lifestyle changes; however, the ratio of physicians who routinely advise their patients ranges from 42 to 78%. These results suggest that more than 50% of the patients with cardiovascular risk may not receive appropriate advice for change in their lifestyle.<sup>35</sup>

Treatment of patients with type 2 diabetes, with hypertension, dyslipidaemia and obesity must be based upon a model which is adequate to the environment of the patient themselves.<sup>36</sup>

There are predisposing factors for the low adherence rate in chronic diseases, such as complications of treatment regimens, age, outpatient treatment, amongst others.<sup>37</sup>

Different factors, such as drugs intolerance, drug interactions, contraindications and compliance, must be considered in treating the patients with type 2 diabetes, who concomitantly present obesity, hypertension and dyslipidaemia.<sup>36, 37</sup>

Patients do not frequently take their medication as prescribed and reasons for the nonadherence are very heterogeneous. It has been demonstrated that the non-adherence contributes to unnecessary hospital admissions, decreases the efficacy of the medication and may lead to the necessity of other diagnosis/treatment procedures.<sup>38</sup>

The use of clinical guidance has been described as an opportunity to decrease the variations amongst physicians in clinical practice and provides the physician with guidance to make decisions in managing patients.<sup>39</sup>

It is expected that the implementation of clinical guidance supports the clinical decisionmaking process and improves the quality of care. These assumptions are based upon some facts: there is heterogeneity in the diagnosis and treatment, thus generating waste of resources and scarce results in health.<sup>39</sup>

There are treatment effectiveness studies which have been performed in patients for managing glucose, and preventing macro- and microvascular complications, in addition to those addressed to manage risk factors in patients with type 2 diabetes mellitus and other chronic diseases, such as obesity, hypertension and dyslipidaemia. These trials have been mainly carried out in developed countries using databases including information coming from pharmacies, hospitals and mainly primary care, and provide better understanding of detection, treatment and evolution of type 2 diabetes mellitus, obesity, dyslipidaemia and hypertension in daily clinical practice.<sup>37, 40-42</sup>

# 3.1.2 Medical Information as a Tool in Medicine

Medical information technology derives from the fusion of essential data groups for organising and managing healthcare services. Some reports have the potential to provide timely information and feedback to physicians and powerfully act in the changes of patients' treatment. Thus, it is important to implement the correct use of electronic clinical files in healthcare institutions and in that manner be able to evaluate adherences and effectiveness of treatment in daily clinical practice according to applicable clinical guidance.<sup>43, 47</sup>

It is sought that primary care, physicians and the pharmacy staff who supply the prescriptions enter information in one electronic clinical record which at the same time would feed a database and in that fashion be able to obtain information to asses the quality of care, and the quality of treatment, as per the indications of the applicable clinical guidance of the patients with type 2 diabetes mellitus, obesity, dyslipidaemia and hypertension in primary care; however, these diseases turn to be complex and their management difficult.<sup>48, 51</sup>

## 3.1.3. Justification

The increasing interest for the evaluation of Health Information Technologies is justified by various causes; which advise for the introduction of rational criteria for planning and ordering health technologies, and before this situation, the background of other countries is of our interest, and being the purposes of this project: to optimise patients' treatments, focusing on three topics: prevalence, co-morbility treatment and co-morbility treatment effect of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia.

Considering that through the database one can follow-up the pharmacotherapy, managing the risk factors and the patients' evolution, being able to detect drug intolerance, drug interactions, contraindications, and treatment adherence.<sup>51</sup>

Parallel to the above, causes of the lack of control of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in primary care can be analysed by assessing the lack of metabolic control, by a deficiency in the adherence to the treatment, quality of life, diet, exercise, quality of care, depression and other factors which may contribute to the lack of control in these patients, as well as the provide feedback on patient's performance to health personnel and patients.

# 3.1.4. Cost

The projected benefits will require proper alignment of the healthcare financing system, strong leadership, effective implementation strategies and focused efforts to successfully adapt the system.

One study used computer modeling to project the benefits of Information Technologyenabled disease management for patients with type 2 diabetes mellitus in the USA. The authors evaluated several different technologies including diabetes registries, computerized decision support, remote monitoring, patient self-management and payer-based systems. In their model all of the technologies resulted in lower healthcare utilization with some having more significant impact on processes and outcomes of care that could translate into decreased morbidity and mortality for patients. This study did not attempt to estimate the costs associated with wide deployment of these technologies on a national level.<sup>51, 52</sup>

# 3.1.5. General Objective

To design applications of safety and effectiveness health information technology contribute to the improvement of efficiency, cost/effectiveness, quality and safety of medical care of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia; thus providing evidence for the execution of effective interventions and management of type 2 diabetes, obesity, hypertension and dyslipidaemia in Mexico, these evidences will contribute to the strategies for decision-making of the Mexican healthcare system to control these chronic diseases.

# 3.1.6. Specific objectives

- 1. To design and implement applications where the information of electronic clinical histories of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia is concentrated, allowing for creation of a database coming from primary care in Mexico and then carry out the analysis of great populations of patients about the treatment and quality of care of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in healthcare institutions. Results of this analysis will be useful in decision-making for the improvement of the prognosis of those patients.
- 2. To achieve control of patients with type 2 diabetes, by linking national databases to

family practice electronic patient records from several primary care clinics in Mexico, Specific data from the system will be fed back to practices in a facilitated educational process and through the intranet.

- 3. To promote high quality care through the adoption and use of health information technology/electronic health records.
- 4. To evaluate the effectiveness of the Electronic Health Record.

Based upon the use of data being obtained from the previous objectives, the following is proposed:

- a) To design and describe the development of the clinical evolution derived from a network data base in patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in primary care.
- b) To investigate and analyse the prescription of antidiabetic and cardiovascular drugs in patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in primary care.
- c) To study the pharmacological management of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in primary care.
- d) To measure the association between the adherence to treatment and the clinical evolution of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in primary care.
- e) To evaluate and identify the causes of the lack of metabolic control of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia in primary care.
- f) To evaluate the impact in prescription costs through a computerized decision support system which may give clinical recommendations based upon evidences during the process of electronic prescription in patients with type 2 diabetes, obesity, hypertension and dyslipidaemia.
- g) To perform the measurement of global economic impact.

## 3.1.7. Methodology

For the development of projects where the health information technology applied to the needs of patients from healthcare institutions, the following must be included:

- 1. Technical support including components of the system previously tested, where the clinical information is concentrated, by using the pre-existent technology infrastructure, e.g., network system of primary care units (where electronic clinical histories are entered).
- 2. This technology must be user-friendly and with quick response systems, and have

support for specific or special actions, Vg., Clinical content, medical orders, support of clinical decisions (which may be fed by the contents of applicable clinical guidance and the inter-institutional basic clinical profile) and good acceptability.

3. Trends of chronic disease evolutions of these diseases in Mexico and letter would be compare with others countries.

Out of these databases, elaborating capturing sheets is suggested, for the patients' general data, treatment starting date; it is also suggested that basic clinical profile drugs are coded as per the "Anatomical Therapeutic Chemical" (ATC), and that the application of the ATC/DDD methodology is performed focusing on the drug statistical consumption.

Coded and mapped coded elements will be utilised according to the International Classification of Diseases.

## 3.1.8. Conceptual Design of the System

The design and implementation of an information system will allow for the optimization in medical care in patients with type 2 diabetes, obesity, hypertension and dyslipidaemia. Suggested modules would be as follows:

Information master module, fed by:

#### a. Electronic file. Data obtained will be:

- i. Patient's demographic data (age, gender, origin, etc.).
- ii. Physical examination results.
- iii. Main diagnoses and co-morbility.
- iv. Utilised therapeutics.
- v. Effectiveness of the therapeutics utilised (adjusted by adherence, persistence and safety.
- vi. Pattern of use of resources (number of consultations, interconsultations, laboratory studies, cabinet, admission to other services, etc.).

#### b. Economic module. Information that will be included in this module:

- i. The following will be measured from the electronic file:
  - 1. Pattern of use of resources.
  - 2. Effectiveness of therapeutic interventions.
  - 3. Effectiveness of preventative interventions.
  - 4. Ratio of patients who pass from one health status (healthy, neuropathy,

myocardial infarction, etc.) to another.

- ii. It processes the information and produce as an outcome the costing of the disease (burden of illness).
- iii. It will send raw data to the analysis module in order to be processed.
- c. Analysis module.
  - i. With information of the economic module.
    - 1. The burden of the illness will be measured.
  - ii. It will receive from the electronic file.
    - 1. The patient's situation inside the natural history of the disease.
    - 2. Effectiveness of interventions.
  - iii. It will process the information received (based upon therapeutic guidance).
    - 1. Through analytic tools (models), decision tree, Markov models, simulation of discreet events, etc.
      - a. Economic evaluation of interventions (cost-effectiveness analysis, utility, benefit or cost minimisation).
      - b. Intervention budget impact análisis.
  - iv. As an exit, it will submit the information to (medical-administrative) decision makers.
    - 1. Expected effectiveness of interventions.
    - 2. Patient's expected cost.
    - 3. Management suggestions.

Suggested determinations to be performed to these patients are: HbA1c, insulin, peptide C, total cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol, VLDL-cholesterol, drugs level (captopril, glibenclamide, pravastatin, metformin) and one sample or urine for micro albuminuria, ocular fundus.

#### 3.1.9. Inclusion Criteria

Patients with type 2 diabetes, obesity, hypertension and dyslipidaemia are considered to be included in the study, which will be identified through the clinical file in primary care units.

The inclusion to different representative states of the various regions of the Mexican Republic is suggested.

#### Variable to be measured:

- 1. Age, Gender.
- 2. Adherence to treatment: (Diet, Exercise, Drugs prescribed for the management of type 2 diabetes, hypertension and dyslipidaemia, Total cholesterol, Triglycerides, HDL-cholesterol, LDL-cholesterol, Blood pressure, HbA1 BMI,anthropometric measures, Smoking status, Alcohol consumption status, and Microalbuminuria).
- 3. Drug levels in blood: (oral hypoglycaemics, sulfonylureas and biguanides), antihypertensives (ACE inhibitors, Captopril), statins and hypolipemiants used in the treatment of dyslipidemia.

#### 3.1.10. Challenges

A one important concern is privacy and confidentiality of patients from physicians, other healthcare professionals and healthcare organizations must be vigilant in protecting patient privacy.

A workforce capable of leading the implementation of information technology, is necessary.

Barriers to the implementation of Health Information Technology include.

- 1. Time and financial concerns.
- 2. Physical disabilities and insufficient computer skills.
- 3. Confidentiality concerns and knowledge.

#### 3.1.11. Expected Consequences

In Mexico Instituto Mexicano del Seguro Social (IMSS) has started providing a lifelong electronic health record that is accessible regardless of geographical location or the application through which it is retrieved. Information System, IMSS has begun the roll-out of an open source architecture that allows a quick and cost effective deployment to automate clinical operation of its over 250 hospitals. The system considers the integration of all care pathways through the Electronic Health Record and making the flow of information all the way from the family practitioner to the attending specialist a reality. Experience of IMSS could be used for the rest of Mexican Health System.

### 3.2. Proposal 2

Self-assistance alternatives for metabolic control of patients with type 2 diabetes mellitus, hypertension, obesity and dyslipidaemia in Primary Care through new information/communication technologies.

#### 3.2.1. Introduction

Most studies include systems trying to improve the self-control and self-management capability.<sup>53</sup>

Other systems are oriented at improving the management of chronic diseases or even the diagnosis and adherence to treatment.<sup>54</sup>

Telemedicine is a technological tool that cans helps in the communication and follow-up of patients with chronic pathologies (telesurveillance, telemonitoring); request for help and diagnostic/therapeutic advice (teleconsultation); communication between professionals and patients (teleconferencing). Primary care medicine may be benefited from this technology.<sup>55</sup>

The advantages that may be obtained with the utilization of telemedicine are diverse: to prevent users and professionals; to save time and costs; it may reduce the waiting lists of patients in primary care; diagnostic/therapeutic precision; facilitate accessibility to the sanitary system; facilitate physician-patient contact; get sanitary resources closer to rural or remote areas, etc. Drawbacks should also be mentioned, such as the great technological dependency; the need for having education in basic techniques; confidentiality; and interference of the computer itself in the communication between the physician and the patient. <sup>55, 56</sup>

The systems utilized are very diverse according to the kind of intervention or for the support or participation of professionals in the intervention.<sup>57</sup>

The systems utilized may be multiple, from interactive games on CD or more complex interactive systems in websites, by featuring at the same time professionals dedicated to personal training on health habits.<sup>58</sup>

E-mail is increasingly utilized for interactive communication between the sick person and the healthcare staff. Currently, the network-based-message system (via e-mail) has substituted the constraints of traditional messages (via postal office).<sup>59,60</sup>

Before introducing these technologies, a previous selection of patients is important, studies published so far recommend that they may be used in metabolically more unstable patients, who need to regulate their treatment or improve illness control and where technology assumes an added value, and thus preventing patients between states.<sup>61, 62</sup>

It is also mentioned that for the adequate functioning of these methods, a formation and training program is important in order to increase the efficacy of the technique.<sup>63</sup>

These technologies may be applied through devices on the TV set or in mobile phones or even the Internet.<sup>64, 65</sup>

Friedman et al. showed the effectiveness of the interactive systems that allow chatting with the patient at home. These systems aim to promote the adherence to treatment in patients with hypertension, patients call once a week, transmit their arterial tension and receive questions about the adherence to treatment, dosage and side effects of drugs, the monitoring of the arterial tension, in addition to the treatment they have maintained; data are submitted to a database which allows the edition of one report that may be evaluated by the physician and, at the same time, allows for treatment adjustment. Friedman's study was able to demonstrate a significant decrease of diastolic arterial tension and an increase of adherence to treatment in those patients without prior adherence.

Likewise, interventions performed for managing diabetes are especially addressed to educate the patient and monitor and watch over the glycaemia in order to avoid complications.<sup>67</sup>

There are trials where glycosiled hemoglobin management and the decomposition frequency have been evaluated, according to the determination of ketoacidosis or hypoglycaemia, cost analysis and patient satisfaction through a website in diabetic patients, the transmission was via MODEM, finding a significant decrease of the variables to be studied, especially glycosiled hemoglobin.<sup>68, 69</sup>

Meigs et al. performed an essay, whose objective was the participation of professionals and patients in the management and education of the disease. The webpage included an interface where patients introduced their data and could obtain information on the recommendations stated by the American Diabetes Association.<sup>69</sup>

Biermann et al. carried out an essay in patients with intensive insulin treatment. The trial was randomized with a control group with usual care and a telemedicine group. The intervention group consisted of providing the patient with an educational manual and a glucometer which transmitted the glycaemia through MODEM to a central unit. The physician accessed this system and replied over the phone to the patient. Patients could also contact by telephone the physician and arrange interviews if deemed suitable. Costs and time consumed in the processes were considered by taking into account the patient and the time the physician consumed in the telephone consultation, and the documentation management. They also analyzed glycosiled hemoglobin obtaining good results.<sup>70</sup>

Other authors have tested intervention strategies through an IT platform integrated by the professional where clinical data and patients' glycaemia are stored. Professionals may record a message for the patient with specific instructions and jot down in the program their notes and remarks.<sup>71</sup>

Other technological strategies being mentioned in the literature are via telephone where the patient sends information and may receive their physician's recommendations interactively.<sup>72</sup>

Interactions of patient groups are also mentioned through videoconferences with nutritionists, psychologists, teachers in diabetes and physicians; this sort of intervention creates a virtual community of patients and professionals, with a personal trainer who, at least once a week, encourages patients to meet their objectives, *on-line* resources, reminders and a chat (*Active Lives Support Group*) where they share their experiences. Patients have a database available where they enter their achievements and times of activity; graph generation and variable counting can be generated from these data.<sup>73</sup>

### 3.2.2. Justification

Even though from the conclusions of the studies published so far, improvement in the metabolic profile in patients with chronic diseases who have access to a telemedicine system appears to be evidenced; it is not categorically demonstrated. Thus it is necessary to carry out more extensive studies in patients with chronic diseases, such as type 2 diabetes, hypertension, dyslipidemia and obesity in primary care where the utilisation of a tool, such as telemedicine, could be measured in terms of effectiveness. There are no studies described of telemedicine in patients with type 2 diabetes mellitus, hypertension, dyslipidemia and obesity integrally carried out by family practice physicians.

# 3.2.3. General Objective

To propose and evaluate self-help measures for the metabolic control of patients with Type 2 diabetes in primary care.

## 3.2.4. Specific Objectives

- 1. To propose utilization programs of transmissions, monitoring with automatic devices and Internet to improve control and adherence to treatment of patients with type 2 diabetes mellitus, hypertension, obesity and dyslipidemia, and as a result of these interventions:
  - a) To help prevent complications.
  - b) To avoid conglomeration to healthcare units and centres.
  - c) To decrease waiting lists.
  - d) To diminish costs for the better utilisation of resources.
  - e) To improve efficacy and efficiency of units.
- 2. To evaluate the impact of telemedicine utilisation on the clinical evolution in selfcontrol of patients with type 2 diabetes, hypertension, dyslipidemia and obesity, in primary care.
- 3. To examine the extent of satisfaction of patients with type 2 diabetes, hypertension, dyslipidemia and obesity and health professionals in the use of new

information/communication technologies.

## 3.2.5. Methodology

All projects included must evaluate at least one clinical variable (Diet, exercise, drugs prescribed for the management of type 2 diabetes, hypertension and dyslipidaemia. Total cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol, blood pressure, HbA1, BMI, anthropometric measures, Microalbuminuria) or changes in the patients' quality of life regarding the control group.

# 3.2.6. Challenges

The most analysed factors are access (Only 20% of Mexican population have access to internet), cost-effectiveness, decrease of the utilisation of healthcare services, education, support, social isolation reduction, acceptability or satisfaction of use, health results and quality of care or quality of life. In order to be able to homogenise criteria, it is necessary to develop impact indicators. One also has to measure and analyse organisational/social factors or possible ethical implications associated to the use of new information/communication technologies.

The number of consultations or visits may modify the results on education, irrespective of the mean utilised.

## 3.2.7. Expect Consequences

The interest of introducing new information/communication technologies in managing the chronic pathology has the following purposes:

- 1. To improve the self-control and self-management in patients with type 2 diabetes mellitus, hypertension, obesity and dyslipidemia.
- 2. To demonstrate the safety of the techniques and acceptance of professionals and patients.
- 3. Cost analysis.

### 3.3. Proposal 3

Application of information/communication technologies (teleophthalmology) in the assessment of ocular fundus of patients with type 2 diabetes mellitus and arterial hypertension in primary care.

