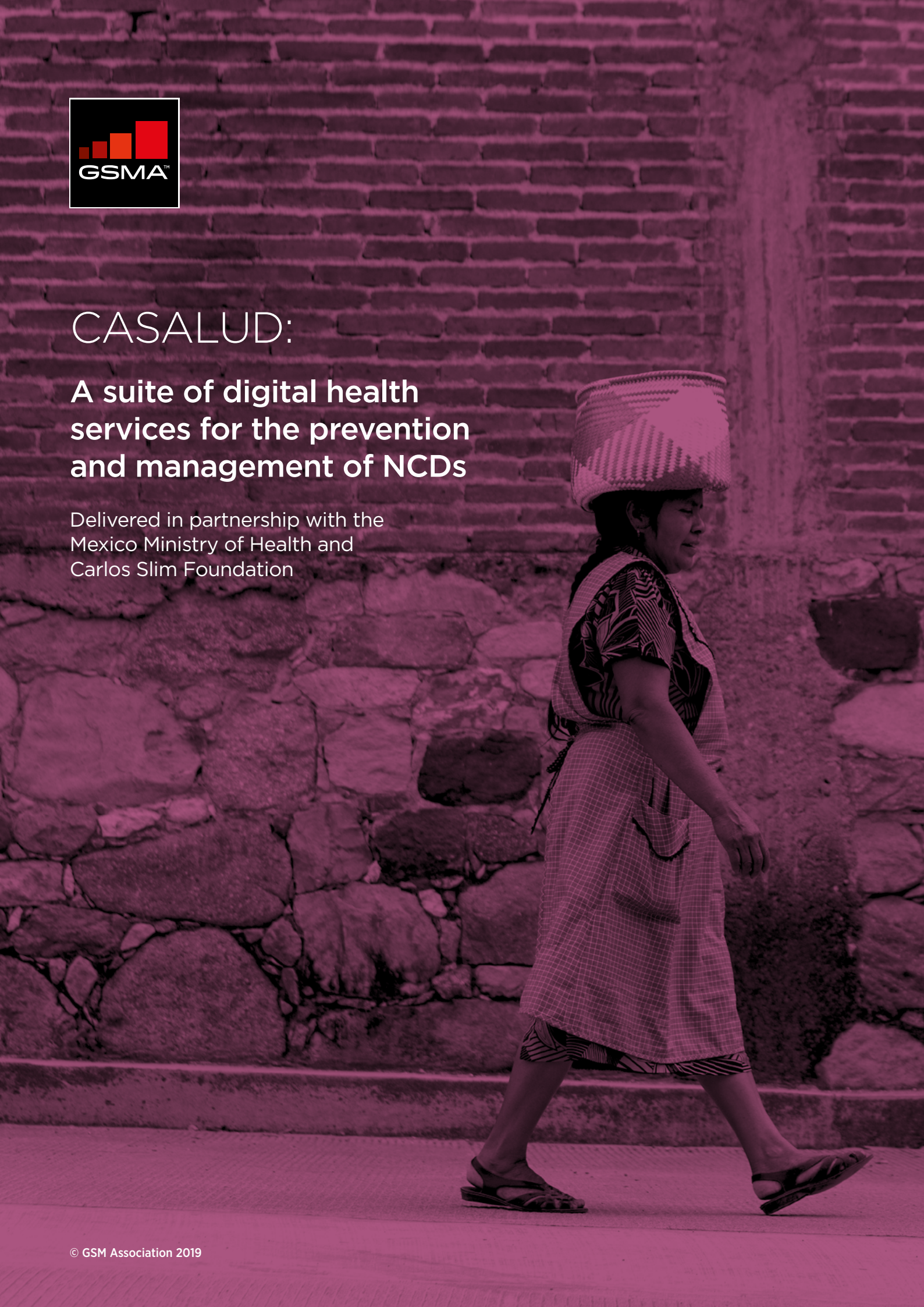


CASALUD:

A suite of digital health services for the prevention and management of NCDs

Delivered in partnership with the Mexico Ministry of Health and Carlos Slim Foundation

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LIST OF ABBREVIATIONS

3G	Third generation mobile networks
A1c test	A1c tests are an essential mechanism for the management of diabetes. A1c stands for glycated haemoglobin.
AI	Artificial intelligence
CME	Continuing medical education
GDP	Gross domestic product
HCP	Healthcare professional
HIS	Health information system
IoT	Internet of things
KPI	Key performance indicator
MNCH	Maternal and newborn child health
MoH	Ministry of Health
NCD	Non-communicable disease
PHC	Primary healthcare centre
SDG	Sustainable Development Goal
SMS	Short message service
T2DM	Type 2 diabetes mellitus
UI	User interface

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Executive summary

Over the last 30 years, Mexico has experienced an epidemiological transition, with a shift away from infectious towards non-communicable diseases (NCDs), such as cardiovascular diseases, cancers, chronic respiratory diseases and diabetes. In 1990, NCDs accounted for 55 per cent of Mexico's mortalities. By 2016 this had increased to 80 per cent, and it is predicted that by 2025, NCDs will account for 90 per cent of all deaths in Mexico. NCDs often accompany multiple health conditions (co-morbidities) and require long-term and integrated healthcare management. For this reason, the rise of NCDs places a significant financial burden on the public health system.

With a 62 per cent unique mobile subscriber penetration rate as of September 2018,[1] and widespread adoption of mobile broadband and smartphone devices, mobile-enabled digital health solutions present an opportunity to alleviate the burden on Mexico's health system. In response to this opportunity, Carlos Slim Foundation (CSF), a nonprofit organisation, developed CASALUD, a portfolio of digital health services within an operating model that addresses inefficiencies in how the public health system manages NCDs.

This case study shows how CASALUD's interconnected digital tools and real-time information systems are enabling data-driven decision-making by healthcare managers and supporting effective prevention of NCDs and national monitoring of the quality of care. CASALUD also empowers healthcare professionals (HCPs) and extends the reach of the public health system by engaging with beneficiaries outside traditional health settings, such as primary health centres (PHCs).

In 2013, the Ministry of Health (MoH) fully endorsed and incorporated CASALUD in Mexico's National Strategy for the Prevention and Control of Overweight, Obesity and Diabetes. As of 2019, the CASALUD disease management information system, *Sistema Nominal de Información en Crónicas* (SIC), is operating nationally in over 12,450 PHCs, making data from over 1.8 million patients available in real time for decision makers. Since 2009, over 20,000 HCPs have graduated from the MoH-certified NCD prevention and management courses offered on *Plataforma Interactiva de Educación en Salud Online* (PIEENSO), CSF's online learning platform. Enhanced screening of over 1.1 million individuals was made possible by a novel solution called *Medición Integrada para la Detección Oportuna* (MIDO),[2] which facilitates all-in-one-place patient health risk assessments, both in PHCs and remotely in the community.

1. GSMA Intelligence, 2018.
2. Available in either a mobile cart or a portable backpack, MIDO integrates patient health assessment equipment and a digitised patient health screening questionnaire with a built-in decision support algorithm for HCPs.

Key insights:

- **CASALUD solutions improve the consistency and quality of care at PHCs, and the monitoring of progress on national health outcomes.** The consistency and quality of patient assessments at PHCs have both improved since SIC was implemented nationwide in 2013. Combined with greater availability of A1c test kits at PHCs (due to an MoH decision to centralise stock procurement in 2014), A1c test coverage for people living with type 2 diabetes (T2DM) has risen from 14 per cent in November 2014 to 54 per cent in November 2018.[3] This has produced positive national outcomes, with the number of patients with controlled diabetes increasing from 36 per cent in November 2014 to 44 per cent in November 2018.

- **CASALUD HCP empowerment solutions have improved the quality of care provision and driven better patient health outcomes.** Over the duration of a two-year study, the perception of quality of care improved by 19 per cent among patients treated at PHCs where CSF's online learning platform for healthcare professionals, PIEENSO, was implemented. A moderate, but significant, five per cent improvement in patient disease knowledge over the same period is an indicator of improved quality of healthcare provision and efficacy of patient-provider education. More importantly, improved patient health knowledge resulted in improved behaviours. There was a 15 per cent increase in the proportion of patients participating in self-care activities,[4] and a 56 per cent increase in the index value of patients owning and using a glucometer.[5]

- **Greater visibility into data has improved the tracking of Mexico's overall progress in managing NCDs.** Prior to the national implementation of Mexico's *Índice de Calidad de la Atención de la Diabetes* (Diabetes Quality of Care Index or ICAD) in July 2016, the Mexican MoH did not have a process for quantitatively measuring, viewing or comparing the quality of care provision across the country. However, this has now been enabled with the introduction of the ICAD rating system[6] and monitoring dashboard. Since it was launched nationally, Mexico's national ICAD rating has increased from 58.7 to 67.6 in October 2018.

- **MIDO all-in-one screening modules have enabled screening of individuals who would not previously have been screened.** MIDO enables patient health risk assessments to be conducted in one place, in any room within a PHC. This convenience allows for random selection and screening of all individuals in the PHC, even those who appear to be healthy or those who have not actively sought care. A research study revealed that 24 out of 60 individuals who were screened using MIDO at PHCs had not visited the PHC with the intention of participating in a health risk assessment.[7] These individuals would therefore not have been screened if MIDO had not been available.

- **MIDO screening enables enhanced detection of patients at risk of developing a chronic condition, as well as those with undiagnosed chronic diseases.** MIDO patient screening incorporates a novel "pre-disease stage"[8] patient categorisation as opposed to the traditional patient diagnosis of either "healthy" or "sick". As of November 2018, over 1.1 million individuals have had their blood glucose levels tested by HCPs using MIDO modules. Thirteen per cent of those who would have previously been classified as "healthy" were identified as pre-diabetic. An additional seven per cent of this screened population had undiagnosed type 2 diabetes mellitus (T2DM). Both groups of individuals were informed about their health status and included in relevant counselling or treatment programmes to proactively prevent the development or progression of diabetes.

3. The A1c test measures what percentage of your haemoglobin — a protein in red blood cells that carries oxygen — is coated with sugar (glycated). A1c tests are an essential mechanism for the management of diabetes.
4. Self-care activities comprised exercising, following a healthy eating plan, checking their own feet, involving their family in care and belonging to a peer support group at their PHC. (2018),
5. A glucometer is a medical device for determining the approximate concentration of glucose in the blood and is an essential mechanism for the management of diabetes.
6. The ICAD rating is a score out of 100 related to the quality of diabetes care at PHCs.
7. Seventeen per cent were accompanying a patient and 23 per cent were handling administrative or paperwork issues at the PHC.
8. Specifically, pre-obesity is defined as a body mass index between 25 and 29.9, pre-hypertension as systolic blood pressure between 130 and 139 mm Hg or diastolic pressure between 85 and 89 mm Hg, and pre-diabetes as fasting glucose between 100 and 125 mg/dL (A1c values between 5.7 per cent and seven per cent), A Policy Analysis on the Proactive Prevention of Chronic Disease: Learnings from the Initial Implementation of Integrated Measurement for Early Detection (MIDO), 2017.

- **By enabling remote screening in community spaces and households, MIDO screening is reaching a more diverse population**. Analysis of data from PHC, community[9] and household screenings revealed a higher proportion of male patients in the remotely screened sample (33 per cent) than those screened at PHCs (25 per cent).

- **The location of MIDO clinics in accessible public spaces is driving increased patient attendance of follow-up consultations.** PHCs are often inconveniently located for general public access. Positioning MIDO satellite clinics within major transport hubs increased accessibility for patients who can simply include clinic visits as part of their daily commute. The patient follow-up consultation attendance rate at the MIDO clinic in Cuatro Caminos Transit Station, a major transport hub in Mexico City, was 11.7 per cent. Although there's still room for improvement, this is significantly higher than the typical 3.9 per cent follow-up attendance rate at a PHCs that are not usually located near transport hubs.

- **A comprehensive understanding of public health needs, and the processes and resource constraints of Ministries of Health is essential for sustainable public-private partnerships (PPPs).** For example, CSF was able to recognise and adapt to the comparatively longer decision-making processes in government organisations. In response to the MoH's search of an integrated model to tackle NCDs, CSF developed the CASALUD solutions for long term ownership by the government, focusing on cost savings that digital solutions bring for the budget holder.

- **Shared incentives, strong alignment with MoH priorities, collaborative product ideation and development are vital to secure buy-in from all levels of the MoH.** CSF and the MoH shared a vision of lowering premature mortality from NCDs. Close collaboration on product ideation with representatives from all levels of the MoH ensured that CASALUD solutions were designed to solve priority issues for the MoH. Healthcare decision makers, providers and patients were all involved in the product development process and user testing, to ensure that their needs and preferences were designed into the products.

- **Continued use and financing of solutions by the MoH is dependent on the evidence of value that CASALUD solutions deliver**. Both SIC and ICAD monitoring dashboards demonstrate the positive impact CASALUD is having on Mexico's NCD outcomes and the quality of care provision. SIC data revealed a nine per cent increase in the number of patients who have managed to control their diabetes, while ICAD data demonstrated an 8.9 point increase in the national quality of care rating for Mexico since these solutions were implemented.

- **Unique patient health identifiers (IDs) and interoperability of digital solutions enable improved patient tracking along the continuum of care and improved performance monitoring.** CSF's digital solutions generate unique patient health IDs that allow HCPs to identify individuals who have not attended the necessary consultations. The SIC monitoring dashboard revealed a 20 per cent reduction in the number of lost-to-follow-up patients between June 2016 and November 2018, following the implementation of patient health IDs and proper follow-up.

9. MIDO screening campaigns are conducted in community spaces, such as community centres, schools, and private and public institutions.


MiDO®

1. Mexico: The digital health opportunity

With a population of over 129 million, Mexico is ranked tenth globally by population size. In recent years, Mexico has seen a gradual increase in average life expectancy, to over 72 years in 2016.[10]

Mexico is ranked fifteenth globally by gross domestic product (GDP)[11] and has a GDP per capita of $8,900.[12] According to The World Bank, Mexico is an upper-middle income country, but it suffers from high levels of inequality and extreme poverty - the top decile shares almost 40 per cent of the nation's wealth and an estimated 43.6 per cent of the population are living below the poverty line.[13] Furthermore, 31.6 million, more than a quarter of the population, are vulnerable through deprivation of one or more basic social needs.[14] High poverty levels result in a high demand for scarce public health funding that is expected to meet the needs of 60 per cent of the population. Digital innovations have a powerful role to play in providing solutions to strengthen the health system, empower HCPs and patients, and ultimately reduce the burden on the public health system.

1.1. The healthcare landscape

Over the last 30 years, Mexico has experienced an epidemiological transition, with a shift away from infectious diseases towards non-communicable diseases (NCDs). In 1990, NCDs accounted for 55 per cent of Mexico's mortalities, and by 2016 this had increased to 80 per cent. It is predicted that by 2025, NCDs will account for 90 per cent of all deaths in Mexico.[15] Furthermore, Mexico is ranked fourth in the world for childhood obesity, mainly due to the types of products and foods consumed by children, as well as a lack of physical activity.[16]

The rise of NCDs has a profound impact on the health system. NCDs often accompany multiple health conditions (co-morbidities)[17] that require long-term and integrated health management, posing a challenge to health systems that have traditionally treated diseases in silos. The rise of NCDs also increases the complexity of care, requiring a shift from a one-size-fits-all, facility-based care model to a personalised treatment plan facilitated outside traditional healthcare settings.

