Special report

Application of eHealth in the Cuban context*

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ABSTRACT   *The achievements and challenges arising from the application of eHealth in the Cuban context to support universal health coverage are presented. The Ministry of Public Health defined the Computerization Strategy, whose lines of work are based on the components declared in the Pan American Health Organization's Strategy and Plan of Action on eHealth, and in the Computerization of Society Policy, approved by the Cuban Government. The paper describes the actions of the Cuban strategy designed to overcome limitations in the technological infrastructure, develop platforms, tools and applications required by health services, and stimulate professionals' abilities to use them. The results of eHealth in Cuba are based on the application and evaluation of the strategy implemented in the health sector improvement framework through projects such as the electronic medical registry called* Galen Clínicas, *human resources training and information and education resources from the Infomed Health Telematics Network. These models of solidarity and collaborative networking have contributed to universal health coverage and have positively impacted the health system beyond borders. Challenges to eHealth are development of mobile health initiatives, in which there is little experience; telemedicine, a project that is stopped; integration and interoperability of applications; sustainability of implemented solutions; insufficient technological infrastructure; and strengthening the legal framework.*

Keywords   Electronic health records; telemedicine; universal coverage; information technologies and communication projects; Cuba

The World Health Organization (WHO) has proposed new strategies to address health problems in the 21st century information and knowledge society. One such strategy is eHealth, which uses information and communication technologies (ICTs)—with good cost-effectiveness and security—to support health and related areas, including health care services; health surveillance and documentation; as well as health education, knowledge, and research (1, 2).

eHealth seeks to improve information flows through electronic media to support health services and health systems management (3). As Dr. Carissa Etienne, Director of the Pan American Health Organization (PAHO), noted, "Well used and widely applied, eHealth can be a strategic tool for improving access, expanding coverage and increasing the financial efficiency of health care systems" (4).

In 2011, PAHO defined its eHealth Strategy and Plan of Action (2012-2017), based on six components: *electronic medical registry* (electronic medical records); *telemedicine* (delivery of health services using ICTs); *mHealth* (or health through the use of mobile devices: medical and public health practice supported by mobile

devices, such as mobile phones, patient monitoring devices, and other wireless devices); *eLearning* (the use of ICTs for learning, including distance education); *continuing education in ICTs* (development of ICT skills for health); and *standardization and interoperability* (communication between different technologies and applications, through the use of standards, for integrated management of health systems at all levels) (2, 5).

In a 2016 review, four strategic areas were established: 1) Support and promote public policies on eHealth; 2) Improve public health through the use of eHealth; 3) Promote and facilitate horizontal collaboration between countries; and 4) Knowledge management and digital literacy for quality care, promotion of training and health, and disease prevention (6).

The global trend, particularly in developed countries, is to frame health in a marketplace with multiple contributors and payment sources, which enables computerization of the sector, even when developing countries lack this capacity. However, progress has been made in Latin America and the Caribbean in setting up eHealth-based systems and services, linked to growing political will and adoption of measures related to the use of technologies to aid mobilization of necessary resources and investment in infrastructure (7).

National eHealth strategies are being developed and implemented in countries such as Brazil, Canada, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Jamaica, Panama, Peru, and the United States of America, a group that also includes Cuba. In Latin America and the Caribbean, progress has been made along these lines; however, challenges still persist—including in Cuba—which are being addressed (7).

This article describes achievements attained and challenges stemming from eHealth applied in the Cuban context to support universal access to health care and universal health coverage.

UNIVERSAL HEALTH COVERAGE AND eHEALTH IN CUBA: CONTEXT

"Universal health coverage means that all people have access to quality systems and services when they need them and can obtain them without becoming impoverished by financial hardship" (8). Cuba, with a population of 11 239 224 in 2016 (9), has a universal, free National Health System (SNS) comprised of 12 409 service units (10), including both medical and social services facilities administered by the Ministry of Public Health (MINSAP). Eighteen percent of these services are located in the capital city, leaving the vast majority of facilities (82%) dispersed throughout the rest of the country. The central core of the SNS are the 10 782 family doctor and nurse offices, associated with 451 polyclinics, which comprise the basic primary health care (PHC) areas that cover 86.2% of all medical visits and are linked to 150 hospitals (10).

This group of institutions requires a constant flow of information among all its components to facilitate timely decision-making and meet the information needs of different government bodies and their own systems and services (11). Strong interest in introducing national programs for computerizing health services is determined by two factors: the existence of a single health services provider for the entire country, and the profusion of health facilities with total geographic and health care coverage. MINSAP has therefore maintained actions for computerizing the sector as part of its development plans (Figure 1).

The first computerization strategy dates from 1997 and was based on five guiding principles: internal and external territoriality, methodological planning, security, network development, and open-source systems. In an advisory visit by the PAHO's Division of Health Systems and Services Development, this strategy was recognized as one of the first created to organize consistent work along these lines (12).

During the 2001 evaluation of the first stage of the strategy, application of the Program to Strengthen Computing at the local level was reported in 22 (75.9%) of 29 selected municipalities, led by three municipalities in Havana City, Cienfuegos and Sancti Spíritus, respectively, with computerized flow from institutions to health administration bodies and provincial governments. All institutions in the Isla de la Juventud special municipality were also integrated into the local network.

The Telemedicine Program brought joined 18 secondary care facilities for image sharing. However, only Santiago de Cuba province used it for second opinion consultations between local hospitals and the Hermanos Ameijeiras Clinical-Surgical Hospital reference center in the capital. Other linked projects were also evaluated as successful (12).
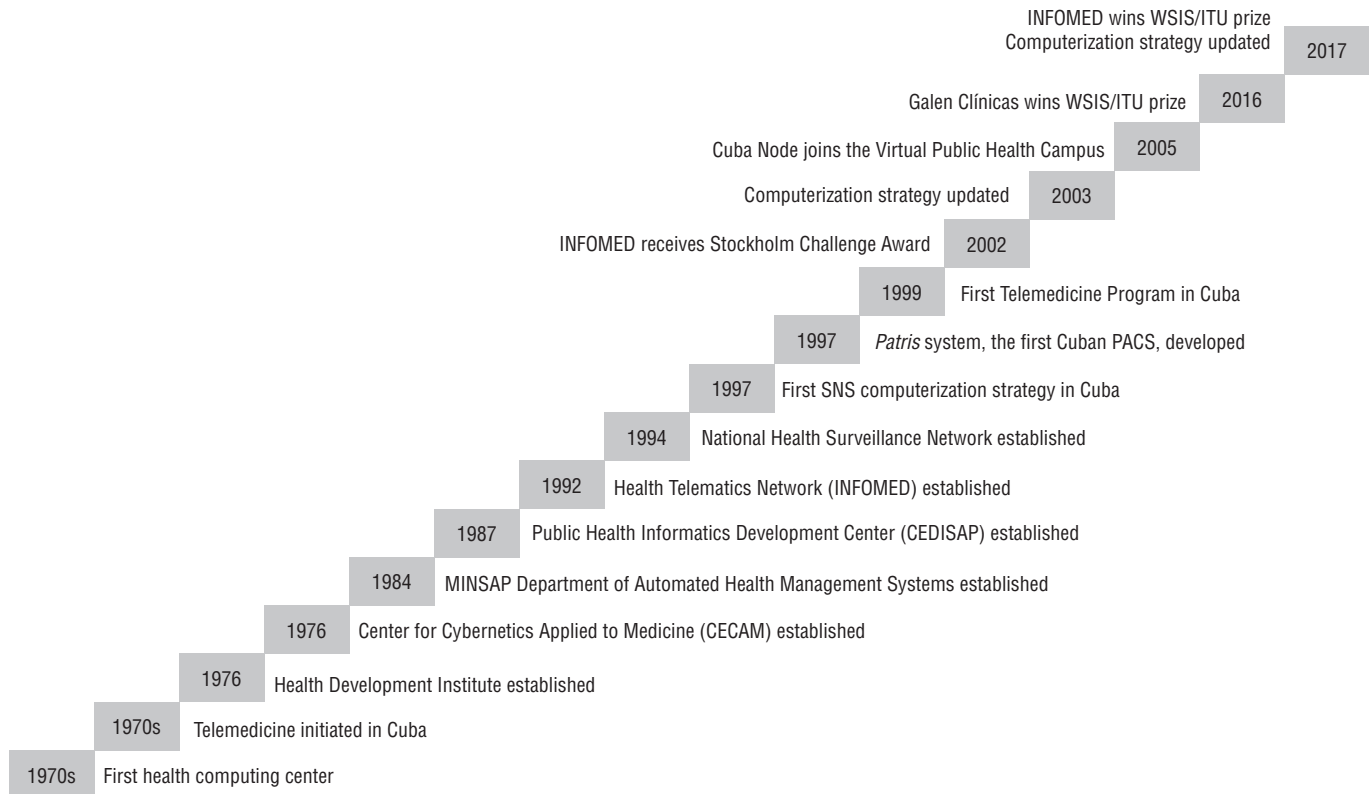
The economic crisis that affected the country in the late 20th century limited expansion of these proven solutions. The difficulties motivated local and alternative initiatives, however, that allowed gains to be maintained in 2002–2016, as well as advances in the Computerized Health Registry as an integrated platform for health systems and services, in the area of scientific and technical information, and in the Health Telematics Network; but institutional projects could not be expanded due to the high cost of investment for the entire SNS.

CUBA'S HEALTH COMPUTERIZATION STRATEGY

Cuba is engaged in a process of refining its economic model in all sectors. The role of computerization as a driving force for social development is recognized within the process (13). In this context, MINSAP's National Information Technology and Communications Department is working to update its legal basis and the ITC development and use plan until 2030. For the 2017–2021 stage (14), this involves health information subsystems and their registries; telemedicine; specialized and patient care networks; and the business, logistics, and security system. This all links together through the smooth operation of three essential components: infrastructure (including connectivity), software, and human resources. This update has taken into account computer security and professional ethics by means of usage rules and regulations for access and transmission, which must be fulfilled to ensure confidentiality, integrity and availability of information (15). The lines of work outlined by the National Information Technology and Communications Department incorporate eHealth components under the principles set forth in the national strategy.

Electronic medical registry

Electronic medical registries are part of the Computerized Health Registry in the Health Information System (SISalud) and are located in the INFOMED Health Telematics Network cloud. In addition to showing required health indicators, these registries contain each patient's unique digital medical record (DMR),

FIGURE 1. Health computerization milestones in Cuba

INFOMED wins WSIS/ITU prize / Computerization strategy updated	2017
Galen Clínicas wins WSIS/ITU prize	2016
Cuba Node joins the Virtual Public Health Campus	2005
Computerization strategy updated	2003
INFOMED receives Stockholm Challenge Award	2002
1999	First Telemedicine Program in Cuba
1997	*Patris* system, the first Cuban PACS, developed
1997	First SNS computerization strategy in Cuba
1994	National Health Surveillance Network established
1992	Health Telematics Network (INFOMED) established
1987	Public Health Informatics Development Center (CEDISAP) established
1984	MINSAP Department of Automated Health Management Systems established
1976	Center for Cybernetics Applied to Medicine (CECAM) established
1976	Health Development Institute established
1970s	Telemedicine initiated in Cuba
1970s	First health computing center

Source: Created by the authors.
Notes: MINSAP: Ministry of Public Health; SNS: National Health System; PACS: Picture Archiving and Communications System; WSIS: World Summit on the Information Society; ITU: International Telecommunications Union.

identified by their citizen identification number. There are different levels of access to review both types of information, according to type of user (16–18).

Several applications have been designed in this component, the most successful of which is the Galen Clínicas program, developed by Empresa Cubana de Soluciones Informáticas, SOFTEL (http://www.softel.cu/), which in 2016 won a prize from the International Telecommunications Union in the eHealth category (http://www.softel.cu/portal/showNovedad/?id=4028908253aacf230153e7f-66fe70053). This application is the basis of the Hospital Information System comprising medical registries; diagnostic media management; consultations and hospitalization; and issuing results reports. It also ensures referral and counter-referral sharing between levels of care, as well as generation of required statistics.

The system has been improving and is implemented in modules by level of care and the complexity of each facility targeted for computerization. According to the timeline for its introduction, it is now being used in 11 (91.7%) research institutes,

53 (35.3%) hospitals, 100% of local blood banks, and is being tested in 3 international health care clinics and 2 polyclinics (primary care facilities) (18, 19). The system is still not operating sufficiently within the country, although Cuban medical brigades are using it with satisfactory results as part of international cooperation in facilities in Angola, Brazil, Ecuador, South Africa and Venezuela.

Telemedicine and mHealth

As a technological necessity for health services, Telemedicine and mHealth pose challenges to the SNS (20). Telemedicine was first tried in Cuba in the 1970s, when systems for remote consultation were explored. In 1998–2001, the Telemedicine Program was implemented nationwide (21, 22). The reference center for telediagnosis is the Hermanos Ameijeiras Clinical-Surgical Hospital in Havana, the capital, which covers all medical specialties.

Clinicians from secondary and tertiary facilities conferred about diagnoses and second opinions (22), but telemedicine consultations are still not a generalized

practice, and the system has been limited to transmission and sharing of images between institutions. However, this use has enabled optimizing the use of technological resources, lowering costs and expanding services. Several financial factors impeded its expansion to rural areas where it was expected to have a substantial socioeconomic impact.

Development of several Cuban systems—Patris, Imagis and Cassandra—enabled automated image transmission and the flow of radiology, cardiology and CAT scan information, respectively, as well the necessary sharing for cross-consultation (23–25). The Cassandra system continues to be used in Cuban institutions and also in some foreign facilities as part of international cooperation in the above-mentioned countries (25). Another telemedicine success story, recognized by PAHO for being innovative, is the neurosciences project, aimed at early detection of hearing loss in children, which has had a major social impact (26).

Experiences in mHealth are much more limited, although its importance has been recognized as an alternative that expands

communication opportunities among professionals and with the entire population, and that is consistent with the international trend to offer increasingly personalized health services (27). Entry into this field has taken two directions: support for teaching—recognizing the usefulness of mobile devices for managing personal knowledge environments—and disseminating health information. Particularly important in the latter regard are text messaging services to address tuberculosis, and health promotion by the Support Line for Persons Living with HIV/AIDS, both of which offer voluntary, no-cost subscriptions (28, 29).

Likewise, investigating and identifying areas of application is being promoted through projects coordinated between the National School of Public Health (ENSAP) and the National STI/HIV/AIDS Prevention Center, and projects related to monitoring chronic patients to the extent that procurement of technology allows.

eLearning experiences

Health computerization strategies have involved all types of human resources training. These have included experiences with continuing education models, developed by Virtual Health University (UVS) academic departments in the country's provinces, by ENSAP, and by the Cuba Node of the Virtual Public Health Campus (https://cuba.campusvirtualsp.org) (30, 31).

The UVS grew out of models and platforms designed by several medical sciences universities. In 2000, these were integrated in a portal with a virtual classroom supported by the Moodle platform, the virtual clinic, and the teaching and research repository. This portal contains numerous courses and links the network of virtual classrooms in universities and SNS teaching and clinical services offering resources for self-learning and training, among other teaching modalities (30). Use of eLearning has benefitted approximately more than 5 000 health professionals, but the challenge remains to expand its use to undergraduate education and thereby increase access to online education and to innovative forms of teaching (31–33).

Cuba joined the Virtual Public Health Campus in 2005. The Cuba Node consists of a network of institutions and individuals that create, share and collaborate on educational processes to attain best practices in public health. Through this regional network, online courses, open educational resources linked to the repository, contributions to the virtual clinic space, diagnostic discussions, consultations with experts, aspects of clinical pathology and case studies have been shared. Specialized networks and scientific-teaching-clinical work promoting lifelong learning have also been supported (Table 1).

Continuing education in ICTs for health

Séror explains that the Cuban health system offers a model to show how a national health information portal can contribute to system integration, including research, education and service delivery, as well as international trade in medical products (34).

The university degree in health information systems is a broad program of study designed around a rigorous action research project. It is offered at all the country's medical sciences universities and also has several graduate-level programs. From 2003 to 2016, 4 759 professionals graduated and are working on information and technologies for medical registry services, health statistics, medical library science, and scientific and technical information, health information technology, and information technology security (35).

The Health Telematics Network (www.sld.cu) is the Cuban health portal, known in Cuba and around the world as INFOMED. It was founded in late 1992 as a project of the National Medical Sciences Information Center to mitigate restrictions on acquiring and disseminating scientific and technical information imposed by the difficult economic situation affecting the country since 1989 (36). As a center for graduate study in medicine and ICTs in particular, its role in continuing education is undeniable, and it has become a bastion of medical education through its eLearning platforms and value added services.

INFOMED constitutes the communications infrastructure upholding computerization of the SNS and supports development of numerous content and services in the entire health network. It currently connects 1 327 institutions in all provinces, provides professional services and forms the SNS cloud, with 16 provincial nodes and over 300 000 users through a national node with international scope (36). INFOMED is recognized as an innovative and socializing

TABLE 1. Academic contributions to the Virtual Public Health Campus by Cuba Node

Academic Modality	Topics and Resources	Year Offered	Number of Graduates[a]
		2007	12
	Health promotion	2008	24
		2010	28
Certificate Courses	Health promotion in the context of primary health care	2012	17
		2015	23
	Pharmacoepidemiology	2013	14
		2015	24
Courses	Pharmacosurveillance	2014	32
		2015	28
	Immunoenzyme techniques	2011	17
		2012	19
	Prevention of meningococcal disease	2011	21
		2012	12
	Essential elements for work in primary health care	2014	31
	Information literacy	2015	10
	Self-taught course on open educational resources	2017	Self-taught
Open Educational Resources	General educational resources	2005–2017	372
	Recorded nursing teleconferences	2010–2017	68 recordings

Source: Created by the authors.
[a] Some graduates are from countries that have benefitted from these educational interventions: Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Peru, Spain, Uruguay, Venezuela.

project at the service of Cuban public health, for which it was awarded the 2017 World Summit on the Information Society eHealth prize by the United Nations' International Telecommunication Union (37).

In the universalization of health knowledge, the Virtual Health Convention Center (CENCOMED, www.cencomed.sld.cu) also stands out for its role in facilitating the promotion and organization of online scientific events, with access for professionals from around the world who are interested in participating.

One of the most important services offered by the network is the Virtual Health Library (BVS, http://bvscuba.sld.cu), which ensures a space for integrating the main sources of information. This service, which is part of the Scientific and Technical Information System, provides access to Cuban and foreign databases, a collection of books by Cuban authors, links to 53 journals from the Medical Sciences Press and 31 health topic sites; and to the repository of doctoral dissertations, bulletins and other resources that of major importance for information and knowledge management. Cuba's Scientific and Technical Information System is recognized by the most important international scientific journals dedicated to the Internet and

health for the collaborative and participatory criteria sustaining it rather than for its technological infrastructure (36).

Cuba heads a group of networks in the Americas including the Computerized Nursing Network, the Child Health Nursing Network, and the Gender and Health Collective Network, which use ICTs as a communication and continuing education alternative, disseminate information, and coordinate trainings and projects among several countries (29).

Standardization and interoperability

The exchange of information among all health system components requires implementation of standards guaranteeing interoperability. The Architecture Group for Developing Computerized Solutions in Health takes care of these aspects. Recommended international standards were adopted for representing clinical data, diagnoses and procedures, technology support and communications, as well as for identification, content, structure and languages for designing a computerized patient registry that includes dental records (38).

The legal basis and definition of regulations and other specifications allowing compatibility among technologies and

programs in the Cuban health system are being updated in order to guarantee interoperability and secure, cohesive, harmonious operation.

FINAL CONSIDERATIONS

Advances, shortcomings and challenges

Development of eHealth in Cuba has gone through different stages influenced by the country's economic conditions. Despite limitations, computerization of the sector has remained a priority for the SNS. In line with national policies, in the current stage, MINSAP is in the process of updating and revitalizing its national computerization strategy.

Cuban eHealth projects are advanced models of solidarity, in which information and knowledge are shared through the collaborative work of thematic networks and health services. Educational and information resources in the UVS and BVS, distance education, opportunities for organizing virtual scientific events, among others, have contributed to human resources training. Nevertheless, persistent economic and financial shortcomings constrain technological development needed by the sector, and there are limitations in the legal and

TABLE 2. Lessons learned during introduction of eHealth in Cuba

Component	Difficulties	Solutions
Electronic medical registry	• Restrictions on procurement of equipment due to financial problems. • Difficulty in design and installation of the electronic registry system for health care. • Insufficient legal basis in electronic registry coverage.	• The government prioritized computerization of the sector by budgetary allocation and obtaining other sources of funding. • Third parties were contracted to develop the DMR, as part of the hospital computerization system. • The DMR concept was expanded as a unique health record for each individual, regardless of level of care. • Proposed registries were validated and the Galen Clínicas program was progressively scaled up in health care facilities.
Telemedicine	• Insufficient technological development. • Telemedicine not used for second opinion consultations.	• Technological and connectivity standards required for this process were applied. • The national repository of medical images and the telemedicine service were set up in the cloud. • Technological solutions and in-service training strategies were developed and integrated into the cross-consultation and second opinion system.
mHealth	• Insufficient use of mobile devices for health and poor development of applications.	• Conceptual research and identification of possible spheres of action at the national level were encouraged to the extent acquisition of technology allowed. • Computerized health-related solutions for mobile devices were implemented.
eLearning	• Growing needs to use virtual environments for the teaching-learning process.	• The Virtual Health University project was carried out to support the universalized teaching model that promotes workplace-based lifelong education for health professionals, as well as human resources training using a distance education model.
Continuing education in ICTs	• Insufficient knowledge of the potential of ICTs in continuing education. • Difficulties obtaining print materials.	• A class on information technology was added to the curriculum of health majors, which covers, among other things, ICTs. • An information literacy project was implemented, which reaches the entire country through the INFOMED Health Telematics Network. • A strategy to digitalize scientific journals was adopted. • All Cuban medical journals switched to digital editions. • The Virtual Health Library and the Virtual Health Convention Center were created.
Standardization and interoperability	• Lack of up-to-date standards.	• Standards were defined. • All implemented projects are standardized and interoperable.

Source: Created by the Authors.

regulatory framework, and in setting standards facilitating information exchange. These factors restrict cross-consultations and second opinion consultations, medical registries, and, in particular, nationwide expansion of unique DMRs for all citizens.