### 3.3.1. Introduction

Diabetes mellitus is the most frequent metabolic disease in humans and diabetic retinopathy is one of its chronic microvascular complications. Diabetic retinopathy is currently the main cause of blindness in industrialised countries in patients between 20 and 74 years of age, being responsible for 12% of new cases of blindness *per annum*.<sup>24, 25</sup>

Prevalence of arterial hypertension in Mexico in people elder than 20 years is 30% and it is calculated that 61% of individuals affected are unaware of their illness. 46.2% of diabetes mellitus patients suffer from arterial hypertension, whilst only 16.4% of hypertensives suffer from diabetes mellitus.<sup>24, 25</sup>

The risk for complications by arterial hypertension is similar in men and women; however, it may show up up to 10 years before in men. One of the most frequent complications is retinopathy.<sup>24, 25</sup>

Diabetic and hypertensive retinopathy may be diagnosed in a preventive manner, before symptoms appear. <sup>24, 25</sup>

Early detection of ocular fundus alterations in patients with diabetes and hypertension is part of the study protocol to assess the organic repercussion of these diseases.<sup>74</sup>

Ocular fundus examinations in patients with diabetes and hypertension must be carried out at least once a year by the ophthalmologist.<sup>75</sup>

This need of performing frequent reviews exceeds the possibilities of assistance that are currently in place in primary care in Mexico, causing long waiting lists for interconsultations with the ophthalmologists; and postergating diagnosis and decision-making of patients.

Telemedicine in ophthalmology could help detect affected cases and discard those that are not, thus diminishing the harmful effect that the delay has in treatment. <sup>76</sup>

The concept of telemedicine, referred to ophthalmological topics, is what we understand as teleophthalmology, which allows extending ocular care to many patients who previously lacked thereof. This allows making preventative medicine and enables the creation of an image file of ocular pathologies, that in addition to serve as indicator of the diabetic and hypertensive patient's actual situation provides orientation on the prevalence of other associated ocular pathologies. These data facilitate new options, for further investigation. Finally, it promotes cooperative work between the first level of care and the specialist in the networked system.<sup>76</sup>

That is, that teleophthalmology is a novel Internet consultation system that may provide faster diagnosis, and enables the primary care physician to know the status of their patient's retina carried out by an ophthalmologist, avoiding unnecessary visits to primary care and encouraging communication between primary care and the specialist's consultation. It also allows the integration of ophthalmologists of the diabetic patient.<sup>77</sup>

The process starts in the family practice consultation, which is the part that performs the request of interconsultation and continues with the shooting of digital pictures in the Healthcare Centre through a retinograph and the download of pictures to the computer.<sup>78</sup>

Although teleophthalmology cannot substitute direct ophthalmological exploration ever, performed by an ophthalmologist, it is without any doubt a new tool for managing this disease.

### 3.3.2. Costs

Costs would be categorized as either capital costs (purchase of camera, vehicle, analyzer, computers, software and a printer) or as recurrent costs (staff salaries, vehicle running costs, equipment maintenance, and medical disposables).

The cost-effectiveness of any screening program depends on the disease prevalence, compliance to the program, the sensitivity and specificity of the screening method and cost.

James et al made a cost-effectiveness study, comparing a systematic screening program, utilizing a mobile unit visiting inner city general practices to perform mydriatic retinal photography, to opportunistic screening available through general practitioners, optometrists and diabetiologists. This study was conducted in Liverpool with a prevalence of 14.1 per cent of diabetic retinopathy. The cost per true positive detected of the systematic mobile screening program was \$474 (sensitivity 89%, specificity 86%, compliance 80%, annual cost \$238,341), and of the opportunistic screening program was \$656 (combined sensitivity 63%, specificity 92%, compliance 78%, annual cost \$228,081). The incremental cost-effectiveness of completely replacing the opportunistic screening program was \$73 per person. A sensitivity analysis revealed the effect of varying the prevalence of diabetic retinopathy on the cost-effectiveness of screening. The cost-effectiveness for the systematic program improves when compliance increases from 30 per cent (\$1105) to 100 per cent (\$400). Systematic, compared to opportunistic screening, produces a saving of \$98 per true positive case detected. Referring all patients annually to an ophthalmologist would cost \$15,488 dollars, however performing retinal photography on the same patients would cost between \$8698 to \$10,092 dollars. <sup>7</sup>

Jacob et al and O'Hare et al (diagnostic level of evidence II) estimate the cost per patient screened to be \$29 and \$32 (\$Australian Dollar), respectively.

