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ABTms
Associação Brasileira de Telemedicina e Telessaúde

eHealth:

A Step towards the Universal Health Coverage in Developing Countries

Editors
Malina Jordanova, Leonid Androuchko, Isao Nakajima

EDUFMA
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Contents

Preface

Dear Reader,

The book "eHealth: A Step towards the Universal Health Coverage in Developing Countries" is now in your hands.

Its publication is realized with the kind support of the Brazilian Association of Telemedicine and Telehealth (ABTMS, http://www.abtms.org.br/) and the VIII Brazilian Congress of Telemedicine and Telehealth, which will be held on 14-17th November 2017, at Rio Grande do Sul State (http://congresso.abtms.org.br/2017).

The use of telecommunication technology in health care has grown exponentially during the last century. The wide application of all types of telecommunication tools, from telegraph, radio, telephone to the internet and data transfer protocols in the health sector, gave birth to eHealth.

The aim of the book is to focus on the extensive eHealth implementation in developing areas as a way to pave the road towards Universal Health Coverage as well as to underline the important role of the collaboration between healthcare system and telecommunications.

The book consists of Introductions, presenting the Brazilian Association of Telemedicine and Telehealth and its contribution to the universalization of health care access and two other parts. The first outlines briefly some general issues such as terminology, eHealth economics, standardization, etc., while the second offers a wide range of bottom-up and top-down approaches and solutions and presents successful stories of eHealth implementation, covering the main areas – prevention, treatment, rehabilitation and training. "What", "How" and "Where", are only part of the questions that authors are trying to answer.

The book provides a glimpse at some of the best practical achievements, existing solutions and experiences in countries from all continents and reveals different national and cultural points of view. The goal is to share these experiences with other institutions and policy makers as well as with all groups or individuals involved with healthcare. The results and guidelines presented apply to all – national and local administration, individual practitioners, group practices, healthcare systems, as well as to providers of health-related services, where there are eHealth interactions either directly to the patient or from provider to provider for the purposes of healthcare delivery.

The book offers useful information to those who are preparing to introduce or expand the eHealth. It allows them to rely on the experience of others and makes them aware of the benefits and problems encountered during and or after implementation of systems or services, and as such, helps to avoid mistakes and reduce potential problems.

Yet, it is necessary to underline that:

- Papers in each section of Part II are listed alphabetically;
- The original style of the authors was respected as much as possible;
- In order to shorten the repeated references the abbreviation “ibid” (Latin ibidem, i.e. "in the same place") is used;
- The book is partially based on the lessons learned within the work of ITU-D, Question 2/2: Information and Telecommunications/ICTs for eHealth (https://www.itu.int/net4/ITU-D/CDS/sg/questions.asp?lg=1&sp=2014) in which the editors were actively engaged;
- Despite the amount of information included in the book, no doubt that many events and facts are still out-of-sight. We hope to be able to fill these gaps in later editions.

We firmly believe that everyone involved in eHealth will find this book not only interesting, but most valuable as well.

Enjoy your reading!

The Editors

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Introduction

The Brazilian Association of Telemedicine and Telehealth Contributing to the Universalization of Health Care Access

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Brazil is a country of continental dimensions composed of five regions with their own peculiarities. For example, there is the northern region where most of the Amazonian forest is located; the northeast region where there are areas of drylands and bushlands; the center-west region characterized by the Pantanal; southeast region where most of the Brazilian population is located and the southern region where the pampas (prairie) are located.

Regarding the Internet, it currently has around 24.3 million fixed broadband access points, ranging from 2Mbps to 12 Mbps, with a very heterogeneous distribution (Figure 1).

The Unified Health System (SUS) unified health in Brazil since the country's Federal Constitution of 1988. From that moment, the public health system began to coexist with supplementary health, being composed, respectively, of approximately 78.8% of public health and 21.2% of supplementary health, according to data published by the Brazilian Institute of Geography and Statistics. Universality is one of the fundamental principles of the Unified Health System (SUS) and it determines that all Brazilian citizens, without any type of discrimination, have the right to access to health care services and actions.

In this context of geographic diversity, of access to health and to Internet, the mission of the Brazilian Association of Telemedicine and Telehealth [1]

(ABTMS) is to promote the exchange of knowledge and experiences in Brazil's public and private sectors along with international organizations, adopting actions such as the support of universal access to health.

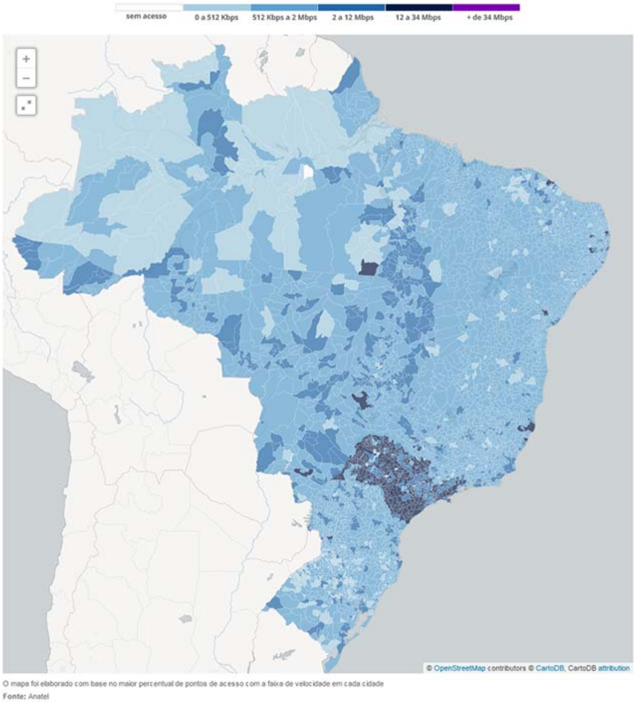

Fig. 1. Map of the distribution of Internet speed in Brazil
(source: Anatel Brasil)

ABTMS was founded in 2003 and since then it has been actively participating in the development of protocols and recommendations for good practices and contributing to the formulation of public policies and legislation for telehealth [2].

Brazil is one of the few countries that adopted a National Policy for Telemedicine and Telehealth. In five years, it has created a network that encompasses 24 out of Brazil's 27 States, promoting for health professionals:

- The offer of tele-education and tele-assistance;
- Distance specialization in Primary Care by the Open University of the Unified Health System (UnaSUS) [3-4];

- Distance specialization in Telehealth by the Post-Graduate Program in Telemedicine and Telehealth [5],
- As well implementing the University Network of Telehealth, an Internet network dedicated to give infrastructure support for teaching and research among Brazilian universities [6].

This exponential panorama of Telehealth in Brazilian public health is accompanied by the private sector, which incorporates the newest information and communication technologies, largely developed in partnership with public universities and consolidated by the private sector.

The Brazilian Association of Telemedicine and Telehealth has also been actively acting in order to develop joint actions with national and international institutions and bodies, promoting biannual congresses, with highlight to the 7th Brazilian Congress of Telemedicine and Telehealth. This one took place in 2015, in the city of Rio de Janeiro, in association with the 20th Telemedicine and Telehealth Conference, promoted by the International Society for Telemedicine and eHealth (Figure 2). In addition, this year there will be the 8th Brazilian Congress of Telemedicine and Telehealth in the city of Gramado, in the state of Rio Grande do Sul, when the launch of this work will happen.

Fig. 2. From left to right, Frank Lievens (ISfTeH), Andy Fisher (ISfTeH), Claudio Souza (ABTMS), Alexandra Monteiro (ABTMS), Ana Emilia Oliveira (ABTMS), Ana Estela Haddad (ABTMS), Yunkap Kwankam (ISfTeH) and Luiz Ary Messina (ABTMS)

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Part I: General Issues

Terminology: Do People Really Know What They Are Talking about

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To avoid misunderstanding, the starting point of the book is the clarification of terminology as authors and experts from various countries and continents, often use different terminology.

Health

Health is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". This definition of health is part of the Preamble to the Constitution of World Health Organization (WHO), as adopted by the International Health Conference in New York, 19 June - 22 July 1946. The WHO Constitution also claimed: "The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition".

Global Health

Today the world is moving closer together and globalization is shaping our world. Trade, technology and investment increasingly connect countries and people around the globe. People and products move, time and distance are no longer obstacles. Ideas do spread faster than ever before.

Nowadays we are talking about *Global Health*. One of the definitions, given by the USA Institute of Medicine in 1997, outlines global health as "health problems, issues, and concerns that transcend national boundaries, which may be influenced by circumstances or experiences in other countries, and which are best addressed by cooperative actions and solutions". Examples include infectious diseases (tuberculosis, avian influenza, malaria,) non-infectious diseases (diabetes mellitus, tobacco related diseases) and other health risks (global warming, conflict, nuclear power) etc. Global health refers to everyone, as disease knows no borders. That is why it is often underlined that the global health is the foundation for building a stable economy. To explain this, let us cite some numbers illustrating global health from the 2017, Deloitte, Global Health Care Outlook [1]:

- Global health care expenditures are projected to reach $8.7 trillion by 2020, from $7 trillion in 2015;
- Chronic and communicable diseases are an ongoing threat as health care spending as a percentage of Gross Domestic Product (GDP) will rise from ~10.4 % in 2015 to 10.5 % in 2020;
- Life expectancy is projected to increase by one year by 2020, which will increase the aging population (> 65 years old) by 8% in 2020;
- By 2020 50% of global health care expenditures will be spent on 3 leading causes of death: cardiovascular diseases, cancer and respiratory diseases.

Major Health Treats

It is not easy to summarize present major health treats. The topic is vast, dynamic and almost open ended. This paragraph outlines the subject and provides references for possible further consultations as it is just as important to know where to go for available information as to receive the exact information itself. The present major health treats are:

- Globalization – as it leads to a faster distribution of diseases and pathogens;
- Changing social structure – aging population, immigration, unprecedented movement of people as compared to previous centuries;
- Unhealthy behaviors – increasing incidents and prevalence of chronic diseases, increasing tobacco and alcohol consumption, decrease physical activity …;
- The logic to finance health systems - currently health systems finance their services based on illness, which means resources have to increase, as more people get sick. This mechanism becomes unsustainable because it encourages a system based on disease and not health, and for this reason over time, the system, as well as the resources would be limited [2].

The result of the above is an increasing health inequity, i.e.:

- High level of inequity and inequality, with a significant percentage of the population in the base of the pyramid. This means that many sections of the population are at a higher risk, as health problems are often influenced by societal factors such as education, socio-cultural level, income, and ethnicity. For example, maternal mortality rates are worse in indigenous and rural populations compared to the urban and high-income citizens;

- Global disproportions of medical care and medical specialists - based on a threshold of 4.45 skilled health professionals per 1000 population. WHO has estimated that the needs-based shortage of health-care workers globally would be about 17.4 million of which almost 2.6 million are doctors and over 9 million are nurses and midwives. The largest needs-based shortage are in South East Asian and African regions. If current trends continue, the global needs-based shortage of health-care workers is projected to be still over 14 million in 2030 [3].

Local or Global Health

This is an extremely unfair dichotomy. Our understanding of health and wellness, illness and health care are changing rapidly as the world changes. The boundaries between global and national challenges are weakened because of developing globalization, which leads to intricately connected local and global health challenges.

So, how to meet the global health challenges? The health of a population is the result of the decisions taken at the political, economic and social level. Therefore, health problems should be solved by interdisciplinary and inter-sector action, not only by health professionals. We must understand that health is a pillar of development. If health is neglected, the social and economic improvements will not be sustainable. The increasing of investment in public health, the promotion of healthy lifestyles or encouragement of prevention are necessary. Yet, innovative solutions must be explored. And here is the role of the cooperation between telecommunications and healthcare providers.

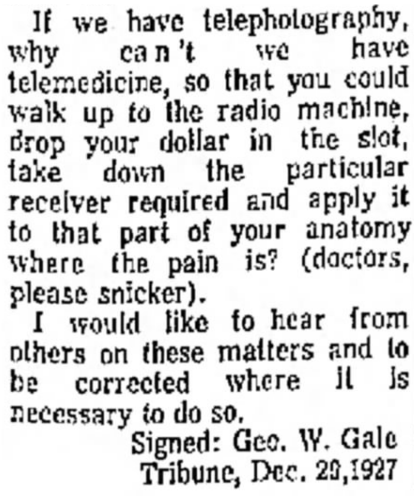
Telemedicine and eHealth

Wide implementation of information and communication technologies (ICT) have the potential to transform health care delivery and address many care challenges facing the health care systems all over the world. It can facilitate remote, mobile and site-to-site medical care. During the years two terms became commonly popular - telemedicine and eHealth.

Telemedicine encompasses diagnostic, treatment and prevention processes within the frame of modern health care services, which are carried out primarily by means of telecommunication and computer technologies. In sum, telemedicine is a delivery of healthcare and exchange of health care information across distance. It encompasses two Greek words - τήλε = tele - meaning “at a distance” and “medicina” or “ars medicina” meaning “healing”. Its history goes back to over 150 years [4].

What is to say about the term "telemedicine"? Many authors dated its origin in 1974, referring to the article of R. G. Mark [5] from 1974. However, as it is mentioned in [4] the term "telemedical technique/technology" was used by R. L. Murphy et al. in 1970 [6]. But, further historical investigations have forced us to revise even this discovery. In 2014, while working with reference sources, we found that the term "telemedicine" had been used as far back as 1927!

A column of the retrospective articles and letters to the editors were published on page 47 in the newspaper "Greeley Daily Tribune", Greely Town, Colorado, USA, on November 16, 1970. They cited the story of Geo W. Gale “Wants Plane to Change Weather Here”. This information represented a rather doubtful discourse concerning meteorological changes that could be caused by planes. However, the last paragraph was of special interest as the author unexpectedly quotes the following: "If we have telephotography, why can't we have telemedicine, so that you could walk up to the radio machine, drop your dollar in the slot, take down the particular receiver required and apply it to that part of your anatomy where the pain is? (doctors, please snicker)" [7] (Fig. 1). The cited article is from December 29, 1927.



If we have telephotography, why can't we have telemedicine, so that you could walk up to the radio machine, drop your dollar in the slot, take down the particular receiver required and apply it to that part of your anatomy where the pain is? (doctors, please snicker).

I would like to hear from others on these matters and to be corrected where it is necessary to do so.

Signed: Geo. W. Gale
Tribune, Dec. 29,1927

Fig.1. Fragment of the note with the term "telemedicine" dated 29.12.1927, author Geo W. Gale

It is obvious that this material is not a scientific article. Nevertheless, we record that the term “telemedicine” was used for the first time in a publication in December 1927.

For decades, there was no internationally accepted definition of telemedicine. A study published in 2007 found 104 peer-reviewed definitions of the term telemedicine [8]. Recognizing this, the World Health

Organization (WHO) adopted the following broad description of telemedicine [9] according which telemedicine is:

"*The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities*".

WHO underlines that telemedicine includes four germane elements:

- Its purpose is to provide clinical support;
- It intends to overcome geographical barriers, connecting users who are not in the same physical location;
- It involves the use of various types of information technology;
- Its goal is to improve health outcomes.

With more involvement of the electronic communication systems, the major International Organizations, European Union (EU), International Telecommunication Union (ITU) and European Space Agency (ESA) have officially adopted the denomination "eHealth". "eHealth refers to the use of modern information and communication technologies to meet the needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers" [10].

WHO described eHealth [11] as "*the transfer of health resources and health care by electronic means. It encompasses three main areas:*

- *The delivery of health information, for health professionals and health consumers, through the Internet and telecommunications;*
- *Using the power of IT and e-commerce to improve public health services, e.g. through the education and training of health workers;*
- *The use of e-commerce and e-business practices in health systems management.*

E-health provides a new method for using health resources - such as information, money, and medicines - and in time should help to improve efficient use of these resources. The Internet also provides a new medium for information dissemination, and for interaction and collaboration among institutions, health professionals, health providers and the public."

One more term is often used – *telehealth*. Tele-health includes surveillance, health promotion and public health functions. It is broader in definition than telemedicine as it includes computer-assisted telecommunications to support management, surveillance, literature and access to medical knowledge.

What is the correct terminology? Which one of the terms – telemedicine or eHealth is the right one? To this very moment, the terminology has not been agreed neither in Europe nor at worldwide level. Paradoxically even between and within the countries from EU different terms are used to describe the same service. Positions differ and the preferences are usually influenced by individual experience, personal and professional viewpoints. Thus for some authors telemedicine and eHealth are synonyms. Others accept that eHealth is a broader term and includes telemedicine. A third group separate the terms, accepting that telemedicine incorporates telecardiology, teleradiology, telepathology, tele-ophthalmology, teledermatology, telesurgery, tele-nursing, etc., while eHealth comprises of e-Santé, Information and Communication Technologies in health (ICT-Health), all types of health communication services, PACS, patient information systems, e-education, e-prescription, etc. (Fig. 2).

Having in mind the above, further, in this publication, the terms telemedicine and eHealth will be used as synonyms.

In 2005, the World Health Assembly recognized eHealth as the way to achieve cost-effective and secure use of ICTs for health and related fields, and urged its Member States to consider drawing up long-term strategic plans

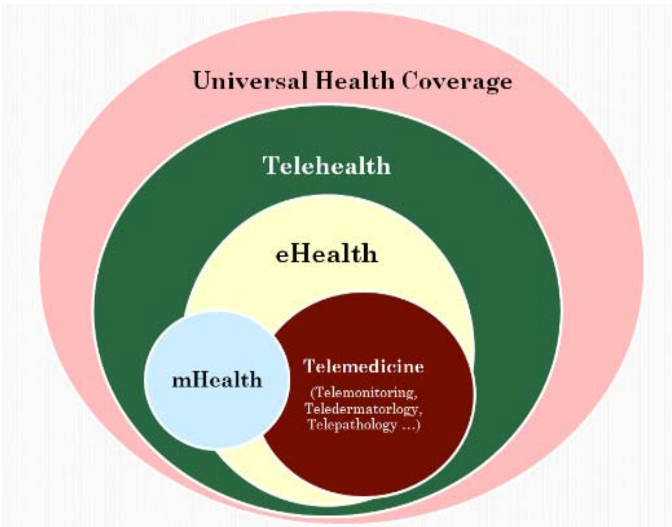


Fig 2: Relation between telemedicine and eHealth

for developing and implementing eHealth services and infrastructure in their health sectors.

Universal Health Coverage

Universal Health Coverage (UHC) is ensuring that all people can use the promotive, preventive, curative, rehabilitative and palliative health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose the user to financial hardship. As Dr. M. Chan, underlined, while addressing the 65th World Health Assembly, in May 2012, "Universal health coverage is the single most powerful concept that public health has to offer".

WHO underlines that UHC embodies three related objectives [12]

1. Equity in access to health services - everyone who needs services should get them, not only those who can pay for them;
2. The quality of health services should be good enough to improve the health of those receiving services and
3. People should be protected against financial-risk, ensuring that the cost of using services does not put people at risk of financial harm.

UHC is firmly based on the WHO constitution of 1948 declaring health a fundamental human right and on the Health for All agenda set by the Alma Ata declaration in 1978.

The need of UHC is due to many facts, to cite some [13]:

- At least a billion people suffer each year because they cannot receive the health services they need;
- Annually 100 million are pushed below the poverty line because of direct payments for health;
- Only in the European Region annually 19 million people still make out-of-pocket health payments that place an enormous burden on their household budgets;
- Globally, in the next twenty years, 40-50 million new health care workers must be trained and deployed to meet the needs of world population for decent healthcare service, a goal that will hardly be achieved.

Today, UHC is a global health priority. It is part of the Sustainable Development Goals under target 3.8. Expectations are high concerning the impact on the health of populations across the world.

Yet, UHC is not a panacea. Many things are not part of it [13]. The most important is that UHC does not mean providing all possible healthcare services free of charge to the population, as there is no country that can afford this. Yet, it is essential to underline that UHC is not only about ensuring a minimum package of health services. It is also about progressive expansion of health services, includes population-based services as public health campaigns, etc.

Moving towards UHC is a continuous journey. There is no single model or any universal successful program yet. The transition depends on the characteristics of each country or community - economic growth, available resources, government's political will and implementation capacity, degree of solidarity in society and many more. …

In sum: The question is not whether to implement UHC but how. The dimensions to consider when moving toward universal health coverage are presented on Fig. 3 [14]. One of the answers is – by applying eHealth and telemedicine. This is the field where telecommunications are able to contribute a lot and help shaping the future.

That's why, the next section is dedicated to the long lasting fruitful collaboration between healthcare and telecommunications.

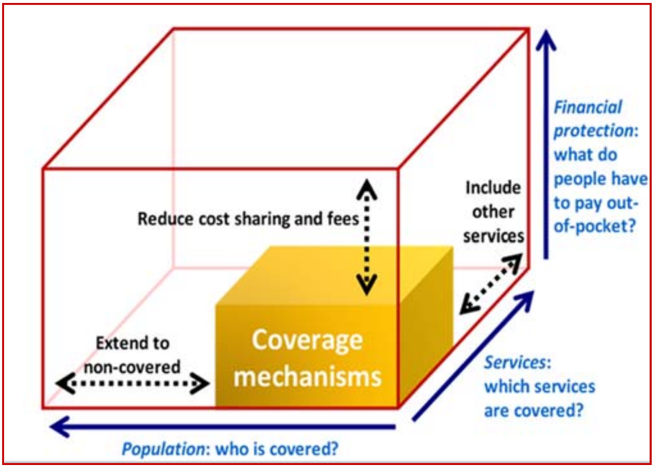


Fig. 3

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Telecommunication Technology and Healthcare

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[2]Scientific-Practical Center of Medical Radiology, Department of Health Care of Moscow, Moscow, Russia & Editor of "Journal of Telemedicine and eHealth", Russia

The telegraph, telephone and radio connection were the main available telecommunication technologies for information exchange for decades. They were the basic tools during the start-up of telemedicine/eHealth. Even now, the telephone remains as one of the most consistent equipment for medical information exchange, whereas radio is still being used today in transport telemedicine. Later on television, Internet and satellites became part of healthcare services, too.

The following text outlines in brief the enormous role of telecommunications in healthcare.

The Telegraph

Telegraph was the first electrical telecommunication tool in the history of humanity, which provided "globalization", i.e. free communication and information exchange between any points on Earth [1]. This type of communication is now called the "Victorian Internet" [2], because, thanks to it people stopped living isolated and could "reach" any part of the globe.

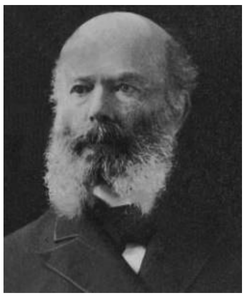


Fig. 1. J. B. Upham (1820-1902)

In 1858 doctor of medicine Jabez Baxter Upham (Fig. 1) and the engineer Moses Gerrish Farmer, with the support of a few other gentlemen, invented a special device - «sphygmosphone». It allows to fix the pulse rate as a graphical curve and to send it via telegraph. The team successfully tested this first telemedicine device in Boston, USA during 1858-1859, and made a number of public demonstrations. Probably last of them was in 1869 during the conference of American Scientific Association [3].

In the 1860s, in the USA (the southern states, the Confederation), William S. Morris and Albert James Myer worked on the development of a national system of telegraph communications in war conditions. Both were medical doctors. Myer proposed using the telegraph for military and medical purposes such as asking for medical supplies on the front line, ordering the required quantity of bandaging materials and medicines, specifying the delivery points, coordinating the transport of patients, etc.

The first documented case of the use of telegraph for teleconsultations was recorded in Australia in 1874. On Sunday 22nd February 1874, the Barrow telegraph station Creek (280 km north of Alice Springs) was attacked by aborigines from the Kaytetye tribe, provoked by what some said was poor treatment of their women by white men on the fence of a water hole [4]. Because of the attack, one employee of the station was killed, three more were wounded, and James L. Stapleton was deadly injured. A surviving police officer, Samuel Gason, sent a message about the incident via telegraph to Adelaide [4]. Doctor Charles Gosse came at night at the Adelaide telegraph station to make a distant consultation for the seriously injured Stapleton. The newspaper "South Australian Advertiser" wrote on 24 February, 1874: "We are informed by Mr. Todd that on Sunday night Dr. Charles Gosse (Fig. 2), at his request, went to the Telegraph Office and gave instructions as to the proper treatment of the

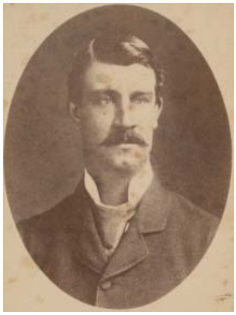


Fig. 2. C. Gosse (1849 Great Britain - 1885 Australia); http://trove.nla.gov.au/ndp/del/article/44948001/4042456?searchTerm=#pstart4042456

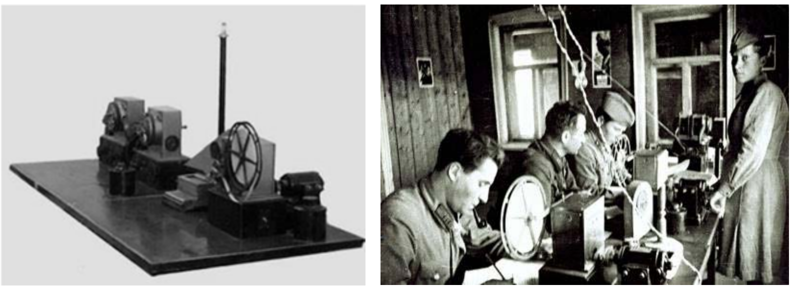


Fig. 3 "Baudot telegraph machine", a military field-type telegraph during the Second World War (USSR, 1941-1945) wounded, and up to about 11 o'clock all were progressing favorably. Later in the day, however, a change for the worse took place in Mr. Stapleton's condition, and notwithstanding all the assistance that was possible to render him, he sank under the effect of his injuries, and died, very quietly, at a quarter to six in the evening”.

In the first half of the twentieth century, telegraph communications were widely used during war conflicts, both for organizational issues of medical help and for teleconsultations.

There are excellent descriptions in the memories of army medical officers' of the telegraph usage during the Russian-Japanese War in 1905, First World War (1914-1918) and Second World War (1941-1945) [1].

Numerous descriptions of teleconsultations, including the help of telegraph and teletype connection ("Baudot machine", Fig. 3), were given in the army diary of the great Russian surgeon, Aleksander A. Vishnevsky [5].

The telegraph became widely used in civil medicine, too. There are reports of the telegraph communications for doctor home visits in the 1900 - 1920s [23]. In 1929, photographic prints of two dental radiographic images were published, which had been transmitted by telegraph. The high quality of the images was pointed out. This service was offered as commercial distant consultations for dentists [6-7], however, there is no available information about the further development of this technology.

Telegraph communication played an important role in the understanding of the significant role of global telecommunications in the development of society in general and in healthcare service in particular. It was a basic telemedicine tool in the late nineteenth century and in the first third of the twentieth century, especially during war conflicts.

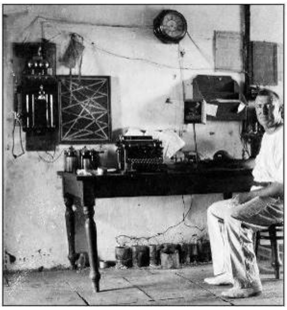


Fig. 4. F. W. Tuckett at his own telegraph office, https://apholland.wordpress.com/2010/08/08/an-outback-dash-my-grandfathers-diary/

Radio Communications

The Air Medical Service in Australia

A sad story happened in August 1917 in the town Halls Creek, Western Australia. A twenty-nine-year-old farmer Jimmy Darcy was seriously injured, having tumbled off a horse during cattle grazing. His mate was taking the injured to the nearest town Halls Creek for 12 hours, having covered over 75 km. There was neither a hospital nor doctors in the town at all. Then a post clerk F. W. Tuckett connected with Doctor John Joseph Holland by telegraph, who was in Perth. Having heard the description of the patient's state, the doctor diagnosed the case as urinary bladder rhexis. Jimmy Darcy needed an urgent operation. A short and dramatic dialogue between the clerk and the doctor followed. Within a few minutes, Tuckett operated the injured, using a penknife, a razor and potassium permanganate. In the course of the surgical intervention he called the doctor from time to time and was instructed how to do the next step in the operation. Following the telegraph consultation, John Holland traveled the long road to his patient. He covered more than 5 000 kilometers in 11 days, getting to his destination by boat, car, on horseback and even on foot. Arriving in Halls Creek, the doctor found out that poor Darcy died the day before due to malaria, but not as a consequence of surgical complications. The doctor conducted autopsy and stated that the operation was performed correctly [9] (Fig.4).

Fig. 5. J. Flynn (1880-1951)

This story was on the front pages of the world newspapers. For the first time the problem of medical assistance in remote and isolated residential areas came to the forefront. The tragedy inspired the reverend John Flynn (Fig. 5.) to create the world's first Medical Aviation Service in Australia. Ten years later, in 1928, upon his initiative, Aerial Medical Service (AMS) was organized. J. Flynn combined distant consultations by means of radio and telegraph and doctors' air travel to patients. It took several years to

Fig 6. A. H. Traeger (1895-1980) and his invention - the pedal radio station of Aerial Medical Service in the 30s of the XX century. Photo by Scott Weatherson

organize this regular service. Now a physician can reach out to seriously ill patients quickly at any point on the Australian continent.

However, the problem of electricity supply under wildlife conditions was crucial. It was solved by Alfred Hermann Traeger [10] (Fig. 6), who worked out the so-called "pedal radio", i.e. a dynamo generator with pedal drive that was used for electricity supply. At first, this ingenuity allowed exchanging messages by means of the Morse code and later, after 1930, also by means of voice messages.

In the 1940s, the distant medicine was really implemented in AMS as all inhabited localities were equipped with standard sets, which contained large supplies of medicines and medical tools. Now a physician, having received an illness description over the radio, would just have to indicate the required medicines or tools and administer the therapy. The combination of medicine, aviation and radio is called "social revolution", which enabled to change fundamentally the healthcare system in Australia. Today this organization still exists and is called Royal Flying Doctor Service [10].

This model of the healthcare service organization became so efficient that it is used in many countries of the world.

At Sea

No wonder that radio communication gained a widespread circulation in marine medicine. One of the first documented medical radio teleconsultation was performed on January 2, 1911, between two sips that were at a distance of over 800 miles [11].

In 1920 in the hospital of Haukeland, Bergen, Norway, for the first time, radio teleconsultations were held for seamen on a regular bases. Physicians not only made remote diagnoses and recommendations for treatment but also guided complicated surgical operations via Bergen Radio [12].

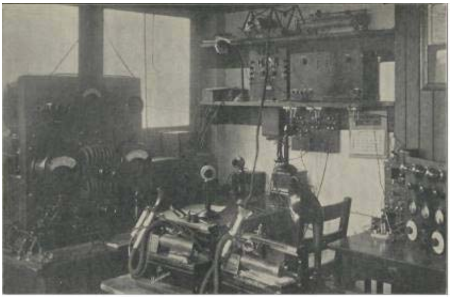


Fig. 7. The medical radio station had call signal KDKF, deciphered as "Kome Doctor, Kome Fixit". The call signal "MEDICO" was used to connect with medical radio service [14]

In 1949, two doctors from this hospital - Jon R. Myhre and Johannes Boe - established a separate service for marine radio consultations. Primarily, the enthusiastic doctors worked for free, but after some years they started to get sponsorship from the Naval Department of the Royal Norwegian Ministry of Trade, and then from the National Social Security. The service, now called "Radio Medico Norway", exists and supports marine crews all over the world [14].

In 1920 in New York, USA, upon the initiative of Captain Robert Huntington, a service for radio consultations for crews of merchant vessels was arranged on the premises of the Seamen's Church Institute (Fig. 7). At the beginning, it provided consultations every day from 9.00 to 17.00, and starting April 20, 1921, it went on around-the-clock. After one year, the Radio Corporation of America and the Health Service joined the project. Radio medical consultation service had improved its own infrastructure by involving all coastal radio stations and a telephone connection with the New York Naval Hospital. All radio teleconsultations were provided to seamen free of charge. Initially, only the staff of the Institute provided radio consultations, however, during the next 5 years, naval hospitals, organized by the public health service system, joined the network, as well as medical centres in Columbia, Panama, Costa Rica, Norway and Sweden. Consulting physicians had to deal with contagious diseases, traumas, acute surgical pathologies and even with childbearing. In the course of time a special doctor's bag was developed, which allowed to improve partly teleconsultations: seamen could follow the instructions carefully, using the standard doctor's bag with medications and instruments [15]. Also, a manual on emergency aid under the conditions at sea was written up.

Fig. 8. G. Giuda (1897-1969)

On February 16, 1935, in Italy, the International Medical Radio Centre (Centro Internazionale di Radiocomunicazione Mediche - CIRM) for providing distant medical assistance to seaship crews and island inhabitants was founded upon the initiative of Prof. Guido Guida (Fig. 8). The famous scientist Guglielmo Marconi became the first President of the Centre. On April 7, 1935, CIRM received its first message in Morse code from the Italian steamship, the *Perla*, which made possible distant consultation between the ship captain and the CIRM medical team. Only in 1955, the Italian government started financially to support the CIRM. Thanks to the new budget the centre developed and in 1957-1958 a scientific department was established there, which enabled to move on from simple teleconsultations to the study of seamen's occupational pathology. A scientifically based conception of medical assistance at sea was developed.

The staff of consulting doctors was enlarged to 50 physicians, who had to deal with the widest range of diseases and injuries. Once, experts had to guide the actions of a captain's mate of one of the merchant vessels over the radio, which had to perform appendectomy on a sailor. CIRM continues its activity nowadays and provides thousands of consultations annually [16].

Centers of marine telemedicine have been established and operating efficiently following the CIRM example all over the world.

It is almost unknown that Germany also had similar service. Since 1931, the Cuxhaven Medical Center in Lower Saxony operates as a hospital-based radio medical advice center for ships worldwide. This center is known as Medico Cuxhaven. In the 1950s, Dr. Meinhard Kohfahl, the "Father of the Naval Medicine in Germany" developed a special check-list (algorithm) for radio medical advising, which made teleconsultations much more efficient. In 1976, he and Dr. Peter Koch developed a special medical kit (box) for sea vessels. This kit permits procuring aid at sea more easily and safely, especially during radio consultations when there is no doctor on board. In the 1970s, Medico Cuxhaven team started to develop a biotelemetry system of twelve-lead ECG, blood pressure, CO_2, SaO_2, pulse and respiration rates.

In the middle of the XX century, the services of marine teleconsultations operated in all countries of the world.

To make the teleconsultations more realistic, the biomedical data of the patients have also to be transmitted via radio channels. The experiments with biomedical information transmission from the sea to coastal medical centre is a separate chapter in marine telemedicine. There is a report about radio transmission of auscultation of heart beating as early as in 1921 by S. R. Winters from the United States Navy board to the coastal medical centre.

In 1964, a team consisting of French and USA medics performed transmissions of ECG and X-ray images from sea to shore [17]. The transmissions were carried out from a French liner to New York and Paris by means of national telecommunication companies. Technically, the process of image transmission (scanned X-ray patterns and ECG curve tapes) represented facsimile transmission. The overall time of the marine teleconsultation using facsimile transmission was about 1.5 hours (from the start of the image delivery to the moment of its receiving by an expert), the further case discussion was held over wireless telephone.

Between 1972 and 1982 in San Diego, USA, the "Navy Remote Medical Diagnoses System" was established for teleconsultations between coastal points and marine vessels. Black-and-white slow-scan television communication and biotelemetry were applied for the exchange of X-ray patterns, ECG, auscultation (electronic stethoscope) and other physiological data. Satellite technologies and radio served as communication means. Based on the results of the testing, the system was improved and special terminals for radiological image exchanges were developed.

In the 1980s in the Union of Soviet Socialist Republics (USSR, now Russia), at the Main Military Clinical Hospital and its Naval Consultative Medical Centre, automated management systems were introduced to support the medical service. Regular day-and-night duty was provided [18].

Radio communication remains one of the basic telemedicine facilities. Medical Aviation Service combined with radio communications represents an efficient model of medical aid arrangement under certain geographical conditions. This mode of communications was used actively in hard-to-reach areas and isolated districts till the 1970s, i.e. until alternative satellite transmission facilities appeared. Naval medicine services have been operating based on the radio since the 1920s up to now.

Radio for Biological Signals Monitoring

The development of physiology and related disciplines in the 20th century led to new specific tasks for biomedical engineering - the development and implementation of systems, which allowed performing distant recording and transmission of physiological data of motor activity.

Special attention was dedicated to records in extreme conditions - underwater, underground and in microgravity. In period 1948-1965 a huge number of laboratories and scientists around the world published information and reports of "miniature devices for radio-telemetry of physiological information from unrestrained human or animal subjects" [1, 23]. Thus, the "Dynamic Biotelemetry" concept was formed.

In the middle of the 20th century, physiology or more precisely the dynamic study of body reaction to external and internal physical, psycho-emotional and other factors became a special sphere of radio-biotelemetry application. Radio-biotelemetry was widely used in air, space and sport medicine and physiology.

Radio Communication in Distant Medical Learning

In the 1930-1940's radio broadcasting, was used in training of physicians and in holding distant round tables on different clinical questions. Popular radio shows for the public were organized, too [19-20].

Starting from 1955, radio connection was used in Albany, USA, to implement distant learning. The equipment was placed in the local medical college and in 24 hospitals, the total audience of the daily 20-minutes' lectures with the subsequent interactive discussion counted 200 physicians (not including the interns and residents). Initially, an amateur equipment set was used, but in 1957, a professional radio center was created at the college.

Later, seven medical universities joined the program. The hospital network was constantly enlarging and up to 800 physicians could take part in the interactive teaching radio conferences simultaneously. The evident disadvantage of such type of teaching was the absence of visual aids. This problem was solved by sending out beforehand copies of tables and illustrations, which were carefully listed. The audience could watch such "charts", following the instructions of the reader.

In 1973, in Ohio, a microwave radio network was applied for medical data exchange between five hospitals. Several years later closed-circuit television network replaced it, which allowed making color video conferences.

Between 1975 and 1989, the Mexican government established the radio network «IMSS-Coplamar» for health care coordination and epidemiological control in isolated areas [21].

Now, the radio networks are generally replaced by Internet.

Emergency Radio Communication by Amateurs

Fig. 9. G. George, B. Wentworth Jr., A. B. Lopez, A. Banks and J. Waley at the street with amateur radio station

In the 20th century, radio amateurs from all parts of the world made certain contribution to the wide development of medical telecommunications. A number of episodes are known when in cases of natural or technologic disasters, some territories practically lost communication with the outside world. The simple voice communications (via amateur, so-called “ham”, radio stations) were used for spreading information, coordination of rescue teams, simple teleconsultations and management of emergency care, including the evacuation of victims.

The first documented case dates from 1913. Herbert V. Akerberg was the person reported to use amateur radio in disaster relief. The 15-year-old Herbert used his modest radio to transmit information to the Overland radio station in the Huntington Bank Building near the Columbus, Ohio, City Hall in March 1913 during a terrible flood. For 3 days, the young man was on duty at his radio set, in communication with the "outside" radio station, sending messages to the mayor and keeping the public advised as to the conditions in the devastated areas [22].

Something similar happened on May 27 1925, when Santa Barbara, USA, was destroyed by an earthquake, which cut off the city from the rest of world. Just in a couple of hours after the hit, a few radio enthusiasts led by 19 years old Graham D. George (Fig. 9) built up a working radio station (from various stations in the city), and did what was necessary to communicate with the outside and inform the authorities about the disastrous situation in Santa Barbara. The emergency station continued its work until other communication was restored.

Numerous examples, revealing amateur radio stations, organizing emergency communications during disasters in the last 100-120 year are provided in [23], just to mention some: the floods in Tula, Russia in 1929; earthquake in New Zealand in 1931; bush fires in Australia in 1939; the earthquakes in Managua, Nicaragua in 1972 and in Guatemala in 1976; the earthquakes in Mexico city in 1985 and in Armenia in 1988 (Fig. 10), etc.

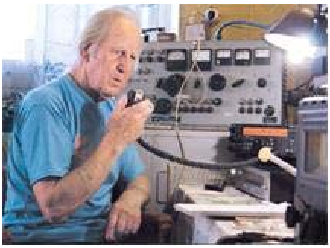


Fig. 10. Anatoliy (Toly) Nikolaevich Bayakin (R3UA) – participant of a number of emergency radio comminications

In the second half of the 20th century, many associations and societies for emergency communications were founded by radio amateurs worldwide. These are the so-called "Amateur Radio Emergency Services". One of these organizations, consisting predominantly from medical doctors, was MARA: Medical Amateur Radio Association in USSR, founded by Anatoly Podolyan and 80 other radio-enthusiasts from different health care institutions (Fig. 11).

Polar Telemedicine

Fig. 11. Medical Amateur Radio Association (MARA) official badge, 1990, USSR

Over decades, radio connections remained the key telemedicine tool in Polar Regions of Europe and North America. Besides, radio teleconsultations were the only means of distant medical support of Arctic and Antarctic exploration for decades.

Some form of a distant medical care at northern territories via radiotelegraph took place in 1914 in Russia. That year a special marine expedition to the Kara Sea took place. The goal of the expedition was the establishment of radio stations at extremely isolated places in the North. For each station, trained crew, special sets of supplies and provisions were prepared. There is a quote from the paper of a radio engineer V. A. Tarasoff [8] concerning the medical issues: “For the purpose of giving medical aid, a trained hospital assistant was left on the Yugor station, who had also, in case of necessity, to visit the Vaigatch radio station. In addition all the stations are supplied with pharmaceutical stores, containing a sufficient quantity of drugs and popular text-books on medicine, and in severe cases the use of the radiotelegraph for communication with Archangel Physicians is allowed to all, free of charge”. Thus, the radiotelegraph used for medical advices in the Northern territories of Russia since 1914.

In the 1950s, the Alaska radio communication were applied for medical purposes. Residents of small villages had the possibility to connect with the hospital for ordinary voice consultations. In 1955, a range of technical standards were issued, which helped substantially the upgrading of the radio stations networks and improving their work.

In 1964, a training program on emergency medical aid for volunteers from small villages and rural settlements was launched. These persons also used radio communication for regular meetings and consultations with doctors. Within next 3 years, the volunteer network significantly increased, despite of the fact that new hospitals were built. In 1968, official timetables and radio consultations schedules were adopted. The attending doctors were bound to connect with the supervised settlements and to guide volunteers’ consultations. A specific term, “radio-medical-traffic” appeared, pointing at the significant amount of medicine information transmitted via radio channels. The presence of voice communication with the medical staff had already positively influenced the way citizens accepted the consultations.

However, because of atmosphere ionization, radio communication suffered constant interruptions and interferences. To avoid natural barriers the newest satellite communication via *ATS-1* satellite was introduced [23].

In the USSR in 1970, during the 15th Antarctic expedition, a remarkable event took place – the first experimental transmission of a range of electrocardiograms from Mirny observatory to Leningrad was carried out. This is considered as the beginning of telemedicine application for healthcare support of the Antarctica polar explorations. A year later (during the 16th expedition) doctors at *Molodezhnaya* station established a connection through photo telegraph with the polar medicine department of the Arctic and Antarctic Research Institute in Leningrad. On three occasions, expedition doctors received efficient radio consultations based on the electrocardiograms of a patient with acute myocardial infarction sent from Antarctica [23].

In 1974, D. Lugg published an article about telemedicine implementation linked to the Australian Antarctic expeditions. It revealed the application of facsimile connection for diagnosing and treatment selection. The expedition doctor sent black and white X-rays prints to the polar medicine centre via fax. The answer came as a text, but when necessary, a voice message was sent via radio [23].

Over decades, radio connections remained the key telemedicine tool in Polar Regions of Europe and North America. Today, satellite are extensively used.

Telephone Communications

At the end of the 19th century, the Italian Antonio Meucci and the American Alexander Graham Bell almost simultaneously presented a new technology of sound communication to the world - the telephone. The German Johann Philipp Reis introduced the term telephone.

It is often cited that Bell made the first telephone call to his friend and assistant Dr. Watson, asking him to provide aid. In 2005, Prof. Magnus Hjelm dispelled this myth.

The first documented use of telephone communication for medical purpose was in 1879. A short note was published in “The Lancet” with the description of the situation. The relatives of a little child called their family doctor at night with a complaint about severe cough. The doctor told to hold a receiver close to the child's head for him to hear the coughing, which was done. In a few minutes the doctor announced, that the child did not have croupous cough and that the matter could be postponed until the morning [24].

In 1887, a telephone communication, probably for the first time ever, was used for communication of patients from a contagious isolation ward (especially, those with scarlet fever) with their relatives [25].

In fact, in the 1880s, the possibility and even the necessity to use telephone

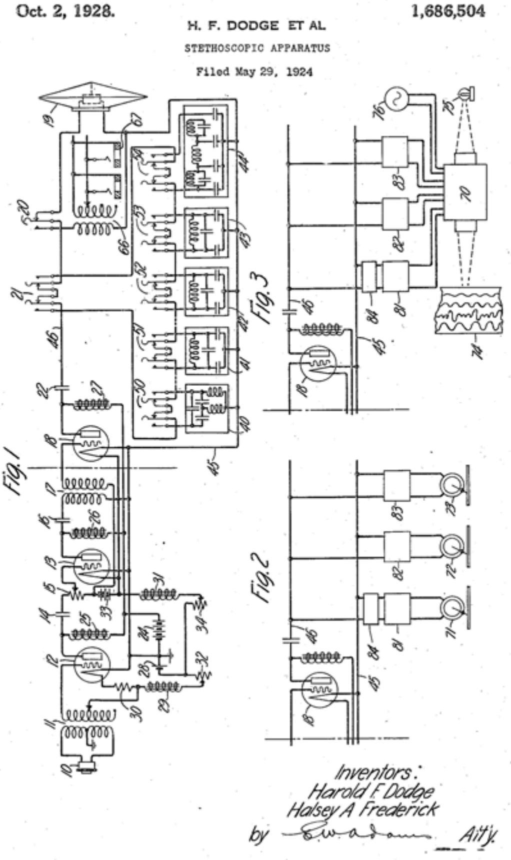


Fig. 12. Stethoscopic apparatus of Dodge-Frederick, which could be "connected to telephone lines", 1928

for communication between doctors and patients were discussed actively. One of the zealous supporters of the installation of a telephone system in medicine was the British Doctor Alfred H. Twining, who recommended in 1888 to use widely the new mode of communication, especially in the rural areas, for “long lasting social or professional conferences around-the-clock“ [25]. The remarkable thing is how fast the telephone became an integral part of a doctor's office. There is a document revealing the installation of telephone system in Birmingham Women's Hospital in 1880 - "all internal and external departments, and also doctors' residences" were connected online [25].

In 1891, the famous English orthopedic surgeon Richard Davy insisted on the development of telephone communications between hospitals for the purpose of logistics optimization and in order to prevent refusals in hospital admission and patient transportation between health care institutions. As an argument, the doctor suggested the description of a clinical case: a boy with lower limb fracture was transported several times from one hospital to another for the reason "no beds available".

The discussion regarding the appropriate installation of telephone system in healthcare service continued up to the 1950s. Yet, emergency medical service, fire emergency and police started to be equipped with telephone communications during the 1920-1930s.

As far back as 1878 the ideas about medical data transmission via telephone was in the air. There were some experiments with transferring heart and lung auscultation via phone in 1877-1878 by doctor Clarence John Blake in the USA and professor John Gray McKendrick in the UK, but the quality of the transmitted sound was inappropriate [1, 23]. Then, the first attempts for combining the stethoscope and the telephone for distant auscultation were expressed. This was realized at the beginning of the 20th century, when in Europe and America several similar stethoscopes and devices were patented (Fig. 12). They allowed the transmission of heart and lungs auscultation over the telephone. Among these devices was the "electrical relay" of S. G. Brown, recognized as the first device to enable auscultation transmission over telephone [26].

Fig. 13. A doctor is using wireless telephone in a medical vehicle (the 1950-1960s); photo of Chris Ware Gallo Images (http://www.timeslive.co.za/lifestyle/health/2011/04/19/telemedicine-time)

In 1910 in Great Britain, the engineer Sydney-George Brown conducted the first world's teleconsultation with the help of his own inventions - an electrical relay and an electrical stethoscope. The auscultation of heart tones was transmitted over the telephone between London Hospital and the Isle of Wight for a distance over 50 miles [27].

In the 1930-1940's cable communications were used to solve practical arrangements in Healthcare Service, to conduct research and to collect epidemiology data.

In the 1950-1970s, there were programs for distant medical learning entirely based on voice communication, i.e. telephone. For instance, around 1958, the medical centre of Nebraska University, USA, performed distant learning. Lectures were presented by phone for doctors from four local hospitals and three hospitals from the neighboring states. In 1972 in Oklahoma, USA, the distant learning network for doctors was developed in 10 regional hospitals. Technically the process was implemented based on a telephone conference line, which allowed carrying out "collaborative conversation" of all the participants of a lecture.

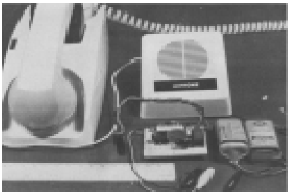
Starting in the 1960s telephone communication and the information transmission services on this basis (telemetry, dataphones, fax machines, teletype machines, etc.) have been used in full scale all over the world for various health information exchanges (Fig. 13).

Telephones were, and still are, widely used for transferring cardiology records. Cardiology was extremely beneficial from telephone communications.

Most researchers consider March 22, 1905 as the birthday of telemedicine. On this day, in The Netherlands, Wilhelm Einthoven, professor of physiology at Leiden University, and Professor Johannes Bosscha, Director of the Delft University of Technology, transmitted a regular electrocardiogram and phonocardiogrammes via a protected telephone cable at a distance of about 1500 meters from the University Hospital to the physiological laboratory at W. Einthoven's house [29]. Within next two decades, the method of tele-electrocardiography gained recognition. For the first time it was applied as a routine tool in the clinical practice approximately in 1935 in Lvov (today Ukraine). Prof. M. Franke and Prof. W. Lipinski organized constant usage of tele-electrocardiography (tele-ECG). The transmitting station was located in the department of infectious diseases of Lvov General Hospital, while the receiving station was installed at the Chair for General and Experimental Pathology of the Lvov University Medical Faculty.

Since then, tele-ECG is one of the most reliable and efficient telemedicine applications that has been intensively used until now. Table 1 illustrates some of the transtelephonic ECG systems.

Table 1. Tele-ECG

	Tele-ECG consultation using Bell dataphone (Omaha, Nebraska, USA, 1963), photo from Northwestern Bell Telephone Company Annual Report for the Year 1963 by Alma F. Jacobson
	Uhley's telemetry ECG-transmitter, USA, 1974
	"Volna" system: ECG autotransmission in home conditions - ancestor of modern home telemedicine (Saratov, USSR/Russia, 1970-80s)
	ECG autotransmission by telephone (Toronto, Canada, 1976-1979)

Telemetry equipment of «pacemaker telephone clinic» (Japan, 1973-1975)

Implementing a telecardiology strategy in a geriatric institution (Brazil, 2016) [30]

Fig. 14 Neurosurgery Anywhere! Anytime! [31]

Telephones are used not only for exchange of ECG records. It serves as a data transmission feature - ultrasound records, neurological and urological data, angiographic data, etc. are transmitted via phones (Fig. 14).

No matter how telephones changed, all types of telephones, i.e. dataphones, videotelephones or mobiles phones, are used. Different types of telephones have different applications. For example, the effectiveness of the videophones in home healthcare service and in mental health was found to be significant [32-33]. Videophone technology enhances communication for deaf and hard-of-hearing patients because it allows those who use Sign Language to place phone calls through a sign language interpreter. This is an example from 2015 from MedStar Washington Hospital Center [34].

Apart from consultations, appointment of meetings and physical examinations, exchange of consultations and information, vaccination alert systems, telenursing practices, etc. it is worth mentioning the application of Short Messages Services (SMS) for management of chronic diseases. This emerging area is especially helpful in psychiatry, neurology and psychology. Most of the mental and behavioral disorders are associated with a considerable risk for relapse after reaching the state of recovery. Unfortunately, once finishing the inpatient treatment, most of the patients never seek after-hospital help. Telephones, mobile phones and Internet offer easy and user-friendly ways to support these patients on their way back to everyday life. Example of SMS application is the developed in the Centre for Psychotherapy Research Stuttgart, Germany, after-treatment of patient with Bulimia Nervosa based on SMS. The intervention consists of weekly messages from the patients on their bulimic symptomatology and a corresponding weekly feedback that is a mixture of pre-programmed parts and individually tailored information. Results indicate that the program is technically feasible, well-accepted by patients and helpful for patients with bulimia nervosa to readjust to everyday life after finishing inpatient treatment.

Nowadays, SMS is extremely helpful and widely used application for management.

Telephone is the most widespread and the oldest eHealth device providing voice and/or communication. In the beginning of the 21st century, the mobile phone became the technical ground for a radically new technology in healthcare service - mHealth (mobile health). Now there are more than 15000 applications for mobiles phones that are connected with healthcare, health education or wellness. New apps are developed every day.

There are many more examples for the application of telephones in healthcare. Some more are provided further in in Part II the book.

Yet, it is worth mentioning, that is cases of disaster, as the tsunami in 2004 revealed, the old plane telephone lines are irreplaceable.

Television

Television expanded the range of telemedicine tools and resulted in the formation of a new trend – medical videoconferencing. As many other technologies, television was not an exclusive invention of one person or a group of people. Many scientists all over the world had been gradually developing more and more efficient means of audio and video information communication. However, two specialists, Semyon Katayev (Russia, USSR) and Vladimir Zvorykin (Russia, USA), are globally recognized.

In 1931, within an interval of one and a half month between, the USSR and the USA, respectively, both scientists patented an electronic television technology that became the main one for decades [23]. Prof. Zvorykin played an important role in the development of medical videoconferences. He was not only an inventor but also an active promoter of television, cooperating with doctors and medical associations on the issues of introducing television technologies in healthcare.

Television was first used for medical purposes in 1939 in the USA. A black and white TV broadcasting system was installed in Israel Zion Hospital, New York, to broadcast operative treatments.

The first most significant experience using medical videoconferencing took place at the School of Medicine, Creighton University, Omaha City, Nebraska. In May 1947, the black and white TV technology was used for distance learning. The first transmission was of a stomach carcinomaectomy [23]. The experience of medical videoconferences was thoroughly analyzed. The ways to improve distance teaching techniques, information protection, sterility, etc. were established, thus ensuring the methodological basis for further interactive distance learning in surgery (ibid).

In 1947, the television system for medical conferences was applied in Cleveland, Ohio, for post-graduate distance learning. The first color television broadcasting of a surgical operation was held on 31 may 1949 between from John Hopkins Hospital and the lecture hall of the American Medical Association in Washington.

On 6 December 1951, the first transcontinental surgical videoconference was held via the cable communication channel between Los Angeles and New York. The videoconference was held by cable and wireless (microwave) data communication. Up to twenty color Zenith television sets were simultaneously used in large lecture halls - one television set per 50 people.

In early 1950s, the television video-conferencing systems were used in Argentina, France, Spain and Russia.

In 1959, Dr. P. Moore and Dr. H. von Leden developed a special helmet equipped with a light television camera, a system of lenses and lighting tools. Thus, it was possible to carry out remote broadcasting of otorhinolaryngology examination or treatment for educational and clinical purposes.

In 1959, the Council on Medical Television was created in USA. In 1971 it changed its name to Health Sciences Communications Association (HeSCA) under which it carries out its activities until today. The organization's main goal is to develop medical education, practice and science by applying different educational technologies. For decades, the organization conducted significant work on promotion, enhancement and introduction of television technologies in practical healthcare and professional education.

At the end of 1950s and the early 1960s, the idea of the use of television technologies for organization of medical videoconferences and especially for education, became widely spread all over the world.

In 1957, a model of a color television surgical unit was developed in Kirov Military Medical Academy, Russia. The system was improved and two microphones and speakers were installed. The latter allows two-way communication and enhanced education.

In 1965, “medical television” was introduced at Glasgow University, Scotland, for postgraduate professional development training, too.

The main disadvantage of “medical television” was “no possible interactivity”, i.e. in most cases, the lectures and the practical presentations were recorded as typical TV programs and then broadcasted.

In the late 1960s - early 1970s the so-called “television networks” of medical institutions were established in several cities (San-Francisco, Indianapolis, Milwaukee, Detroit, Huston). In-house two-way television systems were used for videoconferencing and broadcasting of educational materials (including previously recorded videotapes).

At the end of the 60’s telemedicine networks, based on videoconferencing between the geographically spread branches of the Universities, start to appear. They supported telemedicine consultations on a regular basis (interactive videoconferences), including transmission of photo fluoroscopy, ECG, EEG data and micro images, radiology, psychiatric consultations, etc.

In 1961, one of the first studies on the efficiency and possibilities of cable television systems in intra-group and individual psychological therapy was carried out. It was determined that the application of telesystems did not affect the treatment results, i.e. the results were the same for all compared groups. However, a positive economic and logistic effect was obvious. Consequently, the possibility of application of videoconferences in psychiatry with a respective level of quality was accepted [23].

In late 1960’s two-way television was applied for the development of telemedicine networks. Gradually, the networks were equipped with not only videoconferencing, but also with other tools for distance data exchange, including electronic stethoscopes, special rooms were dedicated for teleconsultations in various areas – radiology, pathology, dermatology, urology, mental health etc. Most effective and famous telemedicine networks based on closed-circuit television was built in Omaha, Nebraska by the team of Prof. Cecil L. Wittson, in Boston Massachusetts by the team of Kenneth T. Bird, also as in New-York City, and other regions of the USA and Canada.

In 1974, a manual by R. Potts on creation of medical television centers in educational establishments was published.

In 1970s and early 1980s closed-circuit videoconferences were used for a medical purposes (including psychotherapy and nursing) in Sweden, Great Britain and other countries. At that period a special television programs were offered, for the first time, to disabled people, as a means of communications, to elderly as well as for physical rehabilitation.

The application of television in healthcare continues today. Apart from all areas of healthcare mentioned above, nowadays television is an extremely powerful educational tool as television viewing is almost a universal phenomenon. Recent studies underlined the role of the reliability of the television programs for healthcare information and for development of health related lifestyle and for health education of citizens [35-36].

Recently a new application of television was found, i.e. continuous closed circle television observation is applied in some hospitals for monitoring the hand hygiene compliance of health care workers in a general intensive care units, too [37].

With the wide spread of Internet, the telemedicine systems based on cable television were less used for biomedical data and image transmissions.

Satellites

Satellites came into use in healthcare in the 1960's after the first transatlantic experiments.

Transatlantic Communications / Telemedicine

In the 1960s, NASA placed the first telecommunication satellites into geostationary orbit, enabling fast data transmission, including biomedical ones, between Europe and America.

In 1963, a transatlantic biotelemetry was performed between Belgium, France, Great Britain and USA. A normal encephalogram was transmitted, successfully, recorded and instantly transmitted back. After the experiment, the results of data transmission through the underwater cable and via satellite were compared. No differences in diagnostic value of both methods were noted, which "opened" the door for the use of satellite communications in healthcare.

On May 2, 1965, the first transatlantic medical videoconference was held during which an open-heart operative replacement of the aortic valve with an artificial prosthesis was presented [38]. The surgery was performed at the Methodist Hospital in Houston, USA. The audience was in the lecture hall of the Medical Department at the University of Geneva, Switzerland.

In 1971, the first telemedicine session between countries on both sides of the Pacific Ocean took place, when a cooperation between the Mayo clinic, Rochester, USA and a hospital in Sidney, Australia was established.

Gradually, satellite communications were introduced for providing medical care especially at sea, for isolated regions and hospitals and in case of emergency.

For example in 1968, several stations with satellite communication were launched in Alaska. Initially the new communication tool was mainly used for distant teaching of doctors and volunteers. In 1971, a program of telemedicine consultations via “Doctor Call” satellite communication was officially opened. Nineteen settlements received satellite communication sets and managed to activate this telemedicine network. Satellite links were used at scheduled times in the morning, and in emergency cases – out of schedule. On average about 250 telemedicine consultations were held annually. They resulted in improvement and simplification of decision taking related to transportation, patients’ transfer, decrease in number and period of hospital admissions, etc.

Fig. 15. Avtosan-82 mobile system and its main developers: A. Berseneva, R. Bayevskyy, I. Funtova, V. Stepanov

The example of Alaska was followed by other remote settlements. In the early 1980s, in USSR/Russia, the *Avtosan-82* mobile computerized laboratory was developed. The *Avtosan-82* was a diagnostic laboratory, mounted on a bus (Fig. 15) and to a certain degree copying the structure of systems of medical and physiological researches on board of the *Salut-7* space station. It was equipped with the range of instruments similar to the system for medical monitoring of cosmonauts. Besides, it included a computer that was similar to prototype of the on-board medical computers, mounted on the *Mir* space station just 5-8 years before.

Fig. 16. Episodes of transatlantic “spacebridge” Armenia/USSR – USA (1988)

The *Avtosan-82* mobile laboratory marked an important step forward not only in space equipment and methods usage in the “Earth” medicine. In fact, this system was a powerful tool for telemedicine screening. *Avtosan-82* was used in factories and rural areas for a preventive examination of the population. The results received were transmitted to the analytical centre in Moscow through different communication channels, including satellites. Operational conclusions were given to the subject via the computing unit of the mobile laboratory.

Unfortunately, one of the best examples of satellite application for healthcare during the last century was in 1988, when an earthquake hits Armenia. 21 cities and 350 villages were damaged, 25 thousand people died, hundred thousand people were injured. Within 2 weeks after the catastrophe, the USA and the Russia launched a joint project to carry out telemedicine consultations for survivors via satellite communication. Four medical centers provided experts to participate in telemedical sessions with the national diagnostic centre in Yerevan. It is remarkable that the system was launched within 24 hours (Fig. 16) [23].

An unexpected follow-up took place after the industrial disaster in Bashkiria. On June 4, 1989, in the region Asha-Ulu-Telyak two passenger trains collided and a powerful explosion of light hydrocarbons gazes occurred in the nearby oil pipeline. 575 persons were killed; more than 600 persons were injured. Immediately, another telemedicine terminal was added to the Ufa medical centre (ibid). During 3 months, 51 telemedicine sessions were held, in which more than 400 doctors and nurses from both hemispheres took part. 253 patients were consulted at a distance. The sessions were organized as bilateral audio-, video and facsimile information exchange.

Fig. 17 Hospital train, source https://sputniknews.com/voiceofrussia/radio_broadcast/2249159/3699285/

By and by satellite communications became inevitable part of providing healthcare services. Today satellites are widely applied in supporting remote and isolated regions, including arctic expeditions as well as in mobile eHealth.

A brilliant example of the last one are the hospital trains in Russia. There 5 such trains in the country that are in fact mobile diagnostic centers. The first hospital trains went into operation in 2004. The trains have medical equipment and personnel and travel from North to South and from East to West along the entire length of Russian Railways to diagnose and render medical assistance to residents in remote areas (Fig. 17). Patients can have electrocardiograms, X-ray and ultrasonic tests and can have their blood pressure and heart rate measured. The equipment on the train functions in any conditions, even in motion. As in ordinary clinics, patients are registered, examined, diagnosed and provided with recommendations for the future. If and when needed, residents of remote villages can get consultation from Russia's top specialists via satellite link.

The train makes a journey once a month for two weeks. It travels from station to station during the night and stops for work in daytime. Up to 150 patients receive medical consultations daily. Qualified medical assistance has thus become available to people living in remote regions of Russia

It is necessary to underline that one of the countries that may serve as an example is India. India has dedicated lots of funds and efforts to organize wide satellite network, which is use in healthcare too. Responsible for the satellites is ISRO (Indian Space Research Organization). ISRO Telemedicine programme started in 2001 has been connecting remote/rural/medical college hospitals and Mobile Units through the Indian satellites to major specialty hospitals in cities and towns. ISRO Telemedicine network covers various states.

Presently, the Telemedicine network of ISRO covers about 384 hospitals with 60 specialty hospitals connected to 306 remote/rural/district/medical college hospitals and 18 Mobile Telemedicine units. The Mobile Telemedicine units cover diverse areas of ophthalmology, cardiology, radiology, diabetology, mammography, general medicine, women and child healthcare.

ISRO provides Telemedicine systems software, hardware and communication equipment as well as satellite bandwidth. The state governments and the speciality hospitals allocate funds for their part of infrastructure, manpower and facility support. More information about ISRO telemedicine program is available at ISRO website http://www.isro.gov.in/applications/tele-medicine.

Apart from delivery of healthcare services, the satellite network is also used for continuous medical education and education of citizens. EDUSAT, was India's first thematic satellite, dedicated exclusively for educational services. It provided wide range of interactive educational delivery modes like one-way TV broadcast, video conferencing, computer conferencing, web-based instructions, etc. The program started in 2004 with 300 terminals. After 2010, the traffic from EDUSAT was migrated to other ISRO satellites.

As on December 2012, 83 networks have been implemented connecting to about 56,164 schools and colleges covering 26 States and 3 Union Territories of the country. About 15 million students benefit from the programme every year. The tele-education networks established by ISRO include the networks set up for users with special requirements like blind people, mentally retarded as well as for rehabilitation purposes. More information is available at ISRO web at http://www.isro.gov.in/applications/tele-education.

Internet

Since its appearance, Internet has a powerful impact on healthcare.

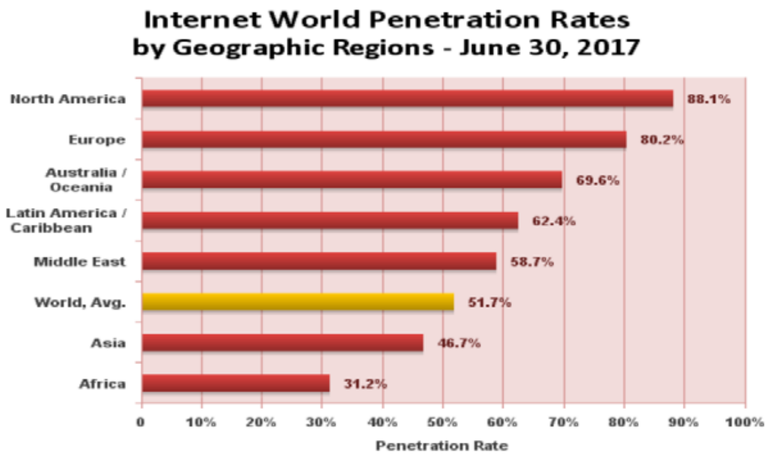


Fig. 18 Source: Internet World Stats. The graph is based on World population and Internet users as per June 30, 2017

The origin of the Internet dates back in the 1960s The ARPANET project (USA) is often cited as a precursor of Internet. Its goal was to build a robust communication via computer networks. The project initially supported remote psychiatric consultations. Later, it served as a backbone for interconnection of regional academic and military networks in the 1980s.

In the mid-1980s, ARPANET was split up into the Internet and MiliNet. Both systems were not user-friendly [39].

This changed when the hypertext markup language (HTML) was invented in European Organization for Nuclear Research (CERN, from French name *Conseil Européen pour la Recherche Nucléaire*) in 1990 by Tim Berners-

Lee. Several years later, the first graphical browser for the World Wide Web was developed.

The rapid acceptance of the Internet has been amazing. In 1995, nearly 5 million Internet hosts or computers provide Web pages. By 1997, there were already 16 million hosts [39]. At the end of the second quarter of 2017, the Internet users were 3 885 567 619 worldwide. This is more than the half of the world's population (51,68%) and the number is constantly increasing (Fig. 18) [40].

The 1980s the extensive funding from national and commercial sources led to worldwide participation in the development of new networking technologies, and the merger of many networks. The linking of commercial networks and enterprises by the early 1990s marked the beginning of the transition to the modern Internet.

Before 1993 as part of its some strategic frameworks, store-and-forward teleconsultations via the Internet were performed. Specially developed dynamic web-applications were tested and various types of medical multimedia information channels were employed [23].

It is impossible to list all Internet applications, yet it is worth stating that now:

Internet Is a Powerful Resource for Health Information

Surveys revealed that almost 80% of the Internet users have searched for some kind of medical information. The Internet, rather than physicians, is the first source of information for many people. Considering how easy it is to search in Internet it is not surprising that many people choose to make an attempt at self-diagnosis using the Internet instead or before waiting hours in crowded walk-in clinics or emergency departments to consult professionals [41]. By and by internet is accepted as an encyclopedic information resource. Many concerns have been raised about the quality of online health information, and the possibility that incorrect, insufficient or misleading information may have detrimental effects on health.

Healthcare professional also benefit from connecting internet. The increased access to clinical data, scientific papers, evidences, policy and guidelines, the chance to exchange ideas and concerns and share opinions as well as training and professional development are helpful. Health datasets, available online, tremendously facilitate research.

Internet Is a Tool for Delivery of Healthcare

Internet enhances communication and makes the connections between patients and medical staff and between healthcare professional easier.

The development of electronic patient records, e-prescriptions and the networking of primary and secondary care are improving the quality and efficiency of health services.

Immediate access to patient information and health history, distant consultations and data transferring, second opinions, organizing appointments, promotion of prevention and healthy life-style, education interventions, immediate notification for critical events, online support groups and virtual communities, fast and timely provision of healthcare in cases of disasters or conflicts, etc. are successfully delivered online.

From the other hand internet is changing the balance of knowledge between healthcare professionals and the public. It empowers patients/citizens and they become more involved in healthcare decision-making. However, the incorrect information, available online, is extremely harmful. It contributes to the de-professionalization of medicine and to distribution of ill practices. The problem with incorrect or biased information is serious and may countries and organizations are trying to overcome it. One of the articles in Part II is focusing on it.

Internet Has Effect on Public Health

The effect is at various levels – from increased education of citizens and enhanced prevention to virtual consultations, successful monitoring of elderly and management of chronic diseases to development of virtual communities and support groups. Yet, the ease of establishing such links, coupled with the anonymous nature of the internet, creates an environment, where deviancy can flourish.

Social media are extremely powerful in the areas just mentioned. They are becoming more and more utilized by hospitals and medical professionals as a means to convey general health information, sometimes even personalized help. From the other hand, many professional underline that social media, as Twitter for example, have to be considered as higher-risk environment, as it is an open forum.

If summarized, the benefits healthcare from Internet are:

- Improved outcomes of treatment - access to information in real time enables quicker decisions;
- Improved disease management - continuous patients' monitoring makes treatment timely and easier and prevents re-hospitalization;
- Decreased costs - significant cutting down on unnecessary visits by doctors, travels, hospital stays and re-admissions;
- Reduced errors and duplications by accurate and automated data collection, while e-prescriptions facilitates drug management,

diminish, and prevents mistakes. The latter also contributes to cost savings [42].

Yet, there are few challenges as well in implementing Internet:

- Legal and social responsibility - rules and regulations for internet use as well as for uploading information on the web are not clear and even do not exist. The boundaries between correct and incorrect may merge.
- Data security and the lack of standard security policy is another challenge.
- In addition, compatibility of medical devices, integration of hospital internet systems, ethical issues, widely accepted and agreed standards for data transmission, etc. are constant challenges.

In conclusion: Between 1880 and 1945 the main telecommunication facilities in medicine were the telegraph, the telephone and radio communications.

Telegraph was used for medical purposes from time to time, primarily during war conflicts.

In the 1920s models for healthcare service were developed, which used radio for care delivery wherever and whenever necessary, such as the system of emergency medical consultations in the transport field (marine medicine) and medical aviation service in combination with teleconsultations and instructions. The above models are still fully performing even now.

Telephone communication was initially used as a mean for simple consultations and coordination of healthcare practitioners' actions; however, it has become a multi-purpose telecommunication tool for various health information exchanges.

The television technologies were used as technological basis for interactive videoconferences in the 20th century. Initially, it was black and white television, although it did not have any significant value. It only demonstrated the possibility of application of new telecommunication equipment in medical institutions, including operating theatres.

The development of the color television in the late 1940s completely changed the opportunities and significance of medical videoconferencing making it an effective telemedicine instrument. Television communication itself was not always used at considerable distances. At the beginning, this was a connection between separate buildings. In number of countries, as part of certain projects, interactive videoconferences were performed within one building. However, large networks for distance learning and consultation were soon in use. From the point of view of functional load, medical videoconferences in the 20th century were mainly applied as a distance-learning tool. Nevertheless, they were also quite efficient in clinical medicine.

In the middle of the century, a separate application, telepsychiatry, was developed, based on videoconferencing technologies. Being an important telemedicine tool, videoconferencing developed significantly, allowing determining its role and place in healthcare service.

With the wide application of mobile phones, internet and satellites, these communication channels became the preferable resources. Now they are everywhere and are inevitable part of everyday healthcare practice. In Part II various examples are provided how they may change the way to organize healthcare services in order to reach everyone, at any time, everywhere and to approach the Millennia Goal – the Universal health Coverage. This is a complex, multifunctional goal and cannot be fulfilled without the active participation of telecoms.

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Problems and Challenges Faced by Developing Countries

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Why this publication is focusing of the role of eHealth for the Universal Health Coverage in developing countries? The answer is simple – today about 82% of the world's population live in developing countries (https://quizlet.com/171877046/chapter-7-flash-cards/). As projected, the situation will not be changed within next decades (Fig. 1).

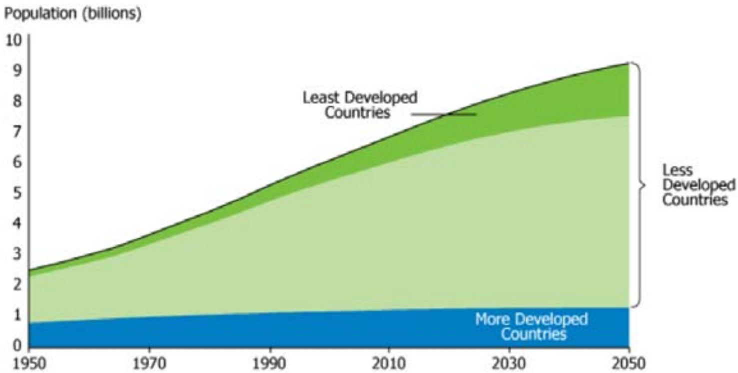

Fig. 1 Source United Nations Population Division, World Population Prospects: The 2010 Revision, medium variant (2011) https://www.quora.com/What-percentage-of-the-worlds-population-lives-in-developed-countries

Why this is so? The answer is in the definition of what a developing country is as well as in the differences between developed and developing countries.

A developing country, also called a less-developed country, is a nation with a low living standard, undeveloped industrial base, and low Human Development Index (HDI) relative to other countries. Nevertheless, there is no established convention for the designation of "developed" and "developing" countries or areas in the United Nations system. The common practice of United Nations (UN) is to consider Japan in Asia, Canada and the United States in northern America, Australia and New Zealand in Oceania, and Europe as "developed" countries or regions. In international trade statistics, the Southern African Customs Union is also treated as a developed region and Israel as a developed country. Countries emerging from the former Yugoslavia are treated as developing countries; and countries of Eastern Europe and of the Commonwealth of Independent States in Europe are not included under either developed or developing regions.

The International Monetary Fund (IMF) uses a more flexible classification system that considers: (1) per capita income level, (2) export diversification—so oil exporters that have high per capita Gross Domestic Product (GDP) would not make the advanced classification because around 70% of its exports are oil, and (3) degree of integration into the global financial system.

The World Bank classifies countries into four income groups. These are set each year on July 1. As per 1.07.2017, economies are divided according to their Gross National Income (GNI) as:

- Low income countries that had GNI per capita of US$1,005 or less in 2016;
- Lower-middle-income countries had GNI per capita of US$1,006 - 3,955
- Upper-middle-income economies are separated at a GNI per capita of US$3,956 - 12,235;
- High-income economies are those with a GNI per capita of >US$12,235 or more.

The World Bank classifies all low- and middle-income countries as developing but notes that "The use of the term is convenient; it is not intended to imply that all economies in the group are experiencing similar development or that other economies have reached a preferred or final stage of development. Classification by income does not necessarily reflect development status."

The above information is important and has to be remembered. There are some aspects, characteristic for developing countries that have always to be considered when discussions about eHealth implementation are held as they may both hinder and shape the eHealth development and wide application.

Financial and Health Care Problems

- The disease burden is different from that in the developed regions;
- The population is younger and is increasing faster as compared to developed regions;

- The medical services are un-efficient due to lack of sufficient number of both medical schools and specialists [1];
- The healthcare spending is times lower as compared to the developed economies.

In addition to the above, based on their experience, Madagascar reports [2] the some more obstacles on implementing eHealth strategy as follows:

- Lack of financing;
- Weakness of technical human resources to carry out the process;
- Low level of commitment to implementation on the part of professionals;
- Legal and regulatory aspects not behind schedule;
- Durability of services rendered by eHealth: the associated operating and utilization costs must be identified and covered by clearly identified institutions;
- Lack of interest on the part of citizens in the use of eHealth services.

The Digital Divide

This is one of the major problems for those that are planning or trying to implement eHealth services.

What is the digital divide? The term was introduced in 1990's [3] and refers to the gap between those who have access to and the ability to use information and communication technologies and those who do not.

The reasons for this divide are many – poverty at first place as well as education, literacy, age, gender, culture, exposure to ICTs, geographic location, infrastructure, connectivity, bandwidth and telecommunication costs. The digital divide occurs not only between developed and developing countries but also within countries, mainly between urban and rural areas.

The digital divide is an obstacle to implementation of eHealth in the developing world and in rural areas of the developed countries too. The expectations were that as infrastructure and connectivity improved, additional bandwidth became available, technology and communication costs came down, and mobile phone use increased, the divide would narrow. These have all occurred to varying degrees in much of the developing world, yet the digital divide remains.

In an article, M. Mars [4] revealed that the digital divide between developed and developing countries has not narrowed over the past 10 years and raises the question as to whether the divide will ever be narrowed. Theoretically, it should, but in practice, this is unlikely as technology continues to evolve. The conclusions of experts as to when the digital gap between developed and developing countries will disappear are not encouraging. That is why all eHealth related activities in the developing countries should be guided by a realistic understanding of the digital divide, its implications and the factors that drive it.

The Copycat Approach, Local Culture and Traditions, Communication Infrastructure

While there are successful eHealth, deployment models within last two decades the healthcare witnesses the failure of thousands of projects in eHealth. Even well developed and working in developed countries solutions, when implemented in the developing areas do not work well and failed. It is more than evident that copy-cat approach is not the best way for wide development of eHealth. Solutions broadly used in developed countries are not always what developing countries are really looking for or what they desperately need!

Lack of respect or even worst – ignorant neglect of local traditions and cultural characters also may blow up even the most carefully prepared eHealth business project. The cultural acceptance of every single eHealth initiative in developing areas is a condition sine qua non.

Infrastructure and lack of ICT skills also remain frustrating obstacles that may eliminate eHealth as a viable option in many areas. Developing countries in Africa, the Americas, and South-East Asia cited infrastructure as one of the greatest barriers to telemedicine implementation [5].

It is worth citing a 2015 survey focused on challenges and hurdles of eHealth Implementation in developing countries [6]. The latter was performed among experts and the results clearly indicated that according to them the important problems that need to be addressed in order to implement successfully eHealth in developing countries are dealing with:

- Cultural and educational problems (95% of the answers),
- Economic support policies of the eHealth status (58%), and
- Development of policies for long periods of eHealth usage (50%).

The Role of Telecommunications

The role of telecoms to support UHC in developing regions is crucial. At least there are two areas where the telecoms are irreplaceable – development of telecommunication infrastructure and educating qualified man power.

Providing the necessary infrastructure telecoms pave the way for the wide implementation of eHealth. The figures below reveal the enormous work that still has to be done. One of the first step has to be to overcome the un-adequately distributed network of infrastructure.

Figure 2 reveals the world internet usage at the end of second quarter of 2017 [7].

WORLD INTERNET USAGE AND POPULATION STATISTICS JUNE 30, 2017 - Update						
World Regions	Population (2017 Est.)	Population % of World	Internet Users 30 June 2017	Penetration Rate (% Pop.)	Growth 2000-2017	Internet Users %
Africa	1,246,504,865	16.6 %	388,376,491	31.2 %	8,503.1%	10.0 %
Asia	4,148,177,672	55.2 %	1,938,075,631	46.7 %	1,595.5%	49.7 %
Europe	822,710,362	10.9 %	659,634,487	80.2 %	527.6%	17.0 %
Latin America / Caribbean	647,604,645	8.6 %	404,269,163	62.4 %	2,137.4%	10.4 %
Middle East	250,327,574	3.3 %	146,972,123	58.7 %	4,374.3%	3.8 %
North America	363,224,006	4.8 %	320,059,368	88.1 %	196.1%	8.2 %
Oceania / Australia	40,479,846	0.5 %	28,180,356	69.6 %	269.8%	0.7 %
WORLD TOTAL	7,519,028,970	100.0 %	3,885,567,619	51.7 %	976.4%	100.0 %

Fig. 2 Population numbers are based on data from the United Nations - Population Division. Internet usage information comes from data published by Nielsen Online, by ITU, by GfK, by local ICT Regulators and other reliable sources

Around 51,67% of the world population has an internet connection today. In 1995, it was less than 1%. The number of internet users has increased

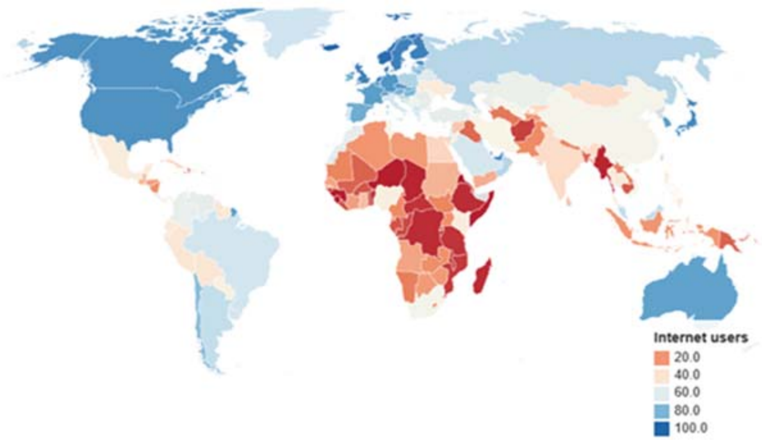

Fig. 3 Countries with the worst internet access. Source: https://www.indy100.com/article/internet-access-net-neutrality-infrastructure-data-map-statistics-world-global-computing-7508551

tenfold from 1999 to 2013 and the first billion was reached in 2005. The second billion in 2010. The third billion in 2014.

Fig. 3 presents the countries with the worst internet access. According to the data from Internet Live Statistics (http://www.internetlivestats.com) ~90% of Africa remains offline as per beginning of 2017. Even with a huge technical boom on the continent in recent years, the findings show that nine of the ten least connected countries in the world are in Africa.

As for the type of connectivity – it differs. A broadband signal is often not available now or may be too expensive to be installed. Its absence may hinder some eHealth applications as real time communication between medical staff or patient and healthcare providers. Satellite communications are expensive but in a long-term plan may be worthwhile to be considered. At the beginning a lower quality communication signal may be used to deliver eHealth services in addition to the extensive use of mobile phones services.

The mobile phones penetration is another source for eHealth implementation. Mobile phones are an indispensable part of everyday life for most people around the globe. According to the new *Digital in 2017 Global Overview Report* from We Are Social and Hoot suite [8] almost three-quarters of the world's population now uses a mobile phone, with the total

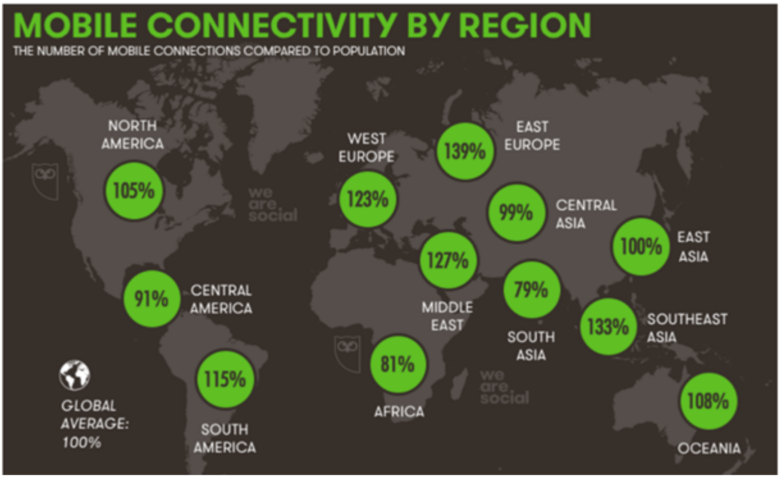

Fig. 4

number of unique global mobile users are exceeding 4.92 billion. With the price of smartphones and data traffic is falling around the world, convenient, always-on internet access will become even more reachable. Figure 4 presents the regional mobile connectivity, i.e. the number of mobile connections compared to the population. It is clear that when it comes to mobile subscriptions data, South Asia and Africa register the world's lowest levels of connectivity compared to local populations, with people in Eastern Europe maintaining the highest number of active mobile connections [8].

The number of smartphones, mobile phones with more advanced computing capabilities and connectivity than regular mobile phones, is also rising. They came onto the market in the late 90s, but gained popularity with the introduction of Apple's iPhone in 2007. The iPhone revolutionized the industry by offering customer friendly features such as a touch screen interface and a virtual keyboard. The first smartphone running on Android was introduced to the consumer market in late 2008. By 2018, over a third of the world's population is projected to own a smartphone, i.e. there will be almost 2.53 billion smartphone users in the world [9].

Today, the access to the internet is considered as a basic human right according to the United Nations Human Rights Council. The non-binding resolution was passed in June 2016. In the UN's 2030 Agenda, internet access is outlined as one of the core accelerators of development. It underlines that

> *"The spread of information and communications technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies, as does scientific and technological innovation across areas as diverse as medicine and energy.„*

Irina Bokova, the director-general of the UN Educational, Scientific and Cultural Organization said:

> *"The 2030 Agenda recognizes the power of new technologies to accelerate human progress, to bridge the digital divide, to develop knowledge societies – we must do everything to support States in reaching these goals, especially developing States.„*

Internet and mobile phones, as channels to access information support the UN Sustainable Development Goal 3, which seeks to "ensure healthy lives and promote well-being for all at all ages". Their availability worldwide, at an affordable price, will support the faster achievement of UHC. This cannot be reached without the active involvement of telecoms.

Telecommunication providers have also a significant role in the training of qualified man-power. The practice of eHealth and the use of eHealth devices requires the assistance of trained personal. The implementation of eHealth has to go hand in hand with appropriate training programs for the healthcare providers, medical doctors, nurses or assistants as well as for medical students and, if and when necessary citizens and relatives of patients. These programs have to cover both the clinical as well as the information and communication technology aspects of eHealth. The healthcare provider have to be trained for operation and understanding of communication infrastructure in order adequately to use it [10].

In addition, providing inexpensive ways to access information, telecoms will also support and participate in the creation of digital and information literacy and skills among citizens. This will not only encourage access to information and knowledge, but creation and production of information and knowledge as well. When more people participate in creating and sharing information, our collective and individual knowledge grows and deepens. There is huge potential for access to information to have a transformational role in better health.

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The Role of eHealth Economics

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One of the strategic promises of eHealth is to increase efficiency in health care, i.e. to ensure high quality medical care 24 hours a day, 7 days a week to all citizens, no matter where they and at the same time to decrease the total health expenditure.

The total health expenditure, i.e. the sum of public and private health expenditures of all countries (Fig. 1), as a percentage of their Gross Domestic Product (GDP), are gradually but steadily increasing during last decades and soon will reach the level when the burden of the costs will be no more bearable.

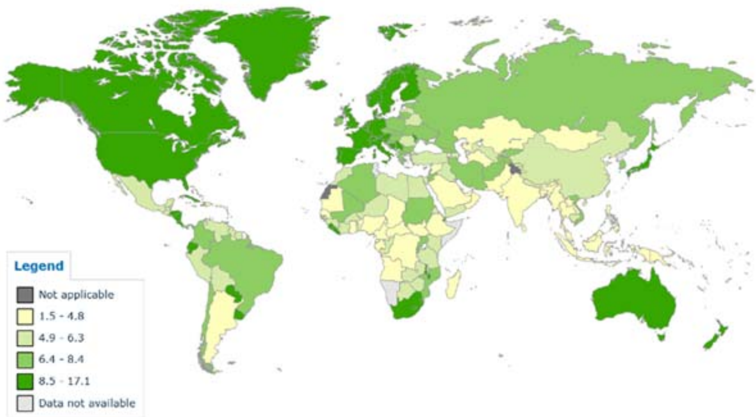

Fig. 1 Total expenditure on health as percentage of Gross domestic product for 2014. The data are based on updates in 2016. Source: http://apps.who.int/nha/database/World_Map/Index/en/

Deloitte, in their annual publication [1] cite that Global Health Care spend is projected to reach $8.7 trillion by 2020. The percentage of GDP spent on health care should rise globally to 10.5 % in 2020. Different regions will vary in the growth of healthcare costs. (Fig. 2).

It is obvious that developing countries are not able to ensure the same amount of funds for healthcare. The wide application of eHealth is the way

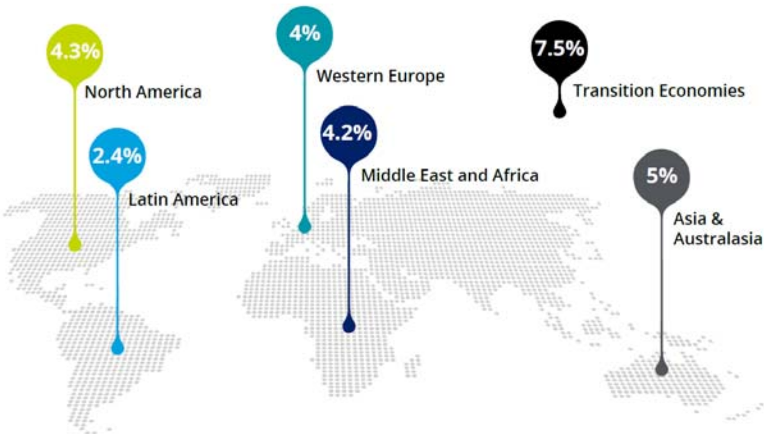

Fig. 2 Projected Health care growth rates through 2020 [1]

to try to achieve better healthcare for their citizens and to approach the UHC goal. Yet, before applying eHealth, politicians would like to know whether this is economically feasible.

The debate whether eHealth applications are cost effective or not is rather serious as eHealth development and wide application is part of the health policy strategy of many local governments as well as of international bodies as WHO, ITU and the European Union. The problem of cost effectiveness of eHealth is vital. The correct, non-biased answer may push the decision makers to take final choice in favor or not in favor of eHealth implementation.

The text summarizes the latest achievements in the field of eHealth economics and answers two questions:

- Is cost effectiveness a characteristic of eHealth?
- How to evaluate the potential monetary effect of eHealth application priory its implementation.

eHealth Economics

The role of eHealth economics is to assess the costs and benefits of an eHealth initiative over time and for several stakeholders, including citizens, patients, careers, health professionals and other health workers, healthcare provider organizations and payers.

Initial studies on cost effectiveness [2] as well as some other publications [3] are definite – there is no good evidence that eHealth is a cost effective way to deliver healthcare. Some authors even underlining that the costs are greater for the remote consultations than for conventional outpatient appointments, although they supported the hypothesis that losses in productivity are lower [4].

Data from more recent studies on eHealth economics focusing on large-scale studies (i.e., based either on a large number of consultations or years of experience) are just the opposite, to cite some:

- A Japanese study, published in 2013, examined the long-term effects of the use of eHealth on the residents of Nishi-aizu Town, Fukushima, Japan, between 2002 and 2010. The authors compared medical expenditure and days of treatment between telecare users and non-users when chronic diseases (stroke, hypertension, heart failure, and diabetes) are concerned. Applying rigorous statistical methods, including system generalized method of moments, they have revealed that telecare users require fewer days of treatment and lower medical expenditure than non-users [5].
- A detailed survey revealed the outcome of a five-year period of telepediatric consultations. The authors underlined that the total cost of providing 1,499 consultations was $ 955,996 (Australian dollars). The estimated potential cost of providing an outpatient service to the same number of patients at the Royal Children's Hospital in Brisbane was $ 1,553,264; thus, telepediatric services resulted in a net saving of approximately $ 600,000 to the health service provider [6].
- The strongest evidence for the efficacy of eHealth in clinical outcomes comes from home-based monitoring of chronic disease management, hypertension, diabetes, and AIDS. There is also reasonable evidence that eHealth is cost saving and with an equal quality to face-to-face care in emergency medicine, and is beneficial in surgical and neonatal intensive care units, as well as patient transfer in neurosurgery [7].

Why are there such contrasting views of the eHealth cost effects? The answers are:

- Limited data or analyses based on journal articles published mainly in “Telemedicine and eHealth” and “Journal of Telemedicine and Telecare”. The two journals published predominantly papers from English speaking communities;

- Small sample sizes – the majority of the studies are based on samples with fewer than 100 participants;
- Very few papers measured the outcomes directly linked to eHealth solutions;
- Only 26% of the studies reported a time frame, which is an essential parameter in determining long-term cost benefits;
- Poor evaluation tools and lack of well accepted methodology;
- Long time to breakeven point;
- Constants technology and cost changes.

When considering the results of long duration studies in countries as Brazil and Russia, the data are quite interesting and convincing.

What, Where, How Much

According to the estimates of West Siberian physicians, based on almost ten years of eHealth practice, patients paid an approximately 40 times smaller fee for the virtual consultations rendered by a highly qualified Moscow expert, than they would have paid, if they'd had to make a trip to Moscow to consult this same expert. The quality of the service is the same [8]. The same authors [9] have done a detailed analysis of return on investment cost in e-clinics and demonstrated that the return on investment starts after an initial period of 2.5 years. Although most of their publications are in Russian, it is interesting to follow at least those published in other languages or translated, as the return on investment is only one of 20 indexes applied in their telemedicine economic analyses.

Another example is the telecardiology service in the State of Minas Gerais in Brazil [10]. The State of Minas Gerais has a territory equivalent to the size of France and a population of 19,000,000 living in 853 cities. Telehealth Network of Minas Gerais includes 780 municipalities with >1000 telehealth sites counting 48 ambulances at primary care, secondary care and urgency. They have performed >2,6 millions of diagnostic exams and 75000 teleconsultations. The telecardiology part of the service is operating since June 2006 in 82 remote and isolated villages. Preliminary results of the evaluation of economic feasibility of the long-term application of telecardiology service have shown that the savings resulting from a 1.5% reduction on the number of treatments outside the village are sufficient to cover the operational cost of the system [10].

Wisely chosen eHealth applications are beneficial everywhere. In a study from a comparatively "smaller" country, Italy, in 2001, a 24/7 toll-free telephone hotline service for children and adolescents with Type 1 diabetes was organized in the Parma region [11]. An extensive survey, carried out from beginning of 2001 until the end of 2006, showed that the total number of children receiving help was 421 (mean age of 10.8 years with a mean duration of diabetes of 4.5 years). Within the five year period 20,075 calls were recorded, or an average of 11 calls per day. Fifty two percent of the calls were emergency calls. Thanks to the available service, the admission to hospital because of diabetic ketoacidosis fell from an average of 10 cases per 100 children per year to three cases per 100 children per year. In other words, the costs for admission decreased by 60% [11].

Since 1994, an eHealth service has been offered in Nishiaizu Town, Japan. Vital physiology parameters are transmitted to a remote medical institution monitoring patients diagnosed with high blood pressure, cerebral infarction, strokes, diabetes, and in the elderly. Several papers [12-13] analyzed the cost effectiveness of the system. They outlined that medical expenditures for lifestyle-related diseases of eHealth users have dropped by 20.7%. The authors also demonstrated that long-time eHealth users had lower medical expenditure than those who used it for a shorter time, a result that once again proved that if we are looking for cost–effectiveness it is necessary to concentrate on large scale and long lasting studies.

Our results also proved that eHealth applications could be cost effective. However, it is always necessary to ask the question: cost benefits for whom. The results of implementation of telepsychology consultations in Bulgaria are promising. Based on almost 6,000 hours of virtual consultations over five years it is clear that clients are saving money [14]. Virtual consultations are three to four times cheaper, compared to face-to-face visits.

How to Evaluate the Economic Effect

It is necessary to underline that there is no a well-accepted and recognized methodology to estimate the economic effect of eHealth implementation. One of the easiest ways is to calculate the return of investment (ROI). ROI is a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. To calculate ROI, the benefit (return) of an investment is divided by the cost of the investment; the result is expressed as a percentage or a ratio.

Another, and probably a better way to judge the economic efficiency, especially in the most widespread case – those of introducing distant consultations and/support, is by taking into consideration:

- The number and distance for referrals, personal and transportation costs, depreciation, taxes and insurance of vehicles used for transportation and communication costs;
- The cost for addition administration, technical and clinical staff costs and communication costs;

- Considering in addition all costs to operate the system plus depreciation and capital cost and dividing this sum by the number of activities developed, is possible to calculate the eHealth unitary activity cost.

In addition, the eHealth activity efficiency, defined as the percentage of avoided referrals caused by the use of eHealth in relation to the total number of referrals, may also be calculated [15].

While comparing costs to benefits, it is possible to establish the minimum number of eHealth activities (equilibrium point) where the system becomes economically feasible and to evaluate the savings [15].

Yet another relatively easy way of estimating the economic effect is proposed in Brazil [16]. The method is derived from enormous pool of eHealth applications – over 33 000 teleconsultations and 850 000 distant ECG analyses provided in 86 municipalities in a period of 5 years. As the method is based on extensive amount of data, it is worth dedicating more space to it and to present it in details.

The authors take into consideration the parameters unitary referral variable cost (RVC) and referral distance (D):

$$RVC = a.D \qquad (1)$$

where “a” represents transportation cost per kilometer.

It is necessary to underline that only the variable cost is applied in the analysis. The reason is simple – eHealth applications do not reduce 100% of the referrals and consequently the fixed costs, such as personal and depreciation, are kept and the savings are based only on variable cost.

The saving (S) of eHealth, applications have to be calculated as:

$$S = \eta .\ RVC = \eta .\ a.D \qquad (2)$$

where η is the eHealth activity efficiency or this is the percentage of avoided referrals caused by the use of eHealth in relation to the total number of referrals. Thus, in order an unitary eHealth activity (UAC) to be economically efficient its cost has to be at least equal to the saving (S) or

$$UAC = \eta .\ a.D \qquad (3)$$

Based on this simple equation, the minimum distance for cost effectiveness has to be:

$$Dmin = UAC/\eta .a (4)$$

If the referral distance for a specific city/medical practice/municipality, calculated as weighted average of number and distance of referrals, is greater than Dmin the implementation of the system will result in savings for that particular city/medical practice/municipality. Based on their experience so far, the authors [16] had calculated that the minimal distance for economic feasibility is 20 km, i.e. introduction of eHealth applications that will reduce referrals far from 20km is economically feasible. In addition, it has to be noted that as the activity efficiency increases or the unitary activity cost decreases even short references distances makes the system economically reasonable.

The authors continue to elaborate their cost evaluation model [17-18]. The latter is designed especially for municipalities in low resource areas in order to permit their health managers to estimate the effect of eHealth application on municipal health budget in advance. The authors also provide a short educational video for authorized users. It is worth following their publications.

Conclusion

Developing countries are facing serious problems in adapting the health care system and securing adequate health service for all, 24 hours 7 days a week. eHealth becomes a must. As most of referral costs are related to patient transportation, knowing (a) the distance to the referral centers and (b) the average number of patients referred from one city to another, it is possible to pre-calculate the economic aspects of introducing specific eHealth applications in every single case.

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Standardization in eHealth

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Towards Technical eHealth Standardization

eHealth standardization is extremely complex question and is one of the main obstacle hindering the implementations of eHealth. It concerns both developed and developing countries.

In spite of the huge amount of money and work spent in this field, the result is rather poor. In fact, eHealth sector suffers due to lags in standardization. Many eHealth solutions are developed. However, these solutions are still too often isolated islands of small-scale applications, unable to communicate with other health systems and/or share information with other devices or systems, developed from other companies.

In order to ensure the wide deployment of eHealth applications in developing countries, it is important to achieve interoperability among systems and thus to reduce the cost of devices and of the services. Consequently, the development of global, widely accepted and respected international standards with the involvement of the major players, i.e. governments, international organizations, non-governmental organizations, medical institutions, service providers, etc., is a key factor to achieve this and make the next step towards UHC. As this is not yet a reality, local decision and policy makers are not always able to assess the actual health situation, which in turn inhibits comprehensive planning, response and policy formulation.

ITU's Standardization Sector coordinates the technical standardization of multimedia systems and capabilities for eHealth applications. The Sector has released two Technology Watch Reports [1-2], focusing on eHealth, standards and interoperability. These reports observe that eHealth development requires more universal ehealth interoperability standards, and strategies to overcome technical infrastructure barriers and address privacy, security, and other legal requirements. Some of the other documents publish by the Standardization Sector, concentrating big data paradigm, the spatial standards for the Internet of Things and standards for technology-enabled learning, are also relevant to various aspects of eHealth implementation [3-7].

At present, there are many generic standards used in eHealth applications for video coding, security, multimedia transmission, and languages for instance. Most of them were developed by ITU-T or in close cooperation with ITU. These, and other issues, are being addressed by experts within ITU-T Study Groups 15, 16 and 17 (Security), the Focus Group on Machine-to-machine Service Layer as well as by other external standardization bodies. International Standards for eHealth need to be based on already existing "mature and stable technologies" rather than only on future advanced technologies.

The ITU Plenipotentiary Conference 2010 in Guadalajara, Mexico adopted a new Resolution 183 on "Telecommunication/ICT applications for e-Health". It was "*calling ITU to give priority consideration to the expansion of Telecommunication/ICT initiatives for eHealth and to coordinate ehealth-related activities between the Standardization, Development and Radio communications sectors and, in particular, to promote awareness, mainstreaming and capacity building in the creation of telecommunication/ICT eHealth standards, reporting findings to the Council as appropriate*". In addition to the Resolution 183, the "Strategic Plan for the Union for 2012-2015" was approved. It underlined that one of the strategic objectives for ITU-T is "*Bridging the standardization gap: to provide support and assistance to developing countries in bridging the standardization gap in relation to standardization matters, information and communication network infrastructure and applications, and relevant training materials for capacity building, taking into account the characteristics of the telecommunication environment of the developing countries*". It exactly concerns that eHealth technical standards have to be appropriate for existing network in developing countries.

The World Telecommunication Development Conference in Hyderabad, 2010 also approved also the Resolution 65 on "Improving access to healthcare services by using information and communication technologies". The latter stated "*…to continue to promote the development of telecommunication standards for eHealth network solutions and interconnection with medical devices in the environment of developing countries, in conjunction with ITU-T and ITU-R in particular*".

The importance of this topic was again underlined in the Resolution 78 – "Information and communication technology applications and standards for improved access to e-health services" adopted during the World Telecommunication Standardization Assembly at Hammamet, 25 October – 3 November 2016. This resolution resolves to "*instruct the Director of the Telecommunication Standardization Bureau, in collaboration with the*

Director of the Telecommunication Development Bureau and the Director of the Radiocommunication Bureau:

- *To consider with priority the enhancement of telecommunication/ICT initiatives in e-health and to coordinate their related standardization activities;*
- *To continue and further develop ITU activities on telecommunication/ICT applications for e-health in order to contribute to the wider global efforts concerning e-health;*
- *To work collaboratively with WHO, academia and other relevant organizations on activities related to e-health in general and to this resolution in particular;*
- *To organize seminars and workshops on e-health for developing countries and gauge the needs of the developing countries, which are the countries with the greatest need for e-health applications*."

The resolutions, cited above, are just sketches. The work on eHealth standards never stops. A brilliant example is the Report of the Final Report for Question 2/2: Information and Telecommunications/ICTs for e-Health from 2017. It includes extensive description of development of eHealth standards as well as list of applicable standards updated or developed within last years. The report for the period 2014-2017 is available for free at https://www.itu.int/pub/D-STG-SG02.02.2-2017. Some of the Annexes of this report, i.e. Annex 2.1 and 2.2 provide glimpse at the standardization efforts of IEEE (The Institute of Electrical and Electronics Engineers) and of the International Organization for Standardization (ISO).

eHealth Quality Standards

While discussing standards, it is essential to distinguish between technical standards and standards for healthcare service delivery, i.e. quality standards.

The successful development of eHealth services necessitates as high level of trust among healthcare staff, service providers, service users and careers. The need for such trust has repeatedly been called for at both national and international levels.

One of the solutions to achieve the above, is the development of a comprehensive Code of Practice for eHealth Services. This is a long running task as such Code has to provide a benchmark standard for services that will assist both service providers and users and will support national and cross-border initiatives to overcome the barriers to effective development of eHealth services. In addition, such Code is not a static one and has to be constantly up-dated.

Telecare Services Association (TSA) executed one of the first attempts to create and introduce such Code. TSA is a not-for-profit organization, the largest industry specific network in Europe. Its members are over 350 organizations, predominantly from the United Kingdom and Europe. TSA members are local authorities, health and private sector care service providers, technology suppliers, telecoms and infrastructure providers supporting about two million telehealth service users mainly in the UK. TSA has developed two Codes:

Telecare Code of Practice (COP) is the first. It was inspired by the wide development of the telecare industry in UK. This industry interacts directly with individuals, who may be vulnerable, elderly or suffering from a long-term condition. As the need for stringent standards becomes imperative in order to provide reassurance, not only for the service users, their families and careers but also to those who commission these services, TSA dedicated time and efforts to develop the COP. The latter is a result of the widest stakeholder consultation exercise, including government departments in England and the administrations of Scotland, Wales and Northern Ireland. COP is structured in a modular framework. Each module is related to different components of a telecare service.

Telehealth Code of Practice is the second Code developed by TSA. Its creation was a business priority. TSA brought together members of its Telehealth Forum – made up of leading policy and opinion makers, technology and service providers, and other interested parties – to help determine the scope of a tender specification. The group recognized that, while there were distinct service standards applicable only to telecare or telehealth, there was also a considerable amount of shared aims across both. The conclusion was the need for a fully integrated Telecare and Telehealth Code of Practice, with elements that recognized the specific requirements of either telecare or telehealth. It again has to have a modular structure (Fig. 1), that makes it flexible enough to allow the Code to reflect local operating practices, legislation and policy.

More information about TSA Codes and their latest version is available at http://www.telecare.org.uk/standards/telecare-code-of-practice.

The European Union (EU) also has its Telehealth Services Code of Practice. A consortium of 13 partners from seven European Member States developed it. The work was funded under the European Commission (EC) Programme of Community Action in the Field of Health. The *Telehealth Services Code of Practice for Europe* provides a benchmark standard for services that assists both service providers and users and, in so doing, supports EU initiatives that endeavor to build trust in and overcome the barriers to effective development of telehealth services in all EU member states.

The approach taken within the Code can be clearly seen to reflect a view that telehealth services can and should help to meet the needs of people of all ages – both with regard to aspects of their clinical health and broader well-being. The critical areas set out in the draft Code are shown in Figure 2. The Code provides a welcome framework to guide telehealth service providers in all member states of the European Union and a potential basis by which telehealth services to be able to be certified and/or regulated.

TSA Integrated Telecare and Telehealth Code of Practice Matrix

tsa telecare services association	PROCESS MODULES								
	ACCREDITED SERVICES								
	Service Blueprint	Referral	Assessment		Service Set Up		Monitoring	Response	Re-Evaluation
Standards Modules	Service Blueprint	Referral/Risk Stratification	User Profiling	Telecare/ Telehealth Plan	Service Tailoring	Installation	Monitoring	Response	Re-Evaluation
Safeguarding	✓	✓	✓	✓	✓	✓	✓	✓	✓
Organisational and Clinical Governance	✓	✓	✓	✓	✓	✓	✓	✓	✓
Staff & Training	✓	✓	✓	✓	✓	✓	✓	✓	✓
Information Governance	✓	✓	✓	✓	✓	✓	✓	✓	✓
Partnership Working	✓	✓	✓	✓	✓	✓	✓	✓	✓
User Communication	✓	✓	✓	✓	✓	✓	✓	✓	✓
Managing Access/ Working in the Home			✓			✓	✓	✓	✓
Technology Management						✓	✓	✓	
Business Continuity	✓					✓	✓	✓	
Development of SC							✓		
Legislation (inc Health & Safety)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Key Performance Indicators	✓	✓	✓			✓	✓	✓	✓

✓ Telehealth only ✓ Telecare & Telehealth SC = Service Centre

Fig. 1 TSA Integrated Code of Practice Matrix. Source https://www.tsa-voice.org.uk/standards/telecare-code-of-practice/integrated-code-of-practice-matrix

The European Code of Practice for Telehealth Services served as a fundament for the development of the next Code – the International Code of Practice for Telehealth Services. Its latest version, from 2017, is available for free at http://telehealth.global.gridhosted.co.uk/download/2017-V2-INTERNATIONAL-TELEHEALTH-CODE-OF-PRACTICE-MASTER.pdf.

eHealth Codes of Practice for Developing Countries

Development of eHealth code, applicable to developing countries, is not an easy task as it has not only to ensure trust and confidence in the wide implementation and use of eHealth services but it must also reflect the local traditions, cultural and religious aspects. Having in mind this, a possible solution may be to follow the main principles that such Code has to be based on. As an example the referral-to-response model adopted by TSA in the preparation of the COP may be applied (Fig. 3) [8].

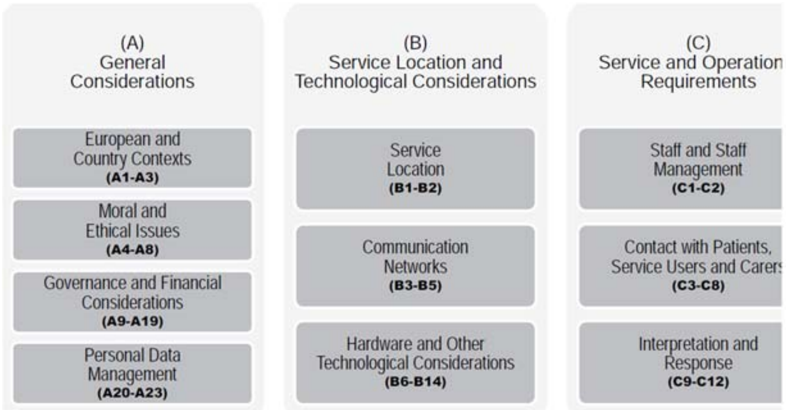

Figure 2: Areas that the European Code of Practice for Telehealth Services addressed

The model include the following components:

- Referral – the initial contact made by potential service users with the service provider.
- Profiling – examines the needs of the individual. Based on the exams the eHealth services are identified.
- Service set up – the eHealth service installation.
- Monitoring – part of it has to be an effective and reliable back-up channel.
- Response – the provision and emergency responder service.
- Re-evaluation – to ensure smooth ongoing service and appropriate changes, when needed.

Of course, the areas covered by the European Telehealth Code of Practice must also be included, if appropriate. Once such principles are outline, each country may easily adapt the Code having in mind national healthcare and eHealth infrastructure, available and/or desired services and needs.

This text outlined some basic problems that have to be taken into account while planning or introducing eHealth services such as eHealth technical and service standards.

Unfortunately, nowadays, the lack of compulsory governance structure and standards to guide the development of eHealth systems across the health

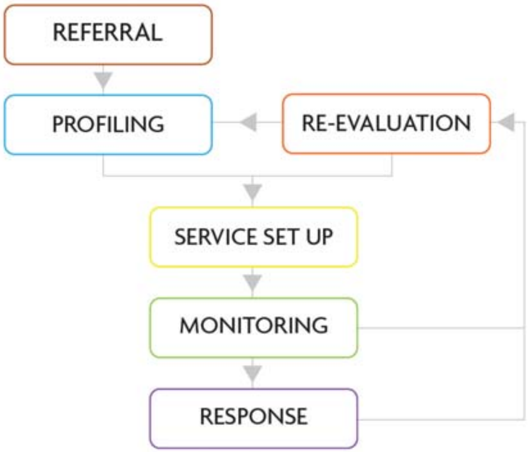

Fig. 3 Referral response model of TSA

sector is one of the leading cause of interoperability problems [9-10]. As it is underlined in [9] there is the need for new approaches to challenge the delivery of practical and affordable standardized and interoperable ehealth solutions across health systems in developing countries and not only there. These approaches need to focus on working cheaply, more effectively and pragmatically with professionals, researchers, and industry experts. Open Source software or Free Software technology offers such solution. Next section provides valuable information about open source in eHealth.

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Healthcare Strategies Using Telemedicine and Sharing Know-How in Open Source

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Introduction

Despite increasing investments in health, societies are not becoming healthier and the global challenges either remain or new challenges arise. One of the main challenges is the lack of health care professionals especially in low resource settings. A patient usually requires the care of a multidisciplinary team of healthcare professionals. Experts are a scarce resource and cannot be everywhere, particularly in remote and developing regions.

Telemedicine, which already exists several decades, holds a great potential to alleviate this situation by providing expert knowledge over distance, by coordinating the work of health care teams around a patient and thus contributing to a more effective and efficient health care delivery. However, although many useful applications have been developed and many problems have been already solved, most of these solutions are not disseminated and adopted at a large scale and the implementation starts over and over again in different locations.

One possibility to overcome this "reinvention of the wheel" and the current fragmentation of solutions is the use of Free/Libre Open source software (FLOSS). FLOSS is a software that is licensed in a way that grants the user the right to study, modify and improve the source code and thus gives the user the possibility to adapt the system to local needs and requirements. Some famous examples from other domains are the GNU/Linux operating system, the Android mobile phone operating system, the Apache Web Server and many other tools like Office Suites or Content Management Systems.

Free/Libre and Open Source Software in Health Care Delivery

As an example for the domain of telemedicine, the project IPATH [1] provides services to remote hospitals that can perform a surgery, but have no pathology expert on site to evaluate the meaning of pathology slides. IPATH

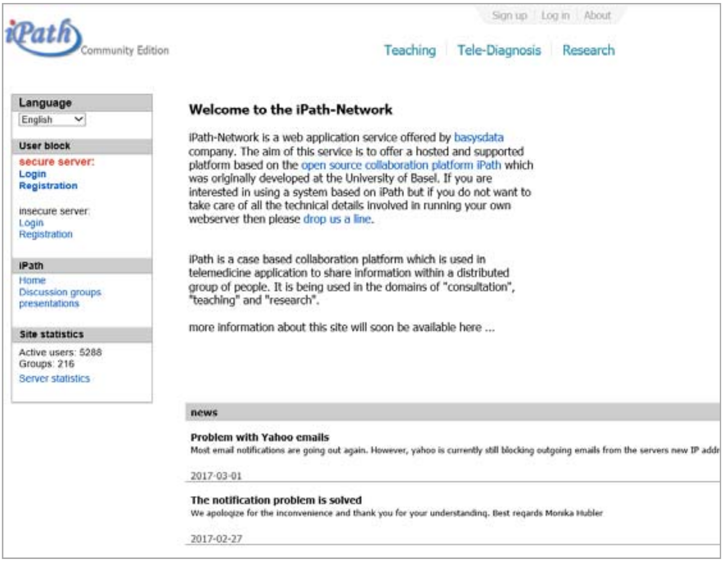

Fig. 1

is working for more than 12 years and is used by many different medical teams to coordinate their work, to discuss cases, to use it for capacity building or teaching. IPATH has been first tested on the Solomon Islands [2] and now covers a global network with more than 4400 users and currently 172 different groups. The IPATH software is freely available and can be downloaded and modified, installed on local servers and adapted if needed (Fig. 1). This is only one of many examples how FLOSS can serve the community. The MedFLOSS database [3] lists more than 350 software systems available under a FLOSS license (Fig. 2). This database has been co-developed and is supported by the "Collaborative Care Team in Open Source (CCTOS) Working Group" of the International Society for Telemedicine and eHealth (ISfTeH, www.isfteh.com) [4].

Sharing of Knowledge and Resources

Healthcare activities are similar in every region of the world, although taking account of some cultural differences. There is no reason to start from scratch again and again in every country. The goal is to share know-how not only about medical knowledge, but also about software, including the full documentation. Open source is a way to avoid dependency from any single informatics provider who could not provide the desired work or could raise the prices unilaterally. Open Source is a factor of quality making peer review easily possible. Moreover, transparency allows to control that the software is doing what it is intended to do and nothing else.

However, Open Source limits the costs, but is definitively not completely free. Indeed every new installation requires support for installation and training of the first users. This means that regional professional support service is essential for the adoption of FLOSS solutions by health care providers.

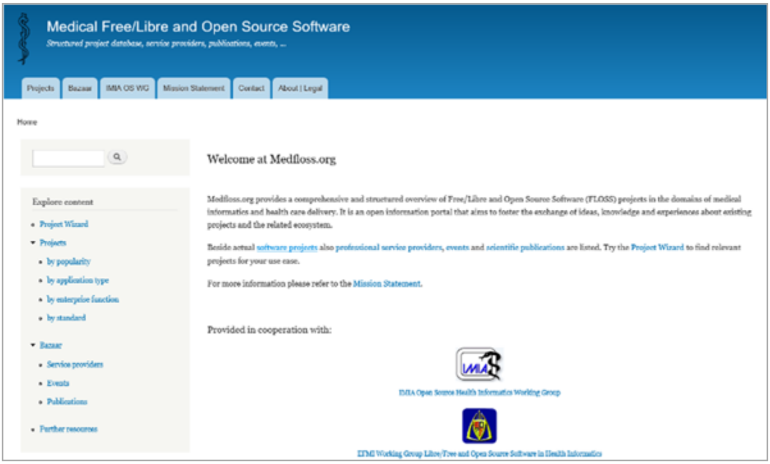

Fig. 2

Collaborative Care – A Team Based Approach

As outlined above health care professionals are a scarce resource. In order to be efficient, the care teams need to share well documented patient records. Questions to a higher level of expertise and specializations need to be well formulated. The main objective is to help to solve patient problems. A "health issue" is here defined as any health concern requiring attention. At an early stage, there is not enough data for a qualified diagnosis. When the health issue will become better understood, it may become a diagnosis. The main steps of a diagnostic procedure are:

1. To record complaints and observation;
2. To identify one or several likely issues;

3. In function of these issues, to take decisions about appropriate actions, more examinations and/or treatments.

These three steps are repeated in an iterative way, as soon as new observations become available.

Most of the available tools do not support this iterative diagnostic procedure and thus do not support the medical workflow in an optimal way. This leads to a lack of adoption of eHealth tools on the side of health care professionals and thus compromises the transition to a paperless and more efficient health care provision. The Collaborative Care Team Open Source Working Group (CCTOS WG) works on a prototype that implements the workflow of a diagnostic procedure and reflects more the “medical methodology” that the traditional user interfaces that have been adopted by most of the eHealth tools.

As already pointed out health care delivery is similar all over the world and differs due to cultural and financial differences. However, health systems are very different and therefore Health Information Systems have to be adapted to local requirements. FLOSS is ideally suited for this situation since it allows the user to access the source code, study, modify, adapt, improve and redistribute the code. This also helps to build capacity in the regions. Since health care providers do need professional support services, FLOSS provides the best opportunity to create local IT (information technology) support companies that can take over the support and maintenance of health information systems.

Best Practice Examples of FLOSS in Health Care Systems

OpenMRS is an open source electronic medical record system and one of the pioneers of EMR systems for low resource settings. Started as a project to create an open EMR for HIV/AIDS [5], openMRS has now grown into a large system with different components and has also a large developer and user community.

GNU Health is an award winning Hospital & Health Information System, especially for low resource settings [6]. Jamaica is the first country in the world to choose a Free/Libre Open Source Software (FLOSS) system for their entire public healthcare system. In 2013, the Jamaica Ministry of Health opted for GNU Health, a Free Health and Hospital Information System under the GPLv3+ license. More installations of GNU Health can be found in Argentina, Malaysia, Kenya, Laos and the Philippines. Recently, GNU Health has been ported to run on a Raspberry Pi board powered by the OpenSUSE operating system [7].

OpenClinic GA is a free and Open source hospital information management software [8]. It is an integrated information system for limited resource health facilities integrating patient identification, administrative record, financial management, health insurance management, medical record, laboratory, medical imaging/PACS, pharmacy, meals management, coding and classification standards with extensive statistical and reporting capabilities. Easy to use through a web-based interface, the system is currently implemented by more than 500 health facilities worldwide ranging from small health centres up to large university teaching hospitals.

The District Health Information System **DHIS2** [9] is considered one of the largest health management information system and is used in more than 30 countries.

The **Bika Open Source LIMS** project provides an open source laboratory information system [10]. Bika Lab Systems from South Africa develop Bika LIMS.

The FLOSS approach is not restricted to low resource settings. As an example, the OSCAR system developed at the McMaster University in Canada has grown into an ecosystem of different applications and has a growing number of companies providing support and an active user and developer community [11]. OSCAR currently serves more than 1.5 Million patients.

Table 1: Examples of Free/Libre and Open Source Software Systems in Healthcare

Name	Type of System	Website
OpenMRS	EMR	http://openmrs.org
GNU Health	HIS	http://gnu.health.org
OpenClinic GA	HIS	https://sourceforge.net/projects/open-clinic/
DHIS2	District Health Information System	http://dhis2.org
Bika LIMS	LIS	https://www.bikalims.org/
Care2X	HIS	http://care2x.org
iPath	Collaboration platform	http://ipath-network.com

Conclusions

Collaboration is key to solve the challenges of health care delivery on a global scale. This is true for the process of health care delivery where all stakeholders should work in a team-like fashion as well as in the process of developing software systems to support health care delivery.

Free/Libre open source principles provide excellent framework conditions to develop systems in a user-driven and evolutionary way as well as building regional capacity in small and medium enterprises that provide professional support services for health information systems. The MedFLOSS database lists more than 350 systems from different domains of healthcare that are available under an open source software license and provides a good starting point for the interested reader to further explore the FLOSS approach in health care.

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Part II: Lessons Learned – What, Where, How

Prevention

As WHO underlines prevention consists of two sections – disease prevention and health promotion.

Disease prevention is understood as specific, population-based and individual-based interventions for early detection of diseases. The aim is to minimize the burden of diseases and associated risk factors. Vaccination, provision of information on behavioral and medical health risks, measures to reduce risks at the individual and population levels, screening programs for early detection of diseases, etc. are just some examples of disease prevention.

Health promotion is the process of empowering people to increase control over their health and its determinants through health literacy efforts and multi-sectoral action to increase healthy behaviors. More details are available at http://www.emro.who.int/about-who/public-health-functions/health-promotion-disease-prevention.html.

Deployment of Mobile-based Child Immunization Alert System (CIAS) in an Indian Setting

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Introduction

Infant mortality is inversely associated with immunisation [1-2]. In 2008, WHO estimated that 1.5 million deaths of children under the age of five were due to diseases that could have been prevented through vaccinations.

In India, for the year 2012, the immunization coverage in the rural areas stood at 58.5% whereas the national average was 61% [3]. The major reasons for such dismal indicators are:

- Lack of awareness: Majority of the mothers are not aware about the vaccines [2-3];
- Lack of knowledge: With the prevalence of traditional beliefs, people feel that their child should develop 'natural immunity'[4];
- Lifestyle: Owing to frenetic lifestyles in an urban setting, parents tend to forget.

Numerous studies by healthcare providers indicate that technology enabled methods could be adopted to overcome the apprehensiveness of parents and prevent diseases from spreading [5]. In this, the use of mobile technology and the text messages have achieved success in different parts of the world [6-8]. Given the scope and penetration of mobile health in India, Child Immunization Alert System (CIAS), a mobile application, was conceptualised. CIAS provides alerts to parents, having children up to the age of 5 years, as recommended by India's Ministry of Health and Family Welfare.

System Design

The Functional Specifications Requirement (FRS) was prepared by having detailed discussions with paediatricians from various healthcare delivery institutes in and around Chandigarh, India. Based on the discussions, it was concluded that:

- The content of the messages should be positive and reassuring;
- Creation of parallel web based system would have wider penetration because of growing number of internet users [9];

- Apart from the parents, access to CIAS needs to be extended to field level healthcare professionals for outreach activities.

Based on the FRS, the CIAS system design was conceptualised both as web based and a mobile application as depicted in Figure 1. The key highlights of the CIAS system developed are:

a. Access: The web-based CIAS has been made responsive with data being stored on a web-based database. It is platform independent as it can be accessed over desktops and mobile devices. The mobile application has been developed on both, Android and Apple OS, platforms and uses the data connection for the exchange of vaccine information.

b. Alert Control:

- Types of Communication Modalities:
  - SMS: The Mobile Service Delivery Gateway (MSDG) designed by the Government of India, has been integrated with CIAS and is being utilised for sending free SMS alerts to the users [10].

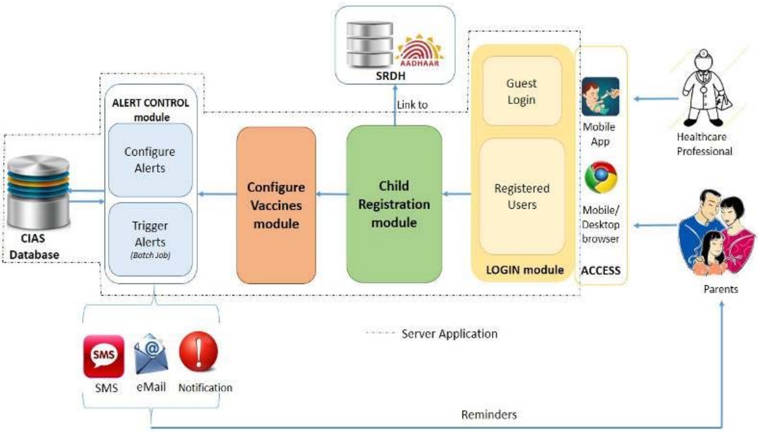

Fig. 1: CIAS System Design

- Real time notifications: CIAS makes use of 'Push Messages' part of Google Cloud Messaging service in Android, which enables the sending of on-the-fly vaccine notifications directly to the user [11].
- Emails: Numerous studies have indicated that people who prefer emails feel that it provides a

quick and convenient access to healthcare information [12]. Hence, this modality was also integrated in CIAS for sending alerts.

- Configuration: The alerts sent by CIAS have been classified into two categories: vaccine-due alert and vaccine-overdue alert. In case of vaccine-due, two alerts are sent - one-day ahead and two-days ahead of the date of vaccine. In the event of the parent receiving the vaccine overdue alert, he/she is prompted to provide the reason for the delay, which would help design suitable interventions in the future.

c. Linkage to Unique ID: Aadhaar, a 12-digit number that uniquely identifies an Indian citizen, a service by Government of India [13], has been mapped with the child details in CIAS for effect tracking.

d. Location based service: To sensitise parents about the existence of healthcare delivery institutions for administering vaccinations to children, location based services are deployed in CIAS. CIAS makes use of the GPS available in mobile devices for providing 'location sensitive' [14] hospital information.

Results

The mobile app, CIAS, has been made available for download on the Government of India's portal, mGov App store. To increase its penetration, it has also been made available on the Google Play store and Apple App store. With the feedback received, the future version of CIAS would be enhanced to provide localised voice-based alerts, so as to enable the section of society, which is non-smart phone and non-IT user, to reap the benefits of this application.

Conclusion

With the deployment of CIAS, it can be concluded that:

- The lack of information, personal beliefs and misconceptions about vaccinations can be removed [5];
- Multiple communication modalities can be used, which are cost effective, to send vaccine alerts;
- Localisation factors like location awareness, training and empowerment of local experts is required to achieve speedier and

deeper diffusion.

Fig. 2 The mobile application Child Immunization Alert System (CIAS) is available on mSwasthya (www.mswasthya.in), a project funded by the Government of India. The latest android version is available on http://mswasthya.in/AllApps_Description.aspx?appid=2

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Fighting Zoonoses and Maintaining Public Health through Veterinary Care on São Vicente, Cape Verde

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Introduction

As the title indicates this paper presents a successful story of application of telecommunication technologies for fighting zoonoses in a small developing country, the Republic of Cabo Verde.

Cape Verde or Cabo Verde is an island country spanning an archipelago of 10 volcanic islands in the central Atlantic Ocean. Located 570 kilometres off the coast of West Africa, the islands cover a combined area of slightly over 4,000 square kilometres. The official Census recorded that Cape Verde had a population of 512,096 in 2013.

The Cape Verde archipelago was uninhabited until the 15th century, when Portuguese explorers discovered and colonized the islands, establishing the first European settlement in the tropics.

WHO defines zoonoses as diseases and infections that are naturally transmitted between vertebrate animals and humans. There are over 200 zoonotic diseases. A zoonotic agent may be a bacterium, a virus, a fungus or other communicable disease agent. At least 61% of all human pathogens are zoonotic. Zoonoses represented 75% of all emerging pathogens during the past decade. The vast majority of zoonoses are not prioritized by health systems at national and international levels and are therefore labelled as neglected zoonotic diseases (NZDs) (http://www.who.int/neglected_diseases/diseases/zoonoses/en).

WHO alarms that the impact of NZDs on health services and economies is most severe on poor households in developing countries, as most of the populations living in rural areas are still largely dependent on animals for feed, transport and farm work. Populations from urban slums are also affected. Zoonotic diseases are under-diagnosed, particularly among poor people, and this under-diagnosis reflects the limited capacity and coverage of health services.

To illustrate the above, let's provide just one example of the economic effect of one common zoonoses – the cystic echinococcosis. The disease is caused by parasites, namely tapeworms of the genus Echinococcus. Humans are infected through ingestion of parasite eggs in contaminated food, water or soil, or through direct contact with animal hosts. A number of herbivorous and omnivorous animals act as intermediate hosts. Carnivores (including dogs, cats, hyenas, and other mammals) act as definitive hosts for the parasite, and host the mature tapeworm in their intestine. They are infected through the consumption of viscera of intermediate hosts that harbour the parasite. Humans act as so-called accidental intermediate hosts. According to WHO "Disability-adjusted life years (DALYs) and monetary losses resulting from human and livestock cystic echinococcosis have been calculated at the global level, assuming substantial under-reporting. The estimated global human burden of echinococcosis may be as high as 1 009 662 DALYs - or an annual loss of US$ 763 980 979. A maximum annual livestock production loss of US$ 2190132464 is also estimated (http://www.who.int/neglected_diseases/diseases/zoonoses_figures/en).

As WHO underlines, "Reducing public health risks from zoonoses and other health threats at the human-animal-ecosystems interface (such as antimicrobial resistance) is not straightforward. Management and reduction of these risks must consider the complexity of interactions among humans, animals, and the various environments they live in, requiring communication and collaboration among the sectors responsible for human health, animal health, and the environment" (http://www.who.int/zoonoses/en).

Improving the control and prevention of NZDs requires multidisciplinary, inter-sectoral and cross-cultural efforts by health, agriculture, environment and other sectors of society at the national level. The paper is an example of such efforts.

SIMABÔ - *Associação para a Protecção dos Animais e do Ambiente* is the only non-profit animal welfare organization based on the island of São Vicente, Cape Verde. As such, they are the only provider of veterinary services for animals living on the streets or with owners on low income. To increase the health status of Cape Verdean dog population, and thus to support the efforts to fight zoonoses, SIMABÔ has been implementing the project "*Fighting stray dogs on Sao Vicente: A pilot project for the Capeverdean Islands*" from February 2012 to January 2016. SIMABO's project is the first, and to date, the only action of this kind co-funded by the European Union [under EuropeAid/130817/L/ ACT/CV (DCI-NSAPVD)] due to its combined value for public health.

The working hypothesis of the project is that surgical sterilization and deworming of the dogs is an effective way to control population density and health. This may improve animal health and subsequently public health as a step towards fighting zoonoses.

Background

As most cats and dogs, both owned and stray, roam freely around the streets throughout the day and night, the Municipalities of the nine Cape Verde Islands have implemented different systems to control the canine population. Amongst these, strychnine poisoning is the most commonly used. Focusing on "elimination", this method is opposed by the WHO because it is ineffective and it is opposed also by the local population because it is dangerous and does not allow discriminating between owned and stray animals. SIMABO's aim is to provide a more humane and more effective alternative to decrease the dog population: surgical sterilization to reduce the overall reproductive index.

In 2013, the Cape Verdean Government recognized SIMABÔ as an Organization of Public Utility and in October 2014, the organisation was included in the list of the beneficiaries of Law no. 45/VI/2004 of 12.7.2004. This states that a limited number of eligible organizations can receive a percentage of the tax paid by Cape Verdean companies. Back in 2010, the local Delegation of the Ministry of Health had authorized the purchase of medications by SIMABÔ from the only Cape Verdean vendor that supplies hospitals, private clinics, and pharmacies.

Rationale

The lack of local veterinarians to help with treatment and care of neutered dogs and cats has meant that SIMABÔ must employ lay staff for these purposes. One nurse and two more lay staff (all with no formal training) take care of the neutered animals with the support of protocols prepared by the veterinarians of Centro Veterinario Monviso (CVM), Italy. The vets from CVM make also themselves available 24/7 via Skype or email when their assistance is needed for more challenging cases. The feedback obtained is used to continuously update existing protocols (Fig. 1 and 2).

In conjunction, Drs. Tizzani and Peano from the University of Turin, Department of Veterinary Sciences, Parasitology Sector, are collecting samples with the aim of preparing specific protocols for treating and preventing *Microsporum canis* infection in dogs.

Microsporum canis is a dermatophyte fungus, and causes dermatophytosis - commonly known as ringworm or *tinea*. Preferential hosts are cats and dogs, and as the infection is zoonotic, it is also of significant public health importance. This disease has been investigated and documented in several countries within Europe, but documentation of the disease and public awareness are lacking within Cape Verde.

Finally evaluation of the long term consequences of surgical sterilization on population dynamic and health conditions was investigated by means of specific census activities carried out at the beginning (year 2012) and at the end (year 2016) of the project.

Objective

The objective of using telemedicine in this veterinary capacity is to support remote lay staff in four main areas:

1. Post-operative care,
2. Anti-parasitic regimes,
3. Appropriate emergency care and
4. Evaluation of population dynamics.

Thus the project provides funding for the castration, microchipping, anti-parasitic treatment and post-operative care of 10 000 dogs.

The overarching aim is the control of the canine population of the island, to make abandoned animals more adoptable and to make stray dogs better companions.

One of the problems with canine overpopulation is the resulting opinion of the public, often being that the animals have little or no value. The animals castrated under the project are thus exposed to numerous risks when put back on the streets, from poisoning to road accidents, from neglect to torture.

Fig. 1. Taking a sample from a puppy with a very severe skin lesions

Fig. 2. A neurological consultation of a paralyzed cat via Skype

SIMABÔ is working to improve public-animal relations through awareness and create a more harmonious human-animal bond by bettering the health of the street dogs, and educating local communities, for example through educational school visits.

To evaluate the impact of the sterilization on the canine population, two census campaigns were carried out at the beginning and at the end of the project, applying direct and indirect census techniques.

Materials and Methods

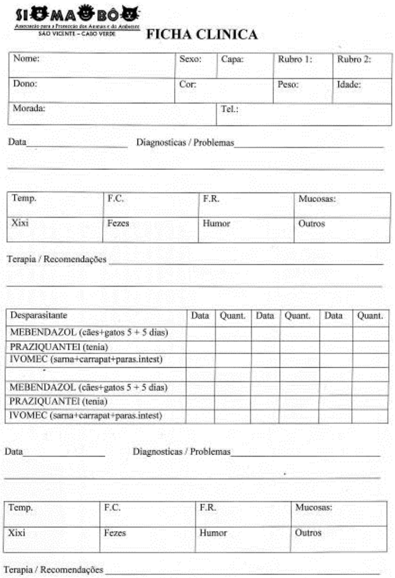
The lay staff relies on the following limited resources:

1. A very limited list of pharmaceuticals that allow treatment of the most common conditions, such as internal and external parasite infestations (mainly round worms, tapeworms, fleas and ticks), ehrlichiosis, pyoderma, mycosis, scabies, other infections, trauma and tumours, especially Transmissible Venereal Tumour (TVT).
2. A protocol for the treatment of common conditions based on the principle “primum non nocere” (first, do no harm), that excludes for instance the use of steroids, cardio drugs, diuretics, antipyretics, if not explicitly recommended for the treatment of very specific conditions or after the web-consultation with CVM;
3. Tele-consultations with Dr. Raineri or her staff for difficult cases – (Fig. 3) a standard form containing all the animal information and clinical parameters is completed by lay staff and sent by email to the clinic in Italy, with pictures if required. On average, two cases per week are handled in this manner including eye conditions, skin problems, systemic diseases and trauma.

During the two census campaigns carried out in 2012 and 2016 the monitoring was done using direct and indirect techniques, to provide an accurate and precise estimation of the canine population (an accurate evaluation using narrow confidence intervals of the estimates). The population estimates were done in almost real time with a first team collecting field information in Cape Verde and a second team, based in Europe that received, analysed and elaborated the data to provide rapid evaluation of population trend.

Results

Since the beginning of the project, there has been a remarkable improvement in the health of the canine population of São Vicente, together with an appreciable increase in public awareness of the importance of animal health. Due to the very low mortality rate of the neutered animals and high recovery rate of these patients, most of whom arrive at the clinic in a very bad condition, the treatment offered by the project in conjunction with the neutering is high in demand. The rapport generated with the local owners during the process of neutering and post-operative care now, more often than not, means that SIMABO's assistance is sought as soon as any further concerns about their animal arise. This conveys that not only is the canine population being managed, but also awareness of animal health and welfare is being raised and the remaining population of dogs are better cared for. This in turn generates benefits in public health.


SIMABÔ
Associação para a Protecção dos Animais e do Ambiente
SÃO VICENTE – CABO VERDE

FICHA CLINICA

Nome:	Sexo:	Capa:	Rubro 1:	Rubro 2:
Dono:	Cor:		Peso:	Idade:
Morada:	Tel.:			

Data________ Diagnosticas / Problemas________

Temp.	F.C.	F.R.	Mucosas:
Xixi	Fezes	Humor	Outros

Terapia / Recomendações ________

Desparasitante	Data	Quant.	Data	Quant.	Data	Quant.
MEBENDAZOL (cães+gatos 5 + 5 dias)						
PRAZIQUANTEI (tenia)						
IVOMEC (sarna+carrapat+paras.intest)						
MEBENDAZOL (cães+gatos 5 + 5 dias)						
PRAZIQUANTEI (tenia)						
IVOMEC (sarna+carrapat+paras.intest)						

Data________ Diagnosticas / Problemas________

Temp.	F.C.	F.R.	Mucosas:
Xixi	Fezes	Humor	Outros

Terapia / Recomendações ________

Fig. 3 Clinical notes

The most important effect of

Fig. 4 Surgical sterilization and deworming

the project was the reduction in the total canine population from 11,838 animals estimated in 2012 to 8,821 in 2016 - a 25% reduction in population density within 4 years. Additionally the incidence of parasitic diseases amongst remaining animals was investigated and showed a reduction over these years.

Considering the above, the project implemented by SIMABO achieved its aims of control over canine/feline population density and net improvement in animal health and welfare, with secondary improvements at the human/animal interface.

In short, the concept of Veterinary Public Health, being "the sum of all contributions to the physical, mental and social well-being of humans through an understanding and application of veterinary science", was well and successfully applied.

Acknowledgment

SIMABÔ thanks the whole staff of Centro Veterinario Monviso, Pinerolo (TO); the Department of Veterinary Sciences, University of Turin; ZOHE E-HEALTH - Promoting Healthcare Through Knowledge, Research and Innovation, Pinerolo (TO); and Dr. Yvette Bell, DMV, for their help and support.

ICT for Preventive and Follow-Up Care – Case Studies in India

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Introduction

The socio-economic burden of health disorders can be significantly reduced by preventing illness or managing existing illness from landing in curative/palliative situations. Most of preventive care is related to issues in life-style, public hygiene, pre-disposed health conditions, and is absolutely necessary for effective preventive care implementation in a population to promote public awareness, training, intervention and follow up. Such activity depends on availability of good information communication and computing infrastructure.

India with its 1.2 Billion population represents a cross section of all challenges in developing countries for ICT transformation in a health system. A study of several pioneering eHealth initiatives across India [1] found several challenges stemming from economic, cultural, linguistic and educational diversity, since one solution does not fit all problems and a solution, successful in a given demography, may fail in another. Lack of coordination and interoperability between services, providers and ICT solutions was found to be an impediment for integration of e-health services. Lack of multi-media documentation with handwriting, video, audio, waveforms and images content apart from regular, formal text was a barrier to adoption by service providers. While collaboration across service provider entities can improve convenience, cost and effective care through integration of workflow, dataflow and commerce, the lack of context-based control on information exchange (i.e. what information is sharable / modifiable / viewable by whom in given activity and circumstance) puts security / privacy / accountability barriers to collaboration. It is also clear that not all ehealth transactions need high-end ICT infrastructure. Activities of preventive care outreach programs can be launched with very basic equipment and infrastructure, which are generally available in developing countries.

A systematic analysis of information exchange [2] across a health system mapped the minimum end-point IT infrastructure needed for effective transactions, considering the type of information, extent of detail, accuracy, presentation format and urgency in various scenarios of health care. The study found preventive care is the least expensive, simplest to implement and needs the lowest end information technology (IT) compared to curative and palliative care. The study also observed that that 100% information exchange can be covered in over 80% of all health care transactions; up to 90% transaction can be covered with 1 Mbps bandwidth; and 50% of all preventive care transactions can be done with users having lowest end text based mobile phones and over 80% with lowest-end smart phones.

Over the last few years, India has experienced a significant growth in ICT infrastructure with growth of optical fiber network lending over 10 Mbps connectivity to homes. 3G/4G wireless infrastructure is reaching out to its 1.2 billion population with 10x drop in associated cost. In addition, the inexpensive cloud-computing infrastructure enable the enterprise to jumpstarts thousands of mobile applications with access to e-commerce. A study found a paradigm shift in bio-medical technologies driving away from invasive, painful or inconvenient interventions in diagnostic and monitoring measurements, fostering a significant jump in acceptability and willingness in patients, especially in managing chronic diseases with treatment for extended periods of time. Several non-invasive, portable, wearable bio-medical measurement [3] instruments have surfaced, with smaller, smarter, simpler, cheaper, and wearable and mobile form factors making preventive care measurements affordable, mobile and simple to use, by not only specialist doctors, but also by patients and their kin, nurses and general physicians. Combined with the advancements in IT infrastructure, this has enabled extension of care from hospital to clinics\homes, from palliative\curative to preventive, from cities to remote rural villages, and from illness management to wellness management. Business models around the device market is also shifting from product sale to rental and usage based billing models, from Capex to Opex based adoption models, enabling faster adoption. The growth of social media is further accelerating awareness and adoption of digital transactions by common people across rural/urban areas.

Riding on top of these changes, innovative preventive care applications have surfaced in disease surveillance, public hygiene, vaccination, routine health management, training and rehabilitation. These relatively inexpensive, simple, innovative applications have the potential to improve preventive measures and arrest economic burden of disease from manifesting into curative and palliative phases. The rest of this paper discusses case studies of a few innovative ICT applications being tried in India that may have potential use for eHealth transformation in other developing countries as well. The conclusion draws some insight into the impact of such applications that can be realized through ICT adoption. While it is out of the scope to identify include and discuss all initiatives in this space, this chapter encapsulates some of the initiatives within the direct visibility of the author. The first case study is tele-monitoring in public health to reduce disease incidence, the second is about an initiative for cold-chain-monitoring for safety delivery of vaccines in preventive care, the third case study is about tele-training of Yoga for mass education and therapy, and the fourth is a remote attention system for patients in remote hospitals.

Case Study 1. ICT Enabled Surveillance of Mosquito Prevalence

Background: This initiative [4] is driven by Center for advancement of Global Health (CAGH), Cochin, India, in collaboration with department of science and technology, Government of India as funding partner. The Administrative Staff College of India, Hyderabad, is a program management partner, while the Applied Cognition Systems private limited, Bangalore is the technology partner and the Cochin College and St. Xaviers College, Cochin, India is the field execution partners of the project. The initiative is an innovative ICT enabled mosquito surveillance approach to simplify monitoring of breeding rates and associated environmental conditions, used by the health governance department. The system is built to assist in early detection and planning targeted intervention to prevent spread of mosquito-

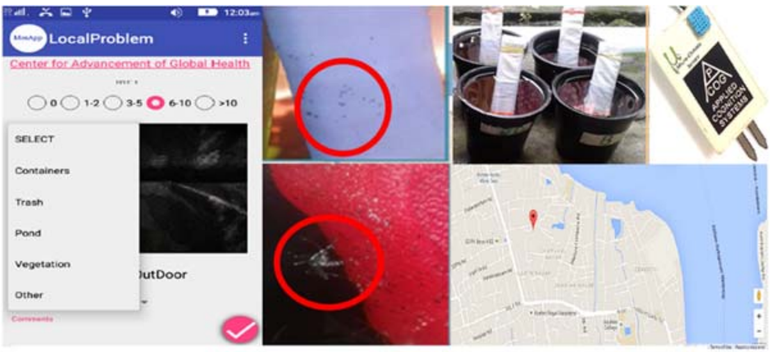

Fig. 1 Mosapp data capture screen and ovitrap images (left), Ovitrap modules, Microclimate device and its location mapping (right)

induced diseases such as dengue, zikka, malaria, etc.

Conventional disease surveillance methods involve getting information about disease incidence, morbidity and mortality rates from patient admission reports of hospitals. However, such post-facto detection and intervention methods are inefficient for diseases of viral infectious spread by mosquitoes, as the pressure will be on curing the infected people than controlling carriers of the disease, the mosquitoes. In doing so, Public health department can target their resources and efforts better to reduce mosquito prevalence, if they have information on when and where the mosquito abundance is likely to be the highest. Currently the process is very tardy and manual collection, sorting and counting of Mosquitoes captured in Ovitraps placed in specific locations in addition to indirect measurement of climatic, topographical, demographic and socioeconomic variables that result in mosquito breeding, typically collected on a few times in a year, by authorized personnel with sensors fixed in a limited number of locations. There is a need for automating this monitoring as much as possible to assist the department targets its resources more efficiently. Another important weakness in public health management is public awareness and participation in disease prevention by keeping their environments clean and informing he authorities of issues, they sense in their surroundings. This initiative aims to bridge this gap in prevention of mosquito-induced diseases through application of innovative ICT enabled mobile monitoring system.

Method: This initiative involves usage mobile microclimate platforms by authorities and volunteers to increase the frequency and coverage of surveillance with a limited number of sensors. The program also embarks on public participation through crowd sourcing of information from mobile phones of individuals who sense mosquito activity in their vicinity and sensitize the community to take preventive measures in their locality. The data are logged into a centralized cloud based surveillance application, enabling a larger scale coverage of localities at much lower cost at higher temporal and spatial resolution. The portable wireless microclimate station consists of sensors connected to an Internet-of-things (IOT) processor module, which samples temperature, humidity, soil moisture and light intensity every millisecond, averages the samples to reduce noise, and relays the data every minute through an authorized WIFI hotspot to a back end web application. A mobile phone application called Mosapp (Fig. 1) issues serves user commands to the microclimate station through WIFIand serves as a gateway to link the reads its data, adds snap-shot images of ovitraps and captures user inputs (about vegetation, trash, stagnant water, food waste, etc.). Mosapp uses store-forward mechanism to transfer this data along with date-time-location stamp into back end web-service, whenever internet connectivity is available. A mobile app called "Disapp" is provided to public to report mosquito activity around them (e.g. felt, seen, bitten, heard) and known illness cases in household and neighborhood, along with any features of mosquitoes seen (e.g. stripes on back, etc.). The Cloud application aggregates information from various users from multiple locations into a common backend storage, which can be browsed in a given date range (Fig. 2-3). This data is then studied to model the Aedes mosquito egg / larva density, breeding rate and micro-climatic conditions at various locations. The latter correlates with public information about disease incidence and mosquito prevalence. A fuzzy logic based mathematical model derives a risk index compared with a threshold to set off early warning alerts to the stakeholders based on day-to-day data. Participants interacting with the system automatically get feedback about the risk index in their locality along with generic information on what they can do to reduce the risk. Lists and demographic maps of density, distribution, growth rate and hotspots over selected date range and region can be generated for prioritizing resources and intervention activities.

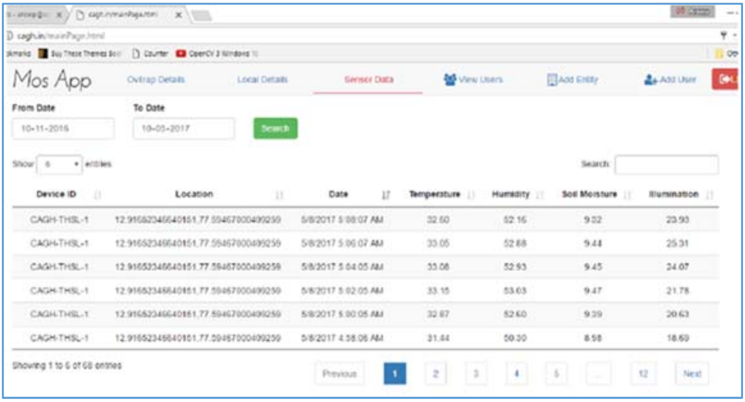

Fig. 2 Log of microclimate sensor data (top) and user input (bottom)

Observations: A team of 30 student volunteers from department of zoology, Cochin College, and St. Xaviers College for Women, Alua Kerala, India used Mosapp on their mