CASALUD: an Innovative Health-Care System to Control and Prevent Non-Communicable Diseases in Mexico

Abstract

Mexico and other Latin American countries are currently facing a dramatic increase in the number of adults suffering from non-communicable diseases (NCDs) such as diabetes, cardiovascular disease (CVD) and chronic kidney disease (CKD), which requires prolonged, continuous care. This epidemiological shift has created new challenges for health-care systems. Both the World Health Organization (WHO) and the United Nations (UN) have recognized the growing human and economic costs of NCDs and outlined an action plan, recognizing that NCDs are preventable, often with common preventable risk factors linked to risky health behaviors. In line with international best practices, Mexico has applied a number of approaches to tackle these diseases. However, challenges remain for the Mexican health-care system, and in planning a strategy for combating and preventing NCDs, it must consider how best to integrate these strategies with existing health-care infrastructure. Shifting the paradigm of care in Mexico from a curative, passive approach to a preventive, proactive model will require an innovative and replicable system that guarantees availability of medicines and services strengthens human capital through ongoing professional education, expands early and continuous access to care through proactive prevention strategies and incorporates technological innovations in order to do so. Here, we describe CASALUD: an innovative model in health-care that leverages international best practices and uses innovative technology to deliver NCD care, control and prevention. In addition, we describe the lessons learned from the initial implementation of the model for its effective use in Mexico, as well as the plans for wider implementation throughout the country, in partnership with the Mexican Ministry of Health.
INTRODUCTION

Mexico and other Latin American countries are currently facing a demographic and epidemiological shift that has transformed morbidity and mortality profiles, creating new challenges for the health-care system. Widespread improvements in sanitation and access to clean drinking water, as well as technological advances, have led to increased life expectancy from birth.\textsuperscript{1} The resultant ageing of the population, combined with increasingly sedentary lifestyles, has produced a dramatic increase in the number of adults suffering from non-communicable diseases (NCDs), such as type 2 diabetes mellitus (DM2), cardiovascular disease (CVD) and chronic kidney disease (CKD), which require prolonged, continuous care.

The prevalence of NCDs in Mexico has increased rapidly in the last 20 years. For example, the prevalence of DM2 in Mexico in 2012 was 9.1%, compared to 4.0% in 1993 (Figure 1), positioning Mexico as the country with the highest prevalence in Latin America.\textsuperscript{2–6} A study from the Mexican National University (UNAM) estimated the 2006 prevalence of DM2 at 14.4%, with almost half the patients not having a formal diagnosis and not being aware they had diabetes, suggesting that the rise in NCDs may be further compounded by a lack of access to healthcare.\textsuperscript{7}
This shift has also increased the ratio of morbidity and mortality attributable to NCDs. In 1975, NCDs accounted for 54.5% of Mexico’s mortality rate; however, by 2000, this had increased to 82.5% of deaths, with the remaining 17.5% associated with transmissible diseases, injuries, nutritional, maternal and perinatal causes. The leading causes of death for both men and women in Mexico are CVD and DM2, accounting for 105,144 deaths (17.8% of total deaths) and 82,964 deaths (14.0%), respectively. It is predicted that by 2025, NCDs will account for 90% of deaths in the country. Expressing the burden of disease in disability-adjusted life-years (DALYs), NCDs account for 72% of total disease burden in Mexico, above the average of upper-middle income countries in Latin America (62.9%).

**Table 1**

Deaths and average prevalence of intermediate risk factors for Latin America and Mexico*

This table is the authors’ own work, based on data from WHO, 2010

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Latin America**</th>
<th>Mexico</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total NCD Deaths per 100,000</td>
<td>585.4</td>
<td>542.6</td>
</tr>
<tr>
<td>Prevalence of pre-obesity in adults aged 20+ years (%)</td>
<td>58.3%</td>
<td>69.1%</td>
</tr>
<tr>
<td>Prevalence of obesity in adults aged 20+ years (%)</td>
<td>24.8%</td>
<td>32.8%</td>
</tr>
<tr>
<td>Prevalence of raised blood pressure in adults aged 25+ years (%)</td>
<td>39.6%</td>
<td>36.1%</td>
</tr>
<tr>
<td>Prevalence of raised blood glucose in adults aged 25+ years (%)</td>
<td>10.8%</td>
<td>14.1%</td>
</tr>
</tbody>
</table>

*Considers most recent national data for each country at time of compilation.

**Latin American countries include: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay and Venezuela (the Americas region classification used by WHO, excluding Canada and the United States of America).

All estimates are age-standardised adjusted estimates, including both sexes. Definitions: Pre-obesity: BMI ≥ 25 kg/m²; Obesity: BMI ≥ 30 kg/m²; Raised blood pressure: systolic ≥140 mmHg and/or diastolic ≥90 mmHg or on medication; Raised blood glucose: Fasting glucose ≥ 7.0 mmol/L or on medication.

The current epidemic of NCDs has serious economic consequences for individuals and society. Direct costs include expenditure on medical consultations, drugs and treatment of complications, but there are also indirect costs such as loss of productivity, absence from
work of patients or and permanent disability. For the Latin American and Caribbean regions, diabetes-related health-care costs were estimated at US$65 billion annually, which is 2%–4% of gross domestic product (GDP) or 8%–15% of national health-care budgets.\textsuperscript{10} Data from Mexico, which considered both direct and indirect costs, estimated the annual cost of DM2 in 2011 as US$7.7 billion: US$3.4 billion direct costs and US$4.3 billion indirect costs.\textsuperscript{11} Data from the Mexican Social Security System showed that all treatment of patients with diabetes, including complications, amounted to US$3.84 million per day.

The human and economic costs of NCDs in Latin America represent a crisis that must be tackled urgently. In planning a strategy for combating and preventing NCDs, we must consider their causes, consequences and how best to integrate plans with existing health-care infrastructure.

\textit{Causes and consequences of NCDs}

An important point in understanding and tackling the rise of NCDs is that they are preventable, and often have common modifiable risk factors linked to risky health behaviors. Behaviors such as tobacco use, physical inactivity, consumption of an unhealthy diet and alcohol use can lead to physiological changes, or intermediate risk factors for NCDs.\textsuperscript{12} These intermediate risk factors include hypertension, pre-obesity or obesity, hyperglycemia and hyperlipidemia. In Latin America, the proportion of deaths attributable to NCDs and the rising regional prevalence of intermediate risk factors for NCDs are significant and call for urgent action (Table 1; Figure 1).

Globally, the leading intermediate risk factor for deaths attributed to NCDs is raised blood pressure, accounting for 13% of global mortality, followed by hyperglycemia (6%), and pre-obesity and obesity (5%). Risky health behaviors such as tobacco use (9%) and physical inactivity (6%) are also major contributors to NCD-related mortality.\textsuperscript{13,14} Evidence suggests that up to 80% of premature heart disease, stroke and DM2 could be prevented through healthy diet, regular exercise and avoidance of tobacco use.\textsuperscript{15} Also, compared to individuals with a normal body mass index (BMI) of 18.5–24.9 kg/ m\textsuperscript{2}, overweight, or pre-obese, individuals (BMI = 25.0–29.9 kg/m\textsuperscript{2}) have twice the risk of developing DM2; obese
individuals (BMI = 30.0–34.9 kg/m2) have three times the risk, and morbidly obese individuals (BMI > 35.0 kg/m2) six times the risk.\textsuperscript{16}

NCDs and their associated risk factors have an enormous impact on the incidence of several inter-related health conditions, and are themselves inextricably related. NCDs account for half of all global disability, including physical (e.g. blindness and loss of limbs) and mental (e.g. chronic depression) impairment.\textsuperscript{17,18} DM2, hypertension and CVD are all major causes of CKD. Over 5\% of people diagnosed with DM2 have CKD and an estimated 40\% of patients with both type 1 and 2 diabetes will develop CKD during their lifetime, the majority within 10 years of diagnosis.\textsuperscript{19} In addition, kidney dysfunction is a major cause of hypertension, which in turn exacerbates CKD and accelerates its progression. Currently, hypertension is the major risk factor for development and progression of diabetic and non-diabetic CKD.\textsuperscript{20} The close relationship between different NCDs provides an even stronger case for prevention, early detection, effective control and treatment and strategies to provide continuity of care in order to reduce the burden of NCDs and their associated conditions.

**TACKLING NCDs IN MEXICO: GLOBAL APPROACHES AND CHALLENGES**

Mexico has acknowledged the growth of NCDs and their risk factors and has applied a number of approaches to start tackling these diseases. However, challenges remain for the Mexican health-care system, and further steps are needed to effectively tackle the rise of NCDs.

Population-wide strategies have recently been implemented to tackle the rising prevalence of pre-obesity and obesity, through the government’s ‘National Agreement for Nutritional Health’,\textsuperscript{21} which promotes collaboration between all government agencies (mainly the Health and Education Ministries) and a series of multi-sector interventions aimed at improving the population’s diet and incentivizing physical activity. A mass communication campaign, ‘5 steps for health’, was launched as a non-profit, public–private partnership to promote healthy habits and change risky behaviours.\textsuperscript{22} Most recently, the incoming government plans to integrate all related interventions in the National Strategy against Obesity and Diabetes, in an effort to priorities the fight against the NCD epidemic and
organize all actions into one effective public policy instrument coordinated by the Ministry of Health and implemented by the states.23

Mexico has also advanced in extending universal health coverage through its ‘Seguro Popular’ health insurance program, which has granted nominal coverage to previously uninsured populations, funding all primary health-care interventions, 95% of second-level care and implementing a reimbursement fund to cover the most important tertiary health-care interventions.24 However, Seguro Popular does not guarantee full access to effective health-care, due to inefficiencies in health-care infrastructure such as insufficient and irregular supply of medicines, lack of access to laboratory tests and insufficient coverage of health services. To increase real coverage, Seguro Popular uses a screening strategy (Consulta Segura)25 that requires all insured individuals to undergo a consultation to identify risk factors, detect NCDs and proceed to treatment. Social security institutions also offer programs aimed at providing preventive services to their beneficiaries and incentivize changes in risky behaviors when diagnosed with an NCD.26,27

Despite these important efforts, Mexico’s current approach to combating NCDs is insufficient in that the model still focuses too heavily on the treatment rather than the prevention of disease, and treatment follow-up is often deficient:

- Services are heavily centered in primary health-care units, but the current infrastructure cannot cope with the increasing demand of services. There are 10,433 primary health-care units; 81% are rural centers and of these, 78% only have one medical room;28
- Despite a slight increase in 2012 as compared to 2000 and 2006, only 23.7% of the adult population were screened for DM2, and 28.4% for hypertension;2
- Treatment follow-up is often passive and insufficient. For example, although an estimated 14.4% of the Mexican adult population has diabetes, half of them are not aware of their disease.7

Also, 6 out of 10 patients with diabetes do not receive a foot examination during consultation, for 6 out of 10, there is no eye examination, and only 7.5% of patients received a HbA1c measurement during the last year;2
• Strategies to train and update health-care providers (HCPs) may be inadequate for primary settings, and the population typically lacks the education to demand preventive services or participate more actively in the management of NCDs.

Both the World Health Organization (WHO) and the United Nations (UN) have recognized the growing threat of NCDs and outlined an action plan based on increasing the body of knowledge of these diseases, recognizing that, so far, the epidemic has been misunderstood and under-reported. The WHO’s 2008–2013 Action Plan aims to implement its Global Strategy for the Prevention and Control of Non-Communicable Diseases. More recently, in 2011, the UN convened the UN General Assembly High-level Meeting on the Prevention and Control of Non-Communicable Diseases, in order to reinforce the Action Plan as an international priority and to address barriers to successfully tackling NCDs. So far, the main focus of health-care for NCDs in many low- and middle-income countries has been hospital-centred acute reactive care, an expensive approach that ignores the health benefits of preventing and treating these conditions at early stages. To ensure early detection and timely treatment, NCD interventions need to be integrated into primary health-care. To achieve the paradigm shift now required for effective control of NCDs, the following principles, based on cost-effectiveness studies and WHO/UN guidelines, should be met:

1. The health-care system should establish priorities guaranteeing effective access to primary care;

2. Primary care should include first contact care – implementing a community outreach strategy as well as care in primary settings;

3. Continuity of care is crucial. Interventions to tackle NCDs must occur at all stages: promotion of a healthy lifestyle, and prevention, early detection, diagnosis, continuous treatment and recommendations, follow-up and monitoring of diseases. The cost-effectiveness of these interventions relies, in most cases, on early screening, detection of pre-disease stages and effective treatment;

4. A trained workforce with appropriate skills must be sustained;
5. A reliable supply chain of medicines and laboratory tests is required across the continuum of care;¹⁰

6. There must be a shift towards collaborative care between patients and HCPs. This approach empowers patients with chronic diseases to make decisions about their care, and provides them with information and the means to detect and solve problems effectively. Such patient responsibility for self-management and self-monitoring is crucial in tackling risk factors for NCDs, such as hypertension;³²,³³

7. Monitoring and surveillance are crucial strategies and provide an impetus for action by governments and policy-makers.¹⁰ Three necessary components of NCD surveillance are as follows: monitoring exposure to risk factors; monitoring outcomes, such as morbidity and disease-specific mortality; and keeping track of health-care system responses, including national capacity to prevent NCDs through access to health-care, medicines and human resources;¹⁰

8. Technological innovations can be used to improve access to health services. Use of technology such as the Internet and mobile phones is an accessible and cost-effective tool to facilitate health-care provision and also responsible self-care and management.³⁴ Data for Mexico indicate that 85.6% of the population has access to mobile phones and 40.2% have Internet access.³⁵

Shifting the paradigm of care in Mexico, and in Latin America more broadly, will require a comprehensive, innovative and replicable model that effectively incorporates the global principles for the control of NCDs described above.

**CASALUD: A PROPOSED SOLUTION**

CASALUD, derived from casa and salud (home and health), offers an innovative model that uses technology to deliver NCD prevention and care in line with international best practices. CASALUD’s main objective is to create health rather than treat disease by providing outreach to patients in their homes, promoting changes in health behaviour and providing effective health services throughout the continuum of care, from prevention to follow-up.
CASALUD is based on four main components, which are summarized in Figure 2. Briefly, CASALUD aims to assure adequate supplies of medicines and laboratory tests, strengthen human capital through ongoing professional and practical education, incorporate proactive prevention strategies reaching the household and community and expand early access to health-care through the strategic use of technological innovations. The operation of CASALUD’s four components is integrated into existing Mexican public health care, adding to (rather than fragmenting) the system. All strategies and solutions are financed by the Carlos Slim Health Institute/Foundation and do not impose any additional implantation costs to the health-care system or, most importantly, to its users or beneficiaries. Using a structured process to deploy these four components, CASALUD aims to strengthen and enhance health-care delivery, increasing the capacity of services and hence improving the efficiency and the quality of care. The main initiatives within these four components are described below.

**Incorporate proactive prevention strategies**

**MIDO™ – Medición Integrada para la Detección Oportuna (Integrated Measurement for Early Detection)**

MIDO, the core innovation for the model, aims to move away from the traditional dichotomous approach of classifying individuals as sick or healthy and instead applies systematic risk assessment to patient screening, identifying people as healthy, at risk (or pre-disease) or sick.\(^{36}\) Identifying individuals at a pre-disease stage is a recommended practice to effectively reduce disease.\(^{37,38}\)

Systematic risk assessment comprises three steps and is implemented by HCPs. Step 1 involves assessment of pre-obesity, obesity and hypertension via a questionnaire to detect risk factors, and measurement of BMI, waist circumference and blood pressure. If the questionnaire identifies five or more risk factors, or the patient is diagnosed with pre-hypertension, the HCP proceeds to step 2, which assesses risk for DM2 via measurement of blood glucose. Individuals identified as pre-diabetic or diabetic, and those identified with pre-hypertension or hypertension, continue to step 3, which assesses the risk of CKD via measurement of serum creatinine, rate of glomerular filtration (GFR) and urinary protein. Again, individuals are classified as healthy, or in the initial, intermediate or advanced
stages of the disease using internationally recognized criteria (Table 2). Finally, depending on the availability of laboratory tests, the HCP can screen for hypercholesterolaemia, with individuals classified as healthy or positive for the disease.

MIDO assessment is available in two formats: the first is provided by nurses in primary health-care settings and public centers using a MIDO Mobile Module™; the second is designed for nurses to administer in patients’ homes, using Portable MIDO™.

Clinics and public places: MIDO Mobile Module

Health professionals can assess NCDs either at a clinic or in public places, including supermarkets, community centers and outside schools. MIDO Mobile Module includes equipment that wirelessly communicates with a USB modem to measure weight, height, blood pressure, blood glucose and urinary protein. It also includes personalized handouts to provide recommendations and treatment options according to the level of risk detected for each disease.
Table 2
Systematic risk evaluation by MIDO

<table>
<thead>
<tr>
<th></th>
<th>Healthy</th>
<th>Pre-disease</th>
<th>Sick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
<td>BMI 18.50–24.99 kg/m²</td>
<td>BMI 25.00–29.99 kg/m²</td>
<td>BMI ≥30.00 kg/m²</td>
</tr>
<tr>
<td>Hypertension</td>
<td>BP 120–129 / 80–84 mmHg</td>
<td>BP 130–139 / 85–89 mmHg</td>
<td>BP ≥140/90 mmHg</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Glucose (fasting): &lt;100 mg/dL; casual &lt;200 mg/dL</td>
<td>Glucose (fasting): 100–125.99 mg/dL</td>
<td>Glucose (fasting): ≥126 mg/dL; casual ≥200 mg/dL</td>
</tr>
<tr>
<td>Kidney Disease</td>
<td>Stage 0: GFR ≥90 mL/min/1.73 m² without markers</td>
<td>Stage 2: GFR 60–89 mL/min/1.73 m²</td>
<td>Stage 4: GFR 15–29 mL/min/1.73 m²</td>
</tr>
<tr>
<td></td>
<td>Stage 1: GFR ≥90 mL/min/1.73 m² with markers</td>
<td>Stage 3: GFR 30–59 mL/min/1.73 m²</td>
<td>Stage 5: GFR &lt;15 mL/min/1.73 m²</td>
</tr>
</tbody>
</table>

Individuals are assessed for obesity, hypertension, diabetes and kidney disease and classified as being healthy, pre-disease or sick. Classification is based on norms and recommendations set by the WHO, International Diabetes Federation, American Diabetes Association and National Clinical Practice Protocols.
BMI, body mass index; BP, blood pressure; GFR, glomerular filtration rate

Household and community outreach: Portable MIDO

Community HCPs can assess diabetes, hypertension and their preceding conditions in the community or household using Portable MIDO, an all-in-one system with a blood pressure meter and glucometer connected to a mobile phone via Bluetooth. Personalized recommendations, aimed at preventing NCDs, are given depending on the patient’s level of risk. HCPs can refer any patients found to have an NCD to a clinic to confirm the diagnosis and start treatment immediately.

For both MIDO Mobile Module and Portable MIDO, measurements of weight, height, blood pressure and blood glucose are transmitted wirelessly via Bluetooth to a laptop or a mobile phone, where the SI-MIDO information system sends the data to a cloud storage provider and performs analysis to provide HCPs with up-to-date information to support them in evidence-based decision-making.
MIDO allows for mass screening, thereby increasing early access to primary health-care services. Treatment through a personalized set of recommendations encourages informed decision-making and patient responsibility for their own health. MIDO is a cost-effective strategy, costing less than US$4 per person, with assessment taking less than 5 minutes.

For MIDO to be effective, the patient must have tools to support them in taking responsibility for their own health, post-screening. CASALUD has therefore developed two innovative solutions implemented via mobile phone and the Internet: ViveSano, an application for managing wellness and a healthy lifestyle, and Diabediario, an application for people living with DM2.

**Strategic use of technological innovations**

**Wellness and lifestyle: ViveSano**

ViveSano is a low-cost application focused on preventing cardiovascular risk and unhealthy lifestyles. Its objective is to teach individuals to understand their health, self-monitor and interpret their own results, adapting their lifestyle to prevent NCDs. Individuals identified by MIDO to be at risk of developing an NCD use ViveSano to capture base health indicators: age, weight, height, tobacco usage, blood pressure, cholesterol level and glucose level. The tool offers criteria to self-assess the level of risk as high, medium or low (e.g. high risk: BMI > 30 kg/m2, medium risk: BMI = 25–30 kg/m2, low risk: BMI < 25 kg/m2). The tool then offers personalized recommendations for disease prevention based on the level of risk detected. Individuals also transmit this information to the cloud storage provider, where the results sync with SI-MIDO to provide continuous assessment. ViveSano also shares data with the patient’s doctor, allowing him to define the best strategies to either prevent the appearance of the disease or control it in the early stages to prevent complications.

**Disease management for people living with DM2: Diabediario**

Diabediario (diabetes diary)\(^{43}\) is an application that focuses on the empowerment of patients already diagnosed and living with diabetes. Its main objective is to improve their
compliance with treatment, thereby helping them achieve effective control of the disease, averting complications and improving quality of life significantly.

People with diabetes can access personalized monitoring protocols, including reminders for taking medicines or attending doctors’ appointments, an educational platform to learn more about the disease, and an application to self-assess risk and health status. In addition, individuals can register their glucose, blood pressure, weight and various laboratory tests, and Diabediario will immediately provide feedback based on the results. Information on health indicators is stored securely and can be monitored by the individual through a webpage indicating their level of risk and giving recommendations on when to seek medical attention. Finally, users receive personalized educational messages.

*Strengthen human capital*

*Center for Education in Health Online*

Primary health-care units must cope with demand for increasingly complex services, where patients no longer seek medical treatment to cure a disease, but rather require a holistic, multidisciplinary approach towards improving their health and lifestyle. HCPs must embrace new theories and public health evidence that consider changes in health demographics and epidemiology. To do so, they must have up-to-date information about treatments and be able to use this knowledge in daily practice. The CASALUD model relies on the Center for Education in Health, a pioneering online educational platform developed by the Carlos Slim Health Institute (ICSS) that incorporates global best practices in health education to support health-care services in strengthening the skills and competencies of HCPs. The center provides Free Online Courses for the Universal Strengthening of Health Professionals (FOCUS), to assess both theoretical and clinical case-based learning with academic endorsement from national universities.

To strengthen human capital for the prevention, diagnosis and management of NCDs, the Center for Education in Health offers a diploma programme called ‘Diploma on Prevention and Integral Attention of NCDs’, awarded by the National Academy of Medicine and the National Normative Committee of General Medicine. The diploma focuses on providing up-to-date and practical information and education on how to treat NCDs, including
prevention, early detection and treatment of obesity, DM2, hypertension, CKD and hyperlipidemia.

The diploma is available at anytime, anywhere with an Internet connection, and is divided into video lessons. Before commencing the diploma, all professionals are subject to a pre-evaluation that indicates the most appropriate level and any lessons that will be of particular use to them.

Table 3
Classification of individuals, not previously diagnosed, using MIDO criteria
Data from the SI-MIDO system

<table>
<thead>
<tr>
<th>Disease</th>
<th>Healthy</th>
<th>Pre-disease</th>
<th>Sick</th>
<th>Total Individuals screened with no previous diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of individuals</td>
<td>%</td>
<td>Number of individuals</td>
<td>%</td>
</tr>
<tr>
<td>Diabetes</td>
<td>4,117</td>
<td>43%</td>
<td>1,628</td>
<td>17%</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1,898</td>
<td>26%</td>
<td>3,066</td>
<td>42%</td>
</tr>
</tbody>
</table>

Data were collected from a total of 11,969 individuals, screened at 12 Mexico City subway stations using a MIDO-Module. Despite having received no previous diagnosis, the majority of individuals were classified as pre-disease or sick on evaluations for diabetes and hypertension.

Digital Portfolio
The Digital Portfolio is aimed at HCPs to support them in adequately preventing, diagnosing and treating people living with NCDs using simplified tools and support documents. It comprises a set of applications, including health calculators to estimate BMI, cardiovascular risk and other health risks, a digital library with information on national health guidelines, flashcards to be used with patients during consultations and a Drug Index describing over-the-counter medicines, generic drugs and specialized drugs. The Digital Portfolio is focused on NCDs as well as prevention strategies targeted by age group. This technology facilitates the continuous education and professionalization of HCPs.
Assure availability of adequate supplies

Finally, CASALUD has designed the following technological application to improve the logistics and efficiency of the medical supply chain, allowing HCPs to provide quality care across the health-care system.

Stock measurement mobile phone application

In rural and suburban areas where clinics are usually small and difficult to access, it is crucial to have systems that monitor the clinics’ efficiency and ensure that quality of care (as compared to urban clinics) is maintained at a low cost. ICSS has developed a mobile phone application that can operate from a low-cost SIM card. The application allows HCPs to report current stock levels and any stock depletions; patients can also report any prescribed medicines not provided, creating real accountability.

CASALUD IN MEXICO: INITIAL DATA AND PLANS FOR EXPANSION

MIDO

Up to November 2012, CASALUD has established partnerships with 7 out of 32 state governments to deploy the model in a total of 28 primary health-care units, reaching almost 1 million users, of whom 400,000 live with an NCD. In Mexico City, MIDO has been incorporated in a pioneering initiative to provide screening in 12 of the city’s subway stations and to date, has screened 24,985 individuals (Table 3). When tested for DM2, 80.6% of individuals had not previously been diagnosed with the disease; however, 14.6% of this group were classified as pre-diabetic and 30.8% classified as sick. Similarly, when tested for hypertension, 62.6% of individuals screened had not previously been diagnosed; however, 28.5% of this group were classified as in the pre-disease stage and 19.4% as sick.

The extent of undiagnosed disease demonstrated by the subway testing initiative can only add to the potential burden of NCDs and associated morbidities. According to national data, only 24.5% of diabetic patients have an adequate metabolic control, while only 25.4% of patients with hypertension have adequate control of their disease. These baseline estimates on disease diagnosis and control imply that there is an enormous window of opportunity for a model such as CASALUD. We anticipate that, although increased early screening will at first increase the number of people diagnosed with these conditions, early treatment
through a combination of strategies such as ViveSano and Diabediario – and more efficient provision of health services – will lead to reductions in NCDs within the decade. This has already been demonstrated in other countries, such as Finland, in which the Finnish Diabetes Prevention Study reported a 43% reduction in the risk of developing diabetes for the intervention group compared to the control after a median of 7 years. Evidence from subgroup analyses of the Action to Control Cardiovascular Risk in Type 2 Diabetes (ACCORD), Action in Diabetes and Vascular disease: PreterAx and Diamicron Controlled Evaluation (ADVANCE) and VA Diabetes Trial (VADT) trials has also shown that tight glycaemic control early in DM2 reduced CVD risk within a median 5 years of follow-up.

In partnership with the Mexican Ministry of Health, and within the context of the National Strategy against Obesity and Diabetes, 13 states will start implementing the CASALUD model in 67 health units, covering a total population of 601,423 and requiring participation of 1,697 health professionals. The main goal is to achieve screening of the whole target population within the time frame of 3 years, as well as to increase effective disease control for those diagnosed with diabetes by at least 50%.

Diabediario

Diabediario has been tested in a controlled trial in Salud Xalapa, comparing use of Diabediario, with or without a glucometer, against a control group. The results of this trial to test the impact of the application and blood glucose self-monitoring in the metabolic control of diabetic patients are being analysed, and will be reported elsewhere.

The evaluation of Diabediario included a qualitative analysis of the utility and the usefulness of the solution as a component of public health services. Among the main results are:

- Diabediario and the glucometer do not work to generate awareness but to raise it in those patients who accept their disease, helping them to gain control over the disease;
• Patients who do not accept their disease change their behaviour, since they feel pressure to do so given the support received through the Project. These patients require a more robust support network, including their family peers and the doctor;

• Diabediario and the glucometer, when used together, enable the patient to monitor himself or herself, increasing awareness of glycaemic control.

Following the evaluation of Diabediario in Xalapa, an updated version will be delivered as part of the CASALUD model through the National Strategy against Obesity and Diabetes with the Ministry of Health.

*ViveSano*

This solution was tested in 2009 and 2010; the full results of the test, which identified real-world patient needs, will be published elsewhere. An updated version will be delivered as part of the CASALUD model through the National Strategy against Obesity and Diabetes with the Ministry of Health. Ultimately, the aim is for both ViveSano and Diabediario to be used by the whole target population.50

*Center for Education in Health Diploma*

Uptake of the diploma has been monitored following its launch. In 2011, a total of 931 health professionals took the diploma – around 75% of all health professionals participating in the CASALUD model. Of this total, 731 professionals graduated (78.3%). During 2012, the diploma was taken by those health professionals within the 28 health units in the 7 states participating in the model who had not previously taken the diploma, so as to ensure a minimum of 90% of health workers trained. Therefore, an additional 111 health professionals took the diploma, of which 73 professionals graduated successfully (71.2%).

Among the total 810 diploma graduates, 142 professionals (17.5%) took the Essential Level aimed at social workers and health promoters, 211 professionals (26%) took the Intermediate Diploma for general and auxiliary nurses, and finally, 457 professionals (56.4%) graduated from the Advanced Diploma for General Practitioners. This increased training in prevention, early detection and treatment of chronic diseases will help address
the need identified in the Mexican health system. The expanded implementation of CASALUD across 13 states aims to ensure that 90% of all participating health professionals actually achieve the diploma.

**Digital Portfolio**

The Digital Portfolio is used in the 28 health-care units where the CASALUD model has been implemented. After its initial deployment, a qualitative assessment of the utility and the usefulness of the solution was made using focus groups (full details of which will be published elsewhere). Refinements to the tool to improve user-friendliness following the assessment included adding a pharmacological dictionary, medical calculators and search tools. The latest version will be implemented in the 13 states participating through the National Strategy against Obesity and Diabetes with the Ministry of Health.

**Stock measurement mobile phone application**

This solution will be implemented for the first time in the 13 states through the National Strategy against Obesity and Diabetes with the Ministry of Health. It aims to contribute to achieving the strategy’s goal of complete supply of all drugs at least 90% of the time.

**Lessons learned from the initial implementation of CASALUD**

Important challenges have been faced and lessons have been learned during the deployment of the CASALUD model. The main conclusions are as follows:

- Any solution or application must be deployed systematically, with clear definitions of leaders that can be accountable, and with clear milestones;
- The appropriate deployment of the model is subject to the leadership of the health personnel of the clinics. Therefore, it is crucial to have a robust social marketing strategy in the clinic to engage the health workers in the adoption of the solutions (gain their ‘buy-in’);
• The solutions must be implemented within the whole NCDs model. High technology use is not equal to high impact unless it is deployed within a structured health-care model;

The CASALUD model began as a model to improve health services from the health perspective only. Nonetheless, the model has now embraced a very ambitious agenda to shift the current managerial model, so as to improve the efficiency and the effectiveness of health-care provision.

CONCLUSION

Prevalence, morbidity and mortality of NCDs are rising rapidly in Latin America and represent a crisis that must be tackled urgently. Mexico has acknowledged that a radical change of health-care paradigm is required to reflect this epidemiological shift; health care must now move towards a proactive, preventive model incorporating community outreach rather than the traditional passive, curative, hospital-centred approach. CASALUD offers a comprehensive, integrated, sustainable and innovative health-care model to assure effective access to continuous health-care and to combat NCDs. Through the initiatives described here, CASALUD delivers solutions to the NCD crisis facing Mexico based on its four key design principles and aims to optimize the existing health-care system and change the health-care paradigm effectively. Initial data reinforce the need to expand access to early health-care and provide proof of principle for the successful use of CASALUD. Plans for expansion of CASALUD throughout Mexico are underway, providing hope for combating Mexico’s current NCD epidemic.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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