# 3.3.3. Justification

The implantation of teleophthalmology in primary care will allow the preventive evaluation of diabetic and hypertensive retinopathy, produce improvement in the quality of life of diabetic and hypertensive patients, enhance the assistance level, increase the resolution capacity, with a decrease of the derivation of patients at second and third level of care, contributing to better communication between primary care and specialised care.

# 3.3.4. General Objective

To early detect ocular fundus alterations in patients with diabetes mellitus and hypertension by applying teleophthalmology.

# 3.3.5. Specific objectives

- 1. To propose a teleophthalmology utilization and implementation program for early detection of diabetic and hypertensive retinopathy in primary care.
- 2. To set up a telemedicine project in primary care by installing a capturing system of images from the ocular fundus and its transmission to ophthalmology services at second or third care level, and thus enhance control and follow-up of retinopathy of patients with type 2 diabetes mellitus and hypertension.
- 3. To install teleophthalmology equipment (retinographs) in primary care, this is connected to a capturing and digitalization system.
- 4. To evaluate the impact of utilization of teleophthalmology in patients with type 2 diabetes mellitus and arterial hypertension in primary care.

## 3.3.6. Methodology

This consultation method is addressed to patients with diabetes and hypertension, because in this sort of diseases, a periodical control of ocular fundus is necessary.

It is possible that a trained nurse can perform the procedure. The equipment being recommended does not need pupil dilatation and taking of various pictures of retina. Then, these images are sent to the specialist over the Internet for analysis.

At a first stage, applications for highlighting retinographies are performed, in such a fashion that ophthalmologists can easily discriminate amongst different signs a patient with diabetic and/or hypertensive presents. And at a second stage, the detection of the number of present hard exudates is intended.

Images of ocular fundus will be stored in a database and then will be sent over the Internet (e-mail) from the primary care consultation to the deference ophthalmology consultation in a second- or third-level care hospital. The specialist will equally send over the Internet a diagnostic report and the recommendations of every patient.

Those patients who show diabetic retinopathy will be sent to ophthalmology services.

# 3.3.7. Challenges

The prevalence of diabetic retinopathy is particularly relevant. The cost-effectiveness of any screening program depends on the disease prevalence, compliance to the program, the sensitivity and specificity of the screening method and cost.

Even for people who do have diabetic retinopathy, receiving a diagnosis will not always be a benefit. Some patients will find the experience of referral to an ophthalmologist in a regional centre, and perhaps transfer to a still more distant centre away from the support of family and friends distressing. On a population level, if screening for diabetic retinopathy is offered to a rural or remote population the need to confirm the results of tests and/or treat disease will create extra financial and social burdens for service providers. Patients will need to be supported to travel to, and stay in regional centers. Health workers will need to face the possibility that patients who screen positive may choose *not* to leave their communities for further testing or treatment.

# 3.3.8. Expect Consequences

This proposal provides an assessment of the current state of development of retinal photography undertaken by health workers and read by ophthalmologists, its present and potential use in the Mexican public health system, and future implications of the use of this procedure.

# 4. Global Expected Impact

- 1. Prevention of complications.
- 2. Better metabolic and pharmacologic control.
- 3. Decrease of costs in healthcare institutions in Mexico.

# 5. Conclusions

- 1. This proposal is aimed to aid and give suggestions for preparing projects promoting the improvement of quality of life of people with chronic diseases, such as type 2 diabetes, obesity, hypertension and dyslipidaemia, given that these chronic diseases have already occupied a priority place regarding concerns of nationwide healthcare interest.
- 2. The idea of this project is providing the interested with information of references for collaborative projects, where academics, investigators, healthcare professionals and the industry can participate, who have interest in developing programmes or projects for the continuous improvement of the quality of care of patients with type 2 diabetes, obesity, hypertension and dyslipidaemia; thus improving the medical prognosis of these patients.
- 3. With the results being obtained, support to health professionals and health managers will be given, for a practice of excellence in the health services units of the Mexican Republic.

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