Many difficulties have had to be overcome to reach the level of development achieved. Through lessons learned, solutions were found that have made a positive impact on public health (Table 2). The scope of these actions is not limited to the national context: they have also made a positive impact on obtaining important health outcomes in other countries with which Cuba collaborates and thereby on attaining universal health coverage and health care.

However, despite this effort, results in telemedicine, mHealth and DMRs are still insufficient, and more experience is needed in direct services to patients. These are challenges to be addressed by implementation of the comprehensive health computerization strategy for the period 2017–2021, designed for continuous improvement of health services and for advancing toward a more just, informed and equitable society.

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RESUMEN

Aplicación de la eSalud en el contexto cubano

Se exponen los logros y los desafíos que provienen de la aplicación de la eSalud en el contexto cubano para apoyar la salud universal. El Ministerio de Salud Pública definió la Estrategia de Informatización, cuyas líneas de trabajo se sustentan en los componentes declarados en la Estrategia y Plan de Acción sobre eSalud de la Organización Panamericana de la Salud, y en la Política para la Informatización de la Sociedad, aprobada por el Gobierno cubano. Se especifican las acciones de la estrategia cubana elaboradas para solventar las limitaciones en la infraestructura tecnológica, desarrollar las plataformas, las herramientas y las aplicaciones que requieran los servicios de salud, y estimular en los profesionales las habilidades para emplear- las. Los resultados de la eSalud en Cuba son producto de la aplicación y la evaluación de la estrategia aplicada en el marco del perfeccionamiento del sector de la salud, mediante proyectos como el registro médico electrónico denominado Galen Clínicas, la preparación del capital humano y los recursos de información y educación a distancia de la Red Telemática de Salud Infomed. Estos son modelos de solidaridad y trabajo colaborativo en redes, que han contribuido a la salud universal e impactado positivamente en el sistema de salud, más allá de las fronteras. Los desafíos de la eSalud consisten en el desarrollo de iniciativas en salud móvil, en lo que existe poca experiencia; la telemedicina, cuyo proyecto quedó detenido; la integración e interoperabilidad de las aplicaciones; la sostenibilidad de las soluciones implementadas; la insuficiente infraestructura tecnológica; y el fortalecimiento del marco legal.

Palabras clave

Registros electrónicos de salud; telemedicina; cobertura universal; proyectos de tecnologías de información y comunicación; Cuba.

RESUMO

Aplicação da eSaúde no contexto cubano

As descobertas e desafios decorrentes da aplicação da eSaúde no contexto cubano para apoiar a saúde universal são expostos. O Ministério da Saúde Pública definiu a Estratégia de informatização, cujas linhas de trabalho são baseadas nos componentes declarados na Estratégia e Plano de Ação da eSaúde da Organização Pan-Americana da Saúde e na Política de Informatização da Sociedade aprovada pelo governo cubano. O artigo especifica as ações da estratégia cubana para resolver as limitações da infraestrutura tecnológica, desenvolver plataformas, ferramentas e aplicações que exigem serviços de saúde, e estimular nos profissionais as habilidades para usá-los. Os resultados da eSaúde em Cuba são o produto da aplicação e avaliação da estratégia aplicada no âmbito da melhoria do setor da saúde, através de projetos como o registro médico eletrônico chamado Galen Clínicas, a preparação do capital humano e os recursos de informação e educação a distância da Rede Telemática de Saúde Infomed. Estes modelos de solidariedade e trabalho colaborativo em redes contribuíram para a saúde universal e impactaram positivamente no sistema de saúde, além das fronteiras. Os desafios da eSaúde consistem no desenvolvimento de iniciativas em saúde móvel, em que há pouca experiência; telemedicina, cujo projeto foi interrompido; a integração e interoperabilidade das aplicações; a sustentabilidade das soluções implementadas; a infraestrutura tecnológica insuficiente; e o fortalecimento do quadro legal.

Palavras-chave

Registros eletrônicos de saúde; telemedicina; cobertura universal; projetos de tecnologias de informação e comunicação; Cuba.