Given the challenges that Mexico's healthcare system is facing, the effective provision of health insurance to cover rising healthcare costs is important. In Mexico, the health insurance sector is highly fragmented. Prior to 2004, the two biggest social security schemes accommodated the needs of private sector employees[18] and federal and state government employees,[19] but excluded 60 per cent of Mexicans who were either

10. World Bank (2016), "Life expectancy at birth"
11. IMF (2018), "GDP ranking for Mexico".
12. World Bank (2017), "GDP per capita".
13. World Bank (2016), "Mexico country profile".
14. Basic needs include education, access to healthcare, access to social security, quality of housing, basic services in the home or access to food; GSMA Intelligence (2016), "Country overview: Mexico".
15. IHME (2017), "Global burden of disease comparison".
16. PAHO (2011), "High-level regional consultation of the Americas against NCDs and obesity: Report".
17. The presence of one or more additional diseases or disorders co-occurring with (that is, concomitant or concurrent with) a primary disease. NHS (2018), "Integrated care".
18. The Social Health Insurance operated by the Mexican Social Security Institute.
19. An insurance scheme offered by the Institute for Social Services and Security for State Employees.

unemployed or engaged in informal employment.[20] To offset this gap, in 2004 the government extended health insurance coverage by introducing *Seguro Popular* ("People's Insurance") — a nationwide healthcare programme covering a minimum level of healthcare for all Mexicans, regardless of their socio-economic status. As of June 2018, *Seguro Popular* counted over 53.3 million beneficiaries, 41 per cent of Mexico's population.[21]

Treatment of NCDs has been covered in Seguro Popular's scope of funding since it was implemented in 2004. However, the prevention and treatment of pre-diabetes was only included in the catalogue of funded services in 2014. With a growing number of public healthcare service beneficiaries and a high burden of disease, the Mexican MoH was forced to look at innovative solutions to meet demand. This is when the Carlos Slim Foundation (CSF) stepped in to develop a holistic suite of digital services to address the pain points of the health system, HCPs and end beneficiaries.

1.2. The mobile landscape

Mexico is the second largest mobile market in Latin America with 81.6 million unique mobile subscribers in Q4 2018, equivalent to 62 per cent of the population.[22] Between June 2013 and January 2018, prices for mobile services declined by 43 per cent.[23] The increased affordability of mobile services, and the zero rating of data usage for certain over-the-top services[24] by all mobile operators in Mexico, have helped to accelerate subscriber penetration, migration to mobile broadband services (3G and above) and smartphone adoption.[25] As of Q4 2018, of the 119.9 million mobile connections in Mexico, 78 per cent are broadband capable, and 64 per cent are smartphone connections.[26]

With widespread adoption of mobile broadband and smartphone devices in the market, mobile is well positioned to support complex healthcare system challenges.



20. International Labour Organization (2014), "Informal employment in Mexico: Current situation, policies and challenges".
21. Sistema de Protección Social en Salud (2018) "Informe de Resultados Enero – Junio 2018".
22. GSMA Intelligence, 2018.
23. Expansión (2018), "Los precios de telefonía móvil caen 43% desde 2013".
24. These include Facebook, WhatsApp and Twitter.
25. SMA (2016), "Country overview: Mexico".
26. GSMA Intelligence, 2018.

2. Carlos Slim Foundation: Optimising national healthcare delivery

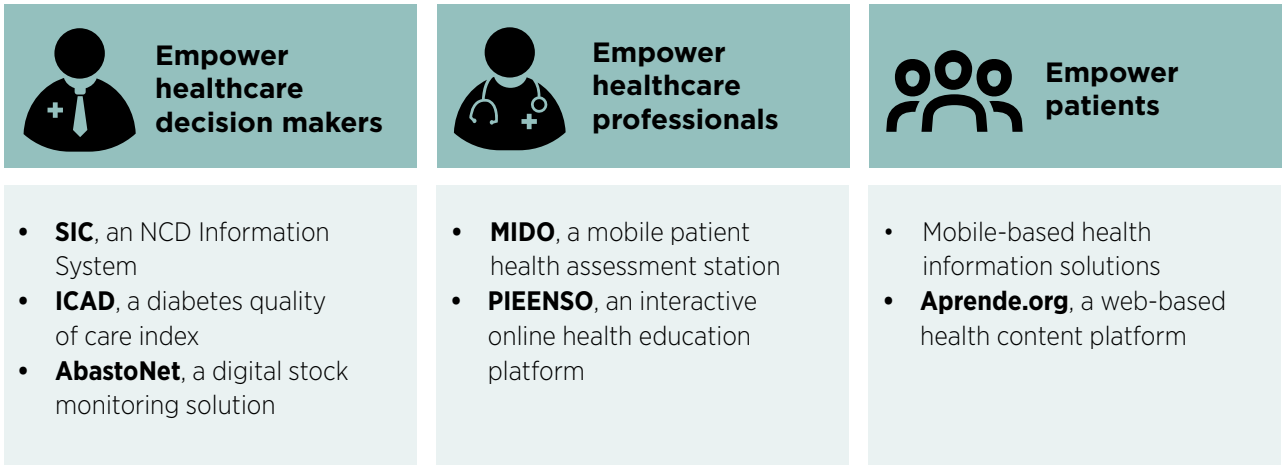
Founded in 1986, CSF is a non-profit organisation with a vision to develop digital interventions that improve the quality of life of people of all ages, promote the development of human resources and create opportunities that foster the fundamental development of individuals and their communities.[27] Although CSF's work spans many sectors, health and education are the two main priority areas for social innovation.

Within Mexico's health sector, CSF works in partnership with the Mexican Ministry of Health (MoH) to address issues affecting the country's most vulnerable populations through innovative, sustainable and replicable solutions. The partnership with the MoH is essential for ensuring national adoption of new solutions in the public health system.

While CSF's portfolio of healthcare solutions covers a range of areas, including maternal and newborn and child health (MNCH) and vaccination, the implementation of CASALUD has been prioritised due to the MoH's desire to deploy an integrated model to tackle the growing burden of NCDs on the health system.

FIGURE 1

The suite of CASALUD solutions



27. Carlos Slim Foundation, 2018.

CASALUD is aimed at improving healthcare provision and NCD management in three ways (Figure 1):

1) **Empower healthcare decision makers to make evidence-based decisions for enhanced healthcare management** – this group of solutions increases access to real-time information for management staff to support decision making.

   - The *Sistema Nominal de Información en Crónicas* (NCD Information System or SIC) is a disease management information system that aggregates, analyses and visualises patient data, enabling the tracking of patients throughout the NCD continuum of care (including patient adherence to follow-ups).
   - *Índice de Calidad de la Atención de la Diabetes* (Diabetes Quality of Care Index or ICAD) is a benchmarking solution that calculates the quality of care rating at different clinics, municipalities and states, and visualises this information on a dashboard.
   - *AbastoNet* is a digital stock monitoring solution that displays stock levels of clinical supplies and lab tests at PHCs on a dashboard.

2) **Empower HCPs to provide improved quality of care for patients** – this group of solutions provides decision support and training for HCPs.

   - Available in either a physical mobile cart or a more portable backpack format, *Medición Integrada para la Detección Oportuna* (Integrated Measurement for Timely Detection, or MIDO) integrates patient health assessment equipment[27] and a digitised patient health screening questionnaire[28] with a built-in decision support algorithm for HCPs.
   - *Plataforma Interactiva de Educación en Salud Online* (Interactive Online Health Education Platform or PIEENSO) is a web-based platform that offers continuing medical education (CME) courses for HCPs.

3) **Empower patients to make informed lifestyle choices for improved health outcomes** – CASALUD's patient-facing solutions are intended to influence optimal health behaviours of patients and their families.

   - There are two different mobile information solutions, one for diabetes patients and one for individuals who are healthy or pre-diabetic. Both solutions provide patients with SMS content on diabetes treatment and management.
   - *Aprende.org* (Learn) is a web-based platform providing patients with access to free video and text-based health content.

27. Both screening tools include equipment to measure waist circumference, height and weight, a body mass index calculator, blood pressure monitor and a glucometer.
28. MIDO's screening questionnaire incorporates the algorithm defined by CENAPRECE, Mexico's National Center of Preventive Programs and Disease Control, to determine the patient's diabetes risk and validate the necessity for a glucose blood test. A Policy Analysis on the Proactive Prevention of Chronic Disease: Learnings from the Initial Implementation of Integrated Measurement for Early Detection (MIDO), 2017.

2.1. A digital healthcare opportunity: The case for CASALUD

When CSF realised that the public health system and traditional healthcare delivery model was failing to address the growing NCD burden, it identified the need for solutions that would enable proactive prevention, timely detection of NCDs and associated risk factors, precision diagnostics and evidence-based disease management. In response to this need, CSF set out to develop a suite of services as part of a new healthcare delivery model that would support and integrate services outside a traditional clinical setting.

A number of CASALUD solutions are achieving scale. As of December 2018:

1) SIC is operated by MoH staff in over 12,400 PHCs across all of Mexico's 32 states, making data from over 1.8 million patients available in real-time on its monitoring dashboard for decision makers,

2) Over 20,000 doctors, nurses, health promoters, nutritionists, psychologists and social workers have graduated from the MoH certified NCD prevention and management courses that are nationally available through PIEENSO (see Figure 2),

3) Enhanced screening of over 1.1 million individuals, in PHCs and remotely in the community, was made possible by MIDO. The number is expected to grow as MIDO continues to be rolled out nationally.

This journey to national scale has not been without challenges, one of which was driving adoption of CASALUD solutions within the public health system. To achieve this, CSF included users at all decision-making levels throughout the entire product development process, ensuring that these solutions were tailored to meet their preferences and needs. CSF also invested in a formal change-management process, by providing training on relevant tools that clearly demonstrated the value of CASALUD to the MoH. The identification of champion users of new digital solutions in each state was pivotal in driving uptake of CASALUD at the national level.

FIGURE 2

HCPs graduate from the MoH certified NCD prevention and management courses on PIEENSO



2.2. Information systems for healthcare management

The primary function of a national health information system (HIS) is to collect and analyse data to help providers and policy makers improve patient care, identify their most important health needs, and decide how to address them.[29] A national-level HIS makes it possible to track a country's progress towards defined health goals or key performance indicators (KPIs).

Historically, NCD management decision making in Mexico was based on inconsistent data from disparate sources and often unreliable paper-based records. Consolidation and digitisation of paper records added significant time delays in this information being made available for decision makers. On average, national-level data was available on a quarterly basis, and for some NCDs no data was available at all. Data aggregation for consolidation purposes often meant losing a degree of granularity, which in turn inhibited accurate decision making and planning, as well as leaving room for fraud and corruption.

CSF designed and developed the NCD Integrated Dashboard, which includes data from MIDO, SIC, ICAD, PIEENSO and AbastoNET. The NCD Integrated Dashboard is accessible through the Mexican Observatory on Non-communicable Diseases (OMENT)[30] web platform (see Figure 3). The NCD Integrated Dashboard consolidates and visualises patient data from over 1.8 million patients from MoH clinics across the country.

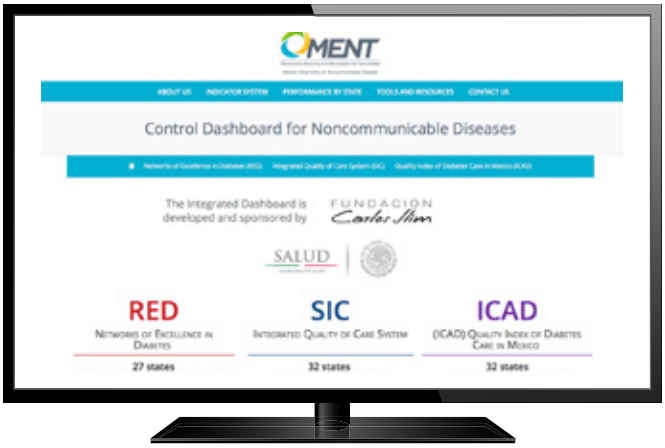
It enables a cross-sectional comparison of Mexico's 32 states across 73 indicators related to the causality of obesity, T2DM and hypertension. The adoption of integrated information systems has clearly delivered an improvement in data management and analysis.

While the NCD Integrated Dashboard successfully made a wealth of data available to decision makers, the true challenge in implementing these dashboards was ensuring the information was used for effective disease management. This required both significant change management and education of decision makers and HCPs on the value of data for healthcare planning and its potential to improve health outcomes for patients.

In the states where the dashboard was first implemented, CSF conducted in-person training workshops with local healthcare managers and HCPs. Eventually, when SIC and ICAD were scaled nationally, the Mexican Federal MoH brought healthcare managers from each of the states to Mexico City for training on the solutions. However, CSF realised that this one-off, in-person method of training was not sustainable at the national level. As of 2016, the training courses are facilitated virtually through video conferencing to enable free, remote and ongoing training for staff and managers. To provide ongoing support for healthcare managers, CSF initiated virtual REVISO meetings (see Spotlight on page 18).

FIGURE 3

The NCD Integrated Dashboard



29. Measure Evaluation (2018), "Health Information Systems Learning Agenda".
30. OMENT was created to monitor health system performance in the management of NCDs as part of the National Strategy for the Prevention and Control of Overweight, Obesity and Diabetes; MoH Mexico (2018), OMENT.

2.2.1. Disease management information system: SIC

SIC is an NCD information system that consolidates patient information digitally captured by medical staff at PHCs. Aligned with government regulation, the SIC data-collection tool has an integrated proprietary algorithm that provides clinical decision-making support to HCPs, guiding them in patient disease management. It also facilitates the coordination of timely follow-up consultations with diagnosed patients. In this way, it ensures consistency of care and accurate diagnosis of patient conditions, supporting effective disease management at the clinic level. First implemented in 2015, by November 2018, SIC had guided HCPs in monitoring over 1.8 million people in managing their T2DM, obesity, hypertension and pre-existing conditions.

SIC works both online and offline and, irrespective of the chosen mode, healthcare provision is uninterrupted. HCPs working in offline mode can save data as an encrypted file and upload this data to the server through a secure connection at a synchronisation hub. The data is securely synced to and stored in cloud infrastructure,[31] where it is automatically analysed and visualised on the SIC monitoring dashboard (Figure 4). Although PHCs are required by the MoH to synchronise their data at least once a month, PHCs in one out of four jurisdictions are not adhering to this requirement.

While SIC is the official MoH NCD information system, paper-based data collection methods are still in use. Duplication of efforts from HCPs and managers has naturally caused some frustration. Given this challenge, both HCPs and managers are increasingly supporting the complete transition from paper-based record keeping and the migration to full digital data records. The other barrier in the digitisation process is the lack of internet access: 66 per cent of urban PHCs have Internet access, while only 25 per cent of PHCs in rural areas have internet access.[32] For full migration to digital, investment in broadband infrastructure is required, and relevant policy changes need to be made to support adoption.

FIGURE 4

Operation of SIC on the NCD Integrated Dashboard[33]



31. CSF's patient data management processes follow best practices in data privacy and security as mandated by the Mexican government and are compliant with the Health Insurance Portability and Accountability Act (HIPAA), ensuring the protection of patient medical records and other health information.
32. OMENT (2018), "Infraestructura de las Unidades de Salud".
33. MoH of Mexico (February, 2019), NCD Information System (SIC); The information provided in the three columns on the right-hand side of the figure represent (from left to right): 1) the number of patients living with the disease, 2) the percentage of diagnosed patients with relevant tests completed and 3) the percentage of tested patients with their disease under control.

2.2.2. Benchmarking and monitoring of quality of care: ICAD

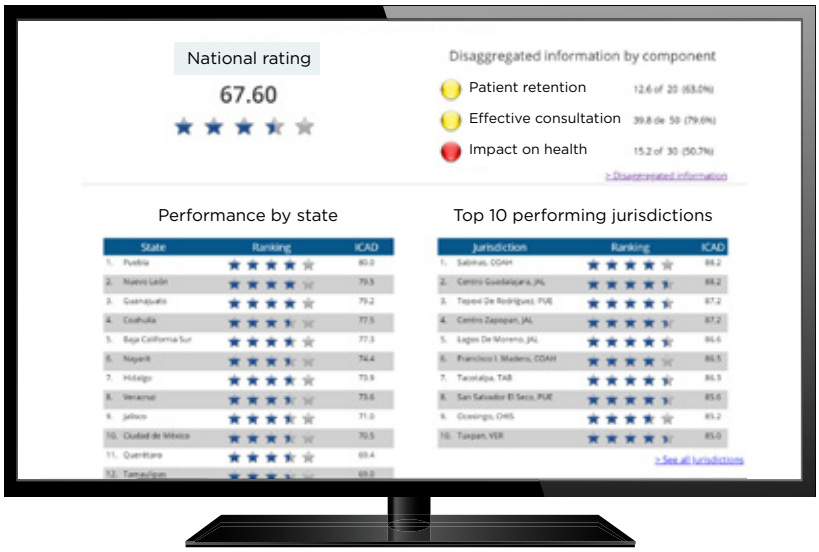
The ICAD index provides an objective framework for assessing the quality of diabetes care at PHCs. Monthly results are displayed on a public digital dashboard (Figure 5). Decision makers can view data disaggregated at PHC, municipality, state and national level, as well as monitor changes in performance over time. ICAD also generates tailored reports for decision makers, including ICAD results and recommendations for improvement. The ICAD rating is calculated as a score out of 100, using data captured at clinics in three areas (the weighting for each area is indicated in brackets):

- **Effective consultation (50 points)** – evaluation of the process of care provided to diabetic patients at PHCs across five key areas: 1) basic measurements in each consultation, 2) annual lab measurements and vaccination coverage, 3) appropriate prescription of treatment, 4) integrated care of co-morbidities and patient referral and 5) reliability and credibility of patient data; and
- **Patient retention (20 points)** – the percentage of diabetes patients who attend their medical consultation on a regular basis;
- **Impact on health (30 points)** – evaluation of the number of T2DM patients who have managed to control their condition.[34]

Together with the MoH, CSF defined specific criteria for health centres to qualify for an ICAD evaluation.[35] As of November 2018, the ICAD quality of care index that reports results from 10,600 PHCs in 32 states revealed a national quality of care rating of 67.6.

FIGURE 5

The ICAD monitoring dashboard[36]



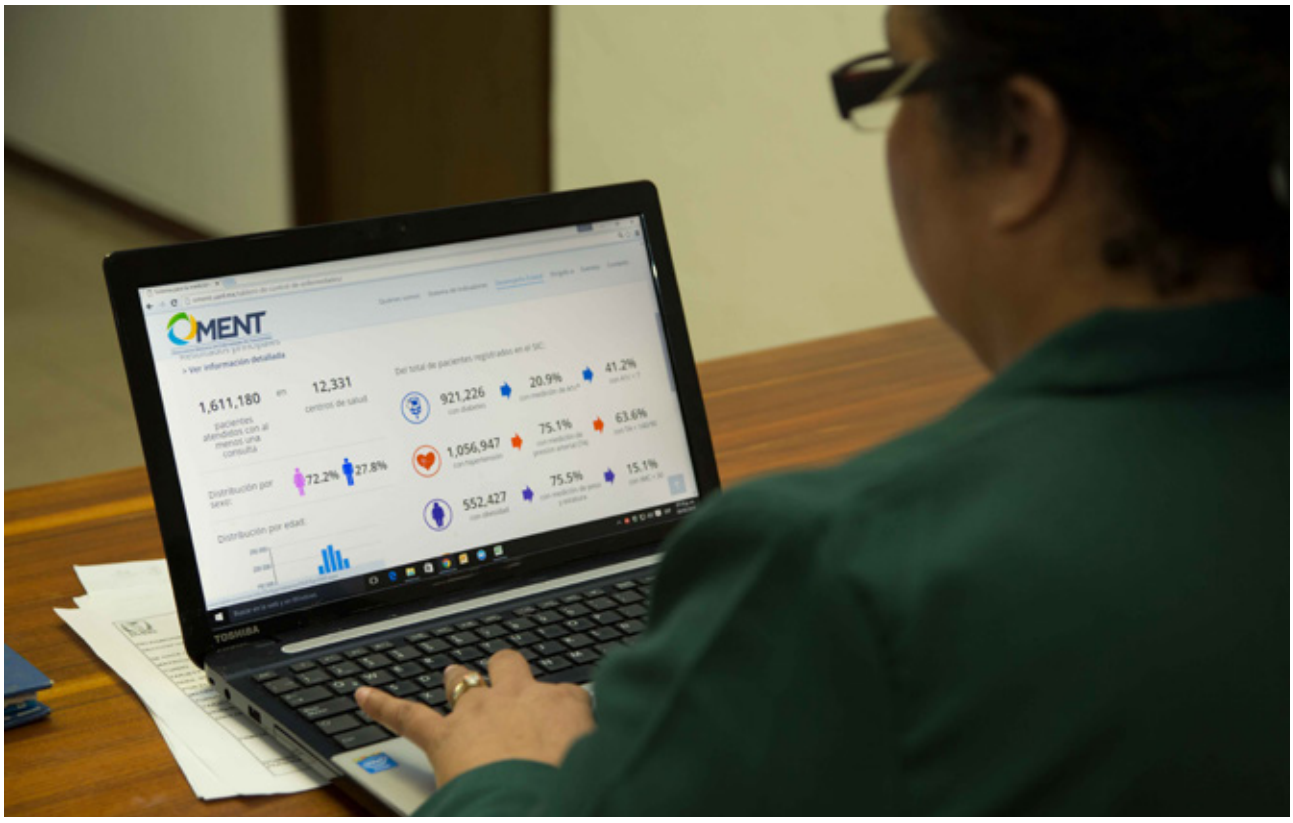
34. For diagnosed T2DM patients, A1c measurements under seven per cent represent a controlled or managed condition.
35. For example, in order to be included in an ICAD evaluation, a PHC must have at least one T2DM patient actively receiving care.
36. MoH of Mexico (October, 2018), ICAD monitoring dashboard.

2.2.3. Improvements driven by transparency

Both SIC and ICAD increase the transparency of performance in disease management and quality of care, which incentivises competition between clinics, municipalities and states to improve their ratings. A combination of dashboard and comparable quality metrics allows healthcare managers to identify top-performing regions or clinics. Further investigation reveals both the key challenges these clinics experience, and which healthcare delivery strategies and approaches are most effective. Operational REVISO meetings were implemented in September 2014 to facilitate the exchange of best practices and learning (see Spotlight on page 18).

Increased visibility into data for managers has also improved tracking of Mexico's overall progress in managing NCDs. Prior to the national implementation of ICAD in July 2016, the MoH did not have a quantitative process for objectively measuring, viewing or comparing the quality of care provision across the country using nominal data. This was enabled with the introduction of the ICAD rating system and the NCD Integrated Dashboard. From the national launch to November 2018, Mexico's national ICAD rating has increased from 58.7 to 67.6.

SIC and ICAD have enabled effective monitoring of the results of management decisions. In November 2016, the MoH centralised the procurement of clinical supplies and lab tests with the aim of improving stock levels at PHCs. Improved stock management in turn resulted in an increased number of tests completed. SIC dashboard provided visibility into the eventual increase in the coverage of A1c tests in diabetic patients from 14 per cent in November 2014 to 54 per cent in November 2018. These positive results reassured decision makers at the MoH of their decision to centralise procurement.[37] It has been estimated that centralised procurement has saved the government 99.1 million pesos (approximately $4.8 million) in 2016 alone.[38]



37. In addition to improved stock availability of A1c test kits from the centralisation of lab test procurement, the implementation of CASALUD's healthcare professional empowerment solutions like PIEENSO and MIDO also likely played an important role in driving greater A1c testing (discussed in more detail in section 2.3.2.).
38. Secretaría de Salud (14 November 2016), "Press release: The Ministry of Health issues epidemiological emergency due to diabetes mellitus and obesity".





Spotlight

Virtual meetings drive adoption and shared learning

While today most clinics are using SIC seamlessly, this was not the case when the solution was first introduced in 2014. Resistance to this digital information system and data collection tool was evident from users at all levels of the MoH. CSF recognised that sustainable end-user support was necessary to drive greater adoption and continued use of its digital tools. In response, CSF initiated virtual conferences called REVISO (*Reunión Virtual de Seguimiento a la Operación*, or virtual operational follow-up) meetings. While REVISO meetings between CSF and Federal MoH take place on a bi-monthly basis to discuss a national agenda, monthly REVISO meetings with representatives from CSF, State MoH and PHCs address aspects related to state-, district- and facility-level implementation and performance.

Initially, REVISO meetings aimed to provide technical support to SIC users and showcase examples from best-in-class users. While part of these meetings is still devoted to addressing technical difficulties, the primary objective of the calls has shifted towards timely sharing of best practices between HCPs. The scope of REVISO meetings has also expanded to include other CASALUD solutions beyond SIC.

During a monthly REVISO meeting, a representative from the State MoH presents data on PHC- and state-level performance, highlighting top performers as well as clinics or states that are underperforming. Further discussion is held around key challenges faced and the sharing of successful mitigating approaches. Representatives from other states are often invited to share best practices in overcoming challenges.

The spectrum of challenges addressed in REVISO meetings ranges from technical implementation or use of CASALUD solutions like SIC, to the interpretation of data and performance monitoring. An example of a challenge addressed in a REVISO meeting was the need to drive greater adoption of CASALUD solutions among users over the age of fifty. Users with lower levels of digital literacy have been more resistant to using tools like SIC. The solution, proposed by a representative from another state, was the implementation of a “buddy system” that partners an older user with a younger, more tech-savvy user who provides support in navigating technical challenges. In turn, the younger users learn from the practical work experience of caring for and influencing patients.

REVISO meetings provided the first digital platform in Mexico to effectively share learning between states and clinics. Both the Federal and State MoH saw great value in regular REVISO meetings, and since 2015, REVISO meetings have been formally organised and chaired by Mexico’s National Center of Preventive Programs and Disease Control (CENAPRECE).

2.3. Solutions for empowering healthcare professionals

There is a significant association between a patient's knowledge of and attitude toward their chronic condition and self-care, especially in the management of type 2 diabetes.[39] Healthcare professionals at PHCs play an important role in empowering, educating and motivating patients to take ownership of managing their NCD.[40] Prior to the implementation of CASALUD, the Mexican medical education system did not train HCPs on educational communication, healthy behaviour strategies or effective patient-provider relationships.[41]

CSF recognised that in order to ensure consistent quality of care, the skillsets of healthcare workers had to be strengthened. CSF adopted a two-pronged approach to enhance the education of HCPs around NCDs, as well as to provide them with continued support for patient care and education. CSF developed two solutions to meet this goal: PIEENSO, an online continuing medical education (CME) programme, and MIDO, a systematic health risk assessment support for HCPs.

PIEENSO is an online platform created by CSF with academic endorsement from the National Autonomous University of Mexico and the National Institute of Medical Sciences and Nutrition. Through PIEENSO, CHPs have increased access to MoH-accredited course material, including video content, tailored to a range of healthcare roles.[42] The content is remotely accessible, on-demand through mobile and includes an offline mode, enhancing accessibility for HCPs in low connectivity areas. Since 2009, over 20,000 doctors, nurses, health promoters, nutritionists, psychologists and social workers have graduated from the PIEENSO NCD prevention and management courses and received a certificate of completion from the MoH. As a qualifier to operate MIDO, each HCP must have completed the relevant NCD courses on PIEENSO.





39. BMC (2015), Modelling of diabetes knowledge, attitudes, self-management, and quality of life: a cross-sectional study with an Australian sample.
40. NCBI (2017), Online continuing medical education as a key link for successful noncommunicable disease self-management: the CASALUD™ Model.
41. Gaceta Médica de México (2012), Innovaciones para la transformación de los sistemas de salud.
42. The PIEENSO CME programme has been created for doctors, nurses and community HCPs, such as health promoters, nutritionists and social workers. PIEENSO offers the following two certificates: a 110-hour online certificate, which updates HCP knowledge on NCDs and current evidence-based NCD prevention, treatment and management strategies (including how to deliver T2DM self-management education) and a competencies certification, a 40-hour course in which physicians solve real-life cases to test their knowledge in practical settings.

MIDO is implemented through a portable module — a mobile cart or backpack — that includes essential equipment for conducting a patient health risk assessment and a laptop. The laptop includes the proprietary information system with integrated risk assessment algorithms to guide HCPs along the patient health risk assessment. Following a patient assessment, MIDO automatically generates a tailored recommendation report to guide the HCP in educating their patients on their health status and how to manage their disease. Patient recommendations are also shared digitally by email, with accompanying links to additional information and support.

MIDO enables an entire end-to-end assessment: results and recommendations are delivered in one consultation in one location, which has significantly reduced time and travel costs for patients. MIDO has also boosted adoption of standardised protocols for NCD risk assessments.



2.3.1 Enhanced screening and earlier detection of NCD patients: MIDO

The screening strategy used in Mexico in the past only included chronic disease screening of symptomatic patients actively seeking care at PHCs. Traditional screening goals were based on the number of tests performed at PHCs. With the new National Strategy and MIDO, the goal is to screen 100 per cent of people over the age of 20 within the geographic boundaries of each PHC. As of November 2018, over 80 per cent of the goal to screen 1.4 million individuals by the end of the 2018 had been achieved.

MIDO enables the screening of all individuals, including those who appear to be healthy or those who have not actively sought care. MIDO Mobile Carts enable patient health risk assessments to be conducted in one place, in any part of a PHC. This convenience allows for random selection and screening of all individuals in the PHC, even those who appear to be healthy or those who have not actively sought care. A research study revealed that 24 out of 60 individuals who were screened using MIDO Mobile Carts at PHCs had not visited the PHC with the intention of participating in a health risk assessment.[43] These individuals would therefore not have been screened if MIDO had not been available.

In addition, MIDO screening enables enhanced detection of patients at risk of developing a chronic condition, as well as those with undiagnosed chronic diseases. MIDO patient screening incorporates a novel "pre-disease stage"[44] of patient categorisation as opposed to the traditional patient diagnosis of either "healthy" or "sick". As of November 2018, over 1.1 million individuals have been screened by PHCs using MIDO modules. Thirteen per cent of those who would have previously been classified as healthy were identified as pre-diabetic. An additional six per cent of this screened population had undiagnosed T2DM. Both groups of individuals were informed of their health status and included in relevant lifestyle counselling or treatment programmes. For at risk patients, this was to proactively prevent the development of diabetes, while for newly diagnosed patients the focus was on preventing the progression of diabetes.

Insights from the research also indicate that by enabling remote screening in community spaces and households, MIDO screening is reaching a more diverse population and driving increased patient attendance of follow-up consultations. Analysis of data from both PHC-based screenings and community[45] and household screenings using MIDO Backpacks revealed a higher proportion of male patients in the remotely screened sample (33 per cent) compared to those screened in PHCs (25 per cent).

The location of MIDO clinics in accessible public spaces is also driving increased patient attendance of follow-up consultations. PHCs are often inconveniently located for general public access. Positioning MIDO satellite clinics within major transport hubs increased accessibility for patients who can simply include clinic visits as part of their daily commute. The patient follow-up consultation attendance rate at the MIDO clinic in Cuatro Caminos Transit Station (see Figure 6), a major transport hub in Mexico City, was 11.7 per cent. Although there's still room for improvement, this is significantly higher than the typical 3.9 per cent follow-up attendance rate at a PHCs that are not usually located near transport hubs.

FIGURE 6

Mido satellite clinic at Cuatro Caminos Transit Station



43. Seventeen per cent were accompanying a patient and 23 per cent were handling administrative or paperwork issues at the PHC.
44. Specifically, pre-obesity is defined as body mass index between 25 and 29.9, pre-hypertension as systolic blood pressure between 130 and 139 mm Hg or diastolic pressure between 85 and 89 mm Hg, and pre-diabetes as fasting glucose between 100 and 125 mg/dL (A1c values between 5.7 per cent and seven per cent) Tapia-Conyer et al. (2017), "A Policy Analysis on the Proactive Prevention of Chronic Disease: Learnings from the Initial Implementation of Integrated Measurement for Early Detection (MIDO)".
45. MIDO screening campaigns are conducted in community spaces, such as community centres, schools, and private and public institutions.

2.3.2. Improved quality of care and patient adherence for better outcomes

CASALUD's health worker empowerment solutions are driving improved diabetes care delivery at PHCs and improving T2DM outcomes at the national level. Although over nine million Mexicans have been diagnosed with T2DM, A1c tests were rarely conducted before solutions like PIEENSO, MIDO and SIC were implemented. A1c test coverage has increased from 14 per cent in 2015, before these solutions were implemented, to 54 per cent in November 2018.[46] As a result, disease outcomes at the national level have shown an increase in the number of patients who have managed to control their diabetes, up from 36 per cent in November 2014 to 44 per cent in November 2018.

Further evidence of the positive impact of CASALUD solutions were the results of a study of diagnosed NCD patients being treated at PHCs with the CASALUD model (including PIEENSO). This study investigated patients' perceptions of the quality of care, knowledge of their disease and adherence to self-management activities.[47]

Results showed that the index of patient perception of quality of care increased by 19 per cent from 0.54 to 0.64 over the two-year study period. A moderate, but significant, five per cent improvement in the index value of patient disease knowledge over the same period is an indicator of better quality healthcare provision and patient-provider education. The PIEENSO online course specifically includes modules on how to deliver diabetes self-management education, which appears to have sharpened HCP expertise in this area. More importantly, improved patient health knowledge has resulted in improved behaviours: a 15 per cent increase in the index value for patients participating in self-care activities,[48] and a 56 per cent increase in the index value for patients owning and using a glucometer.[49]

2.4 Mobile-based information services for patients

With a high burden of NCD disease and pre-disease, prevention plays a crucial role in reducing future stress on the healthcare system. As research by the GSMA mNutrition initiative has shown, information services aimed at the general population via mobile phones have strong potential to drive behaviour change across target populations.[50]

To improve the dissemination of appropriate health knowledge and practices, CSF developed two mobile solutions in 2012: one for end users with diabetes and another for end users who are healthy or in pre-diabetes stage. Initially, both solutions were SMS-based, but due to recent mass uptake of smartphones, CSF is increasingly focusing on rich media services. An improved mobile app is under development that will provide daily support and lifestyle coaching through embedded algorithms and artificial intelligence (AI).

In addition, under CASALUD, *Aprende.org* is an online learning platform offering content on health, employment, education and culture. Health content is tailored for both the public and health professionals. Data charges for accessing Aprende.org are zero-rated for customers of America Movil's mobile operator, Telcel.

46. This is also partially a result of the improved stock availability of A1c test kits as a result of the MoH's decision to centralise clinical supplies procurement as discussed in section 2.2.3.
47. Perceived quality of care was divided into three subgroups: technical quality of care, interpersonal quality of care and availability of care, while patient disease knowledge was divided into T2DM risk calculation and T2DM knowledge. The last group of T2DM self-management activities was divided into glucometer ownership, medication and treatments, self-care activities and no tobacco/alcohol use. NCBI (2017), "Online continuing medical education as a key link for successful noncommunicable disease self-management: the CASALUD™ Model".
48. Self-care activities comprised exercising, following a healthy eating plan, checking their own feet, involving their family in care, and belonging to a peer support group at their PHC.
49. A glucometer is a medical device for determining the approximate concentration of glucose in the blood and is an essential mechanism for the management of diabetes.
50. One of the outcomes of the GSMA mNutrition initiative is increased nutritional knowledge in the target population. Across eight African countries targeted by the mNutrition initiative, 69 per cent of mHealth service users correctly recalled information across all tested nutrition practices compared to only 57 per cent of non-users. GSMA (2017), "Creating mobile health solutions for behaviour change".


Peso
Presión
Azúcar

3. Key Lessons Learned

The CASALUD suite represents a holistic approach to health systems strengthening. CASALUD has enhanced NCD management by strengthening three key health system stakeholders: healthcare decision makers, HCPs and patients. By offering a range of integrated digital solutions,[51] CSF supports evidence-based decision-making for the MoH, increases the pool of trained NCD HCPs and enables more consistent quality of care. By empowering decentralised healthcare delivery, CASALUD solutions have also increased timely detection and prevention of NCDs and enhanced patient experiences.

CSF has learned that, in order to build and sustain effective public-private partnerships, it is important to be aligned with the MoH vision, its needs and priorities and ways of working. Providing value to the government offers a pathway to financial sustainability for digital tools like CASALUD. However, sustained government investment depends on nationwide adoption and measurable results. The most noteworthy aspect of CSF's approach to developing digital health solutions is the focus on health systems strengthening solutions versus standalone solutions that address a single need for specific users. CASALUD solutions are designed to be interoperable and scalable from the start.



51. Digital integration enables data or information on any given electronic device to be read or manipulated by another device using a standard format.

3.1. Shared incentives and private-sector understanding of government priorities is key to public-private partnerships in digital health

The roll out of the CASALUD suite has largely relied on clear shared incentives between the government and private sector. Given the growing burden of NCDs in Mexico, CSF and the MoH had a shared vision to reduce the rate of premature mortality from NCDs (Sustainable Development Goal - SDG 3.4) and achieve universal health coverage (UHC, SDG 3.8) in Mexico. In October 2013, the MoH included CASALUD as the reference model in its National Strategy for the Prevention and Control of Overweight, Obesity and Diabetes, and endorsed the national implementation of several CASALUD solutions.

To implement a sustainable public-private partnership, it has been essential for CSF to develop a solid understanding of the processes and resource constraints of the MoH. For example, CSF recognised and adapted to the comparatively longer decision-making processes in government organisations, a challenge that became evident during planning for pilot testing and national scale-up. Importantly, CSF appreciated the resource constraints faced by government and decided to focus on the cost reductions that digital solutions could deliver for the budget holder.

CSF ensured that the design of each of the CASALUD solutions could solve priority issues for the MoH. CSF achieved this through close collaboration with prospective users at all levels of the MoH, beginning in the early stages of product ideation. Adopting a human-centred design approach has been vital for buy in and successful implementation of digital tools at all levels of the MoH. For example, users at PHCs were initially overwhelmed by the amount of data entry fields included in the SIC data collection tool user interface (UI). CSF worked with these users, as well as management staff, to simplify the UI to meet both the data collection needs of management staff and user preferences. In response to user needs, several CASALUD solutions now have an offline mode to function in areas with low or no connectivity. Similarly, optimised content and low-resolution files reduce the bandwidth requirements for data transmission.

Continued use and financing of digital tools by the MoH is dependent on the evidence of value that CASALUD solutions deliver. Through the SIC and ICAD monitoring dashboards, it is now possible to demonstrate the positive impact CASALUD is having on NCD outcomes and the quality of care provision. SIC data showed a nine per cent increase in the number of patients who have managed to control their diabetes, while ICAD data demonstrated an 8.9 point increase in the national quality of care rating for Mexico.



3.2. Design for interoperability, data protection and patient confidentiality from the start

CSF envisioned that the CASALUD tools would be interoperable and enable seamless exchange and data consolidation within and between data stores, digital tools and the departments using them. Data integration between SIC and MIDO software, completed in 2016, makes data available in real time for analysis and visualisation on the NCD Integrated Dashboard. In addition, algorithms within SIC and MIDO automatically generate a unique health identifier (health ID) for every patient. This combination of data integration and the use of unique health IDs enables effective tracking of each patient throughout the NCD patient care continuum, and improves monitoring of each PHC's progress against their key performance indicators (KPI).

For example, since CASALUD solutions have been implemented, the number of "lost-to-follow-up" patients has decreased considerably.[52] Prior to implementing unique health IDs, HCPs were not able to keep records of newly-diagnosed individuals. In addition, HCPs did not follow protocols to guarantee that newly diagnosed individuals make an appointment with a physician. As a result, decision makers had no way of knowing which individuals were lost-to-follow-up patients. Interviews with 60 individuals screened with MIDO revealed that none of the 25 individuals identified as having a probable NCD went on to book an appointment to see a physician.[53] This evidence suggested that the proportion of patients being lost at this step of the care continuum was significant. The modified SIC-MIDO software not only enables tracking of each patient using their health ID, but also automatically generates an appointment for diagnosed patients. The SIC monitoring dashboard has shown a 20 per cent reduction in the number of lost-to-follow-up patients between June 2016 and November 2018.

CSF has also ensured that its solutions are compliant with national and international standards for patient confidentiality and data protection. All CSF's solutions are compliant with Mexico's Administrative Manual of General Application in the field of Information and Communication Technologies and Information Security (MAAGTICSI, for its initials in Spanish). Each of CSF's solutions are also compliant with the Health Insurance Portability and Accountability Act (HIPAA), which sets the standard for protecting sensitive patient data. In addition, CSF's data management processes follow the practices indicated in ISO 27001.[54]

3.3. Cost-efficient and modular design enables scalability and replicability of CASALUD

Scalability of CASALUD solutions hinges on two key factors: 1) with the exception of the MIDO Mobile Carts or MIDO Backpacks, CASALUD is built primarily on software tools (versus hardware tools), and 2) CSF has adopted a modular design approach to CASALUD software solutions. CSF has reduced its dependence on hardware solutions, such as internet of things (IoT) devices, that require significant upfront investment for national roll out and ongoing maintenance costs. Given public health constraints in Mexico, CSF developed the CASALUD suite of low-cost digital solutions so that they could be sustained within the MoH's budget. CSF opted for this approach considering that digital solutions can be scaled at little or no cost and have low maintenance requirements, which reduces the overall operating costs of CASALUD.

52. Once patients with a disease or pre-disease have their condition confirmed at screening, they must attend their first medical or counselling appointment as a pre-requisite for disease management. Those who fail to do so are classified as "lost-to-follow-up" patients,
53. A Policy Analysis on the Proactive Prevention of Chronic Disease: Learnings from the Initial Implementation of Integrated Measurement for Early Detection (MIDO), 2017.
54. The International Organization for Standardization (ISO) standard 27001 is a specification for an information security management system (ISMS). An ISMS is a framework of policies and procedures that includes all legal, physical and technical controls involved in an organisation's information risk management processes.

4. Future roadmap

Through CASALUD, CSF has demonstrated a model for re-engineering primary healthcare services by facilitating integrated, decentralised and holistic healthcare for improved patient health outcomes. CSF is currently pursuing new initiatives to expand the current CASALUD suite of services to health areas beyond NCDs and to new markets. CSF is also investing on a new patient-facing application with built-in AI to help preventing the occurrence of NCDS in Mexico.

National expansion of MIDO and new international markets for CASALUD

As a priority, CSF will be focusing its efforts on the national expansion of MIDO, scaling from 138 to 12,400 clinics across the country. Since MIDO enables the identification and education of at-risk individuals, scaling the solution nationally will boost the MoH's efforts to prevent further growth in the burden of NCDs on the health system.

In addition, CSF is considering the expansion of the broader CASALUD into new markets where the MoH has expressed interest in implementing the CASALUD model and there is a reliable implementation partner willing to drive operations on the ground.

Deployment of a patient-facing app with built-in AI to help users adopt better health practices

In an effort to further expand Mexico's NCD patient screening and education efforts, CSF is currently piloting a patient-facing app with built in artificial intelligence (AI). The app will serve as a virtual coach to guide and support users on their journey towards a healthy lifestyle. The solution can profile users according to their health status and provide customised information and guidance on nutrition, physical activity and other self-care activities to prevent the development or progression of NCDs. In addition, the app will aid identification of at-risk or undiagnosed NCD patients and encourage them to receive the necessary care.

Collaboration with the government to enable data integration between CASALUD and other CSF solutions

CSF envisions the interoperability of systems of different health divisions within the healthcare system, however, several challenges will need to be overcome to achieve this. As of November 2018, health IDs were already in use within CASALUD solutions, as well as CSF's MNCH and vaccination coverage solutions. If these solutions were to be connected, a patient who is receiving antenatal or postnatal care who has also been diagnosed as having, or is at risk of having an NCD, could be tracked between the two healthcare divisions. The respective care teams would have immediate access to a complete view of the patient's healthcare record — vital for HCPs — to transition from treating conditions individually to holistic patient healthcare. CSF is currently working with the MoH to enable this data integration between CASALUD solutions and its MNCH and vaccination coverage solutions.





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