The development of telehealth in the information age: a general approach.

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Abstract

The technologies of information and communication are essential tools to generate sutentáveis impacts and provide safety and quality in the provision of health services. The article describes the evolution of Information and Communication Technologies in the world and cites successful experiences of developed countries in the field of medical informatics.

Keywords: *Telemedicine; Health Information; Medical Informatics.*

Resumen

El desarrollo de la telesalud en la era de la información: un enfoque general
Las tecnologías de la información y la comunicación son herramientas esenciales para generar impactos sutentáveis y proporcionar seguridad y la calidad en la prestación de los servicios de salud. El artículo describe la evolución de la información y de las comunicaciones en el mundo, y cita experiencias exitosas de países desenvueltos en el campo de la informática médica.

Palabras clave: *Telemedicina; Información en Salud, Informática Médica.*

Resumo

O desenvolvimento da telessaúde na era da informação; um enfoque geral
As tecnologías de informação e comunicação são ferramentas essenciais para gerar impactos sutentáveis e prover segurança e qualidade na prestação de serviços de saúde. O artigo descreve a evolução das Tecnologias de Informação e Comunicação no mundo e cita experiências exitosas de países desenvolvidos no campo da informática médica.

Palavras-chave: *Telemedicina; Informação em Saúde, Informática Médica.*

INTRODUCTION

Different analyzes reflect a world with economic, institutional courses and complex inconstant government, in renewal of forms of production and economic order, a global system transiting the focus on financial gains to focus on answering the demands and real and unsatisfied needs of people and society[1]. The experience of humanity in the twenty-first century is mediated between the invisible, immediate and borderless logic of the information and communication technologies (ICT), providing simultaneous multiple information sources: television, radio, printd media and Internet. The social networks are common spaces on the Internet[2], Facebook (1,650 million of active users- julio de 2015)[3], twitter (7,190 tweets per second- abril de 2016), Instagram (719 photos uploaded per second – abril de 2016), YouTube (121,591 videos consulted in a second – abril de 2016); in June 2014[4] iTunes App Store announced 1,200,000 of applications tying Google Play.

The technological and scientific progress reflect itself gradually in the new forms used to diagnose, treat and provide health services. Engineering, biology, genetics, proteomics, informatics, imaging, robotics, digital manufacturing, 3D printing, virtual reality, sensors, new materials, exponential and integrating technologies such as nanotechnology are redefining our understanding of the human body and the disease ceasing to be the health and clinical domains of conventional knowledge[5].

The telehealth can not currently be thought without considering the growth of the hyper-connected society. Factor generated by the network effect producing new models of scalable collaboration to produce and share content. The social networks position on the radar with the person connecting him with co-creation processes focused on the problems of the society[6] . The challenge lies in the re-structuring of authorities and institutions to link their everyday work framework with collective intelligence for the creation of public goods.

On the other hand, the overload generated by the large accumulation of simple and complex data bring the challenge of informational stress that often goes unnoticed. From the scarcity of information it passes to the shortage of time to process and analyze large volumes requiring increase the capacity to produce, distribute, regulate, process, transform, access and consume reliable sources, without distortions. Gradually to overcome the initial reluctance to share knowledge, the use of information is increased by the public in general and the public policies reinforce initiatives for patients, health professionals and citizens oblige themselves to make healthy decisions and keep informed on relevant issues of the health care.

In human and organizational dimension, the sustainable assimilation of the technological progress and particularly the increase of the quality related to the telehealth has been slow, unclear, so that ICTs are still used in a limited way and poorly integrated in the global health systems[7,8].

The integration of telehealth in the health systems in emerging and developing countries can help meet their challenges and needs of improvement in order to achieve these ends its scope must establish: relevant and lasting results; a transforming institutional conversion of the existing practices; open innovation that fosters the collaboration and participation focused on the value reducing the organizational boundaries; an ecosystem where the capacities of reflection and learning flow in a freely and interactively way.

The implementation of telehealth requires to use active mechanisms of patients' participations, the health professionals, the individuals, civil society, companies, academia, authorities, politicians and public servants for: i) design, explore and implement new ideas about the management processes of the effectiveness, efficiency and quality of the health systems; ii) develop skills, train and enable the critical mass of local experts; iii) build resilient, sustainable and inclusive societies[9].

In this context, this article aims to describe the historical process of incorporation of information and communication technologies in healthcare, the end of the century to the present day. It intended to also place the telemedicine in this historical context.

METHOD

The following steps were followed. A detailed review of literature on the ICT incorporation process in health was held. Sought to recover items that would focus the historical proceso ICT development, the end of the last century to the present days. Next, a periodization was carried out, covering various items. Initially, a contextualization of the el paper of these information and communication technologies organizational efficiency was held. Next, the focus was on health, emphasizing as it did the ICT incorporation process in health over time. He was described in detail the origin and characteristics of hospital information systems, addressing its potential and its limits, as well as the principal existing experiences in the world. Finally, inserted into the subject of telemedicine in this context, stressing its main benefits and the current context of its structure. This proceso was concluded with a reflection on the current state of ICT incorporation process in the world.

RESULTS

The role of information and communication technologies in the organizational efficiency.

Currently, the ICTs play a key role in economic and social areas: they facilitate the maintenance of large volumes of information, enable data processing, support decision making and enable network collaboration among others. The impacts of the development of the ICTs are not outside the areas of health although their development has been slow, which is pertinent to deliver some relevant historical data.

In the United States, in 1880, Herman Hollerith, son of immigrants, develops the first tabulating machine based on punch cards capable of analyzing large volumes of data, as an effective response to reduce the time spent on the population census in 1890. A 10-year work was reduced to three months.

In 1896 Hollerith founded the Tabulating Machine Company, primarily oriented to providing services to the agencies responsible for censuses and insurance companies. In 1911 it merged with four other companies and in 1924 becomes International Business Machines Corporation (IBM). The technology of punch card evolved, being widely

used between 1920 and 1930 for accounting and administrative matters, remaining in the data processing market until 1970.

On the other hand, in the nineteenth century England faces serious public health challenges by the Cholera epidemic. In 1864, Dr. John Snow establishes the basis of the methodology of modern epidemiology research and manually employs a graphical system of geographical information for the spatial analysis. Florence Nightingale is the first woman in the implementation and statistical analysis for public health problems.

The first statistical entities were born in the early nineteenth century. In 1900 it was introduced the classification of diseases that consists of 179 groups , their reduced version for adoption consisted of 35 groups[10]. The classification is adopted by England since 1911 and in 1959 the national office of statistics begins the computerized record for mortality using this classification [11].

In 1945, in response to the challenges of automated calculation required for the services of artillery in the Second World War II, the United States Navy financed the development of the ENIAC, Electronic Numerical Integrator and Computer. It is the first electronic computer of general purpose, weighing 30 tons, comprising 18,000 bulbs with a capacity of 360 multiplications per second. In 1953, it is released the ERA 1103A (Engineering Research Associates) being its version 1103A the first commercial computer to use RAM memory. From 1961, the United States strongly supports the development of medical informatics providing support for research through the National Institutes of Health and with impact at the federal level around 1970.

In 1949, the New Zealander William Phillips, a student at the London School of Economics builds the MONIAC hydraulic computer (Monetary National Income Analogue Computer) to model the national economic processes of England. Such computer consisted of containers of transparent water that represented some aspect of the economy as the spending on education and health, or the different taxes a piping circuit where the water circulated with dye that fed back the treasure tank and that increased or decreased the speeds of pumping. The MONIAC was designed for the teaching, but it was noted that it might be a very effective simulator. [12]

The information and communication technologies in health, The early hospital information systems.

In 1950, Dr. Robert Ledley pioneered the use of computers for medical purposes, conducting researches of dental projects at the National Bureau of Standards in the United States. In 1956, IBM launched the IBM 704 computer being one of the first computers used in biomedical research[13]. In 1960, the academic institutions despite the high cost of computers start developing computer systems to simplify their daily operations.

In 1962 it was born the term "Informatics" in Europe – a composition of two words, information and automatic – that covers the techniques, concepts and applications of the computers[14].

The first medical applications of computers in Europe were for the clinical laboratory and the hospital administrative tasks emerging from 1965. In the United States the first applications in health care services were the hospital information systems (HIS, for its acronym in English).

In the early 1960 starts the MEDINET project developed by General Electric in the Massachusetts General Hospital in Boston that it was never put into operation. In parallel there were similar jobs at the LDS Hospital, in Kaiser Permanente and the Stanford University. During the seventies, the systems were centralized using large computers (mainframes) that evolved the modular systems, to ultimately result in computer networks distributed in the 1980s.

In the early sixties, the emergence of minicomputers allowed the organizational units or hospital individual departments acquired their computers and develop their own applications. In the late 1970s and early eighties were accessible the micro-computers, so that a greater number of organizations could acquire and develop applications, while individuals joined the software industry. In 1970 Texas Instruments launches the first commercial on the use of computers for doctors.

The first articles on the use of computers in medicine appear in medical journals around the 1960s. In 1965, Dr. Robert Ledley publishes the book "Use of Computers in Biology and Medicine" and in 1969 Ledley in conjunction with Lusted publish "Reasoning Foundations of Medical Diagnosis" one of the first articles that marks the beginning of medical informatics.

In 1970, William Schwartz suggests the impacts and challenges of the use of computers in medical practice. In this same decade begins the search for programming languages and specialized vocabularies for health and bio-

medical applications. In Massachusetts General Hospital emerges the MUMPS programming language (MGH Utility Multi-Programming System).

The experiences of ICT use in the clinical laboratory are given mainly in the United States and Germany. In 1952 the first experiences reported the use of punch cards for recording data in the clinical laboratory, in 1968 the link with a hospital information system, in 1974 the report of laboratory results by telephone once it provided the patient identification. In 1969 it is identified in Vienna the link of the analyzers to generate the report of results that integrated the doctor's note and it was used in the medical practice of an internist. The systems described previously employed IBM and Siemens computers.

In this period a very limited number of hospitals had hospital information systems, affecting the development of systems of clinical laboratory which had to include functions to support the management of the patients and in some cases cover the limited record of diagnostics and clinical data. In the late sixties the clinical laboratories had various analytical capabilities, in addition to using computers to produce the reports of results of their patients, even if there were great obstacles to interface with the clinical analyzers. And as processing capabilities of the analyzers increased the intercommunication became more complex.

In 1913, Dr. Eugene Codman suggests the question: What happens to the cases treated? Which methods to formulate in order to the reports among hospitals allow greater possible comparison. Perform this task from the past has required to process the hospital data set, so that the developments in information systems have been critical since 1970 to the date, in order to contribute to the measurement of impact on health and the hospital costs. The hospital information systems, the systems of electronic medical record together with the methods by the Diagnosis Related Groups may allow to increase the transparency of the effectiveness provided by the hospital services and encourage the efficient use of resources according to the quality standards[15].

Main experiences of electronic medical record

The first clinical records date back to the V century A.D., were developed by Hippocrates, who described two main utilities: i) the medical record should reflect accurately the course of the disease; and ii) indicate the probable cause of it. These objectives remain valid and continue to be appropriate. Furthermore, the clinical electronic systems allow to provide alerts and interactive graphics, requests of customized studies, which can not easily be done in paper-based systems.

The systems of support to clinical decisions in 1961 focus on the diagnosis of hematologic disorders; in 1965 to computerized respiratory monitoring; in 1976 the management of severe surgical patients.

The record of the use of computers in the intensive care unit for the purpose of automated collecting of vital signs from medical devices dating from 1966, Shuben and Weil employ an IBM 1710 to gather blood pressure, venous, heart rate, temperature and urine output.

Some relevant projects of electronic medical record in university hospitals are detailed:

• POMR (Problem Oriented Medical Record): it was developed by the University of Vermont

• COSTAR (Computer Stored Ambulatory Record): it was developed at Harvard and became publicly available in 1975 to be soon implemented in hundreds of sites around the world. It was used the MUMPS language (Massachusetts General Hospital Utility Multi-Programming System) for specific health use, subsequently it will be adopted by the Department of Veterans Affairs.

• HELP (Health Evaluation through Logical Processing): it was developed by the University of Utah and introduced to the market by 3M Corporation. It can be considered a precursor of the support system to the decisions.

•TMR (The Medical Record): it was developed at Duke University.

•THERESA: it was developed by Grady Memorial Hospital and Emory University, led to that registration was done by doctors.

• CHCS (Composite Health Care System): it was developed by the United States Department of Defense (DoD). It is a system of CPR type and has been widely used in the world.

•DHCP (Decentralized Hospital Computer Program): it was developed by the Veterans Administration. In 1997, it began the architecture of VistA system.

• RMRS (Regenstrief Medical Record System): it was developed by the University of Indiana, being one of the first systems to integrate the inpatient and outpatient services.

• TDS (Technicon Medical Information Management System): it considers the request and order management, early history of CPOE .

These projects presented various technical and programming problems that still persist, including the use of

vocabularies and non-standard interfaces. However, they are precursors of ideas and technologies that still apply up to the present day, such as MUMPS programming language.

Origin of telemedicine

There are several experiences that demonstrate the benefits of using telecommunications in health or disasters since the nineteenth century. In 1926 we can place one of the first medical devices that are related to home care and the use of telecommunications. This is Radio Disease Killer that resulted from the copy of the Electronic Reaction of Abrams (ERA).

In 1925, a doctor from Maynard Columbus hospital sent a radiogram asking antitoxin to combat diphtheria epidemic that was attacking children in the community and that posed a public health risk. The telegram was also forwarded to other parts of Alaska seeking to trace other places where made available the antitoxin, for which 20 sleds that employed 150 dogs were coordinated. This experience reveals a successful coordination where the modern technology mix with old media.

From the year 1935 in Italy, it was done remote medical assistance to crew ships at sea by means of the International Radio Medical Centre (CIRM). The CIRM provides by radio free medical assistance to ships and other vessels.

In 1959, the Medical Center of the University of Nebraska begins the use of closed circuit of two-way television (CCTV) to the teaching and treatment in psychiatry. The television was used to unite the medical center with hospitals in rural areas and support education programs. NASA has played an important role in the development of telemedicine, the astronauts have sent physiological reports between the space and the earth[16] . Another important factor in the development of telemedicine has been the army, particularly the United States Department of Defense which resulted in a concentration of projects in the United States.

In the mid-sixties, it was established the closed circuit of television (CCTV) service between the radiology department and the emergency area of the General Hospital of Washington. In 1970, it was established an interactive television system using microwave which facilitated the transmission of Logan Airport in Boston at Massachusetts General Hospital to provide medical support to travelers. From that date the use of color displays for the treatment of skin infections in spaceflights, the teledermatology is proposed; and the Miami Medical School starts the health services with prisoners.

In 1980, with the introduction of computers, it moves from applications based on the use of television in real time to the storage and shipping modality. This mode is to collect data and information in digital format, store it and then pass it on to a receptor site. Thus it is eliminated the need to require the patient to the doctors and the support staff in a simultaneous manner, which is known as store and forward.

Currently governments globally face the challenge of radical reconfiguration of the health sector resulting from cost increases in health and socio-demographic changes. In the information age, the informational technological revolution to be transversal to all human activity increases the demand for a health sector network where professionals, patients, citizens, communities and organizations are interconnected, building flexible networks of collaboration and interaction to produce welfare and health, transforming their personal, community, organizational, local and global contexts in accordance with their values and interests[17].

The Regional Experiences

The first World Congress of Medical Informatics MEDINFO was held in Stockholm in 1974. The UNESCO supported the first trainings in 1968. The European Federation of Medical Informatics (EFMI) met in 1976 with the World Health Organization (WHO) for the development of Medical Informatics in the European context. MEDINFO 89 took place simultaneously in Beijing and Singapore.

In 1986, the European Economic Community (EEC) begins the multinational projects considering the strengths and weaknesses of the EEC. Remaining currently numerous from the challenges considered in these initiatives.

On February 8, 1982, it took place in Mexico the first World Congress of Informatics in Health in developing countries. The meeting of experts recognized the importance of medical informatics for the decision-making related to resource allocation. At the same time it was highlighted the dilemma: allocate scarce resources to computing existing millions of people without access to the basic primary care services. The conclusion is that the scarce resources will be poorly invested before knowning the allocation errors if it is not available basic computer systems to identify problems, needs, monitor the development of health programs and more. For these reasons, health informatics should be considered a priority in developing countries.

The two main reasons for the developing countries to become involved in health informatics: i) after the initial in-

vestment in equipment and personnel training, it is necessary to keep the sustained investment in human resources; ii) critical opportunity to react quickly and not rely on the importation of systems likely to be inappropriate to the needs.

In 1982, the areas of opportunity identified public policy development, the need for infrastructure management and training of different degrees in computer science.

The outlook in the XXI century, the transformation of health systems is inevitable because the advances in science make health management moves in the spectrum of the DNA structure at the level of the national health system.

In recent times the technological progress along with the access has increased the capacity of health professionals in the region to adopt telehealth in ordinary activity. Particularly highlights the telehealth program in Brazil focused on primary care. Through this program a common strategy with the ministries of health, science and technology, education, communications and defense. This strategy resulted in a permanent national commission of telehealth, the integration of the medicine university network for the development of the new generation of technologies and telehealth applications and the establishment of the Laboratory of Excellence and Innovation in e-Health between Latin America and Europe.

The first generation of telemedicine programs based on image faced the challenges of requiring wide bandwidths and do not count on advanced developments in data compression, while the technologies and Internet services were in early stages. In 2013, the Center for Asian Telemedicine returns the Exchange project of knowledge focused on endoscopy where currently participate specialized centers of Japan, Korea, Mexico, Brazil, Chile and Colombia among others.

CONCLUSION

From the publication of "To make a mistake is Human" in 1999, globally it is recognized the need to support health care services to reduce medical errors using timely information, today the pressures in the health sector converge to the empowerment that the information technologies offers the public policy makers, decision makers, doctors, nurses, paramedics, patients and citizens. The information and communication technologies are recognized as essential tools to generate substantive impacts on the safety and quality of health services.

The decades of experience of developed countries in the field of health informatics like England, the United

States and Australia among others put in the center of the economy the services based on the telemedicine, the electronic medical record, the information networks, the intelligent dress and the continuous monitoring of the patient among others, these services soon will be a reality without adequate knowledge of the technical, social and organizational challenges that face one another, a response to training for digitization and the transformation of health systems that include the scalability and sustainability of initiatives that really contribute to the quality, efficiency and equity of health impacts, development of health agendas that include the use of information technologies and communications, adapt the legal and regulatory frameworks, definition, adoption and use of interoperability standards, personnel training and workforce at all levels including patients and citizens and regional, national and local integration of services among others.

In our time, it is imperative to make conscious and creative efforts that facilitate the actors that are part and interact with the health systems to guide the development and adoption of solutions based on information technologies and communications to health problems, solutions, understand what the reasons that guide decision-making on projects involving these technologies are. The 2012 report of the agenda of development post-2015 of United Nations concludes, no matter the indicators used, the availability of quality data is a need to improve the measurement and the monitoring of the progress of nations, have good information systems is critical..

On the other hand, the social innovation is a promising approach to solve the many challenges that governments and society face by providing root solutions reducing remedial actions focused on the symptoms. Its adoption requires: clarity of purpose of citizen's participation, exchange management, systematic measurement of its contribution, establish an ecosystem that reduces the isolation of efforts, tools and technological platforms, regulatory frameworks that integrate and legitimize the citizen's participation in the health sector. Telemedicine projects in the region has shown that it is possible to generate public goods based on knowledge.

REFERENCES

1. Bureau of European Policy Advisers. Social innovation: a decade of changes – BEPA report. Luxembourg: Publications Office; 2014.

2. Internet Live Stats. Internet Usage & Social Media Statistics. [Cited 2016 Apr 15]. Available from: http://www.internetlivestats.com/

3. Wikipedia La enciclopedia libre. Facebook. [Cited 2016 Apr 15]. Available from: https://es.wikipedia.org/wiki/Facebook

4. WWDC. iTunes App Store Now Has 1.2 Million Apps, Has Seen 75 Billion Downloads To Date. TechCrunch. 2014. [Cited 2016 Apr 15]. Available from: http://techcrunch.com/2014/06/02/itunes-app-store-now-has-1-2-million-apps-has-seen-75-billion-downloads-to-date/.

5. Wathen N, Wyatt S, Harris R, Webster A, Wyatt S. Mediating health information. Basingstoke: Palgrave Macmillan; 2008.

6. May CR. Making sense of technology adoption in healthcare: meso-level considerations. BMC Medicine. 2015[cited 2016 Apr 15]; 13(1): 92. Available from: https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-015-0305-8

7. Scott R, Mars M. Telehealth in the developing world: current status and future prospects. Smart Homecare Technology and TeleHealth. 2015[cited 2016 Apr 15]; 3(14): 25-37. Available from: https://www.dovepress.com/telehealth-in-the-developing-world-current-status-and-future-prospects-peer-reviewed-article-SHTT   DOI https://dx.doi.org/10.2147/SHTT.S75184

8. Wicks P, Stamford J, Grootenhuis MA, Haverman L, Ahmed S. Innovations in e-health. Qual Life Res. 2014[cited 2016 Apr 15]; 23(1): 195-203. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23852096 DOI: 10.1007/s11136-013-0458-x

9. Mulgan G. The process of social innovation. Innovations. 2006[cited 2016 Apr 15]; 1(2): 145-62. Available from: http://www.policyinnovations.org/ideas/policy_library/data/TheProcessofSocialInnovation/_res/id=sa_File1/INNOV0102_p145162_mulgan.pdf

10. World Health Organization. International Classification of Diseases. History of the development of the ICD. [Cited 2016 Apr 15]. Available from: http://www.who.int/classifications/icd/en/HistoryOfICD.pdf.

11. Welcome Library. Introduction to mortality statistics in England and Wales: 17th-20th century. [Cited 2016 Apr 15]. Available from: http://wellcomelibrary.org/collections/subject-guides/introduction-to-mortality-statistics-in-england-and-wales/#.

12. Elliott L. The computer model that once explained the British economy. The Guardian. 2008. [Cited 2016 Apr 15]. Available from: http://www.theguardian.com/business/2008/may/08/bankofenglandgovernor.economics.

13. Collen MF. The origins of informatics. J Am Med Inform Assoc. 1994[cited 2016 Apr 15]; 1(2): 91-107. Available from: http://www.ncbi.nlm.nih.gov/pubmed/7719803

14. France FR. About the beginnings of Medical Informatics in Europe. Acta Inf Med. 2014[cited 2016 Apr 15]; 22(1): 11-5. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3947935/ DOI: 10.5455/aim.2014.22.11-15

15. Busse R, editor. Diagnosis-Related Groups in Europe: moving towards transparency, efficiency and quality in hospitals. European Observatory on Health Systems and Policies Series. Maidenhead: Open Univ. Press; 2011.

16. Zildzic M, Salihefendic N, Krupic F, Beganovic E, Zunic L, Masic I. Telemedicine in Gastroenterohepatology. Acta Inform Med. 2014[cited 2016 Apr 20]; 22(4): 276. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25395732 DOI: doi: 10.5455/aim.2014.22.276-282

17. Conferencia Completa de Manuel Castells. Nodo Argentina. Campus Virtual de Salud Pública. [Cited 2016 Apr 15]. Disponível em: https://argentina.campusvirtualsp.org/conferencia-completa-de-manuel-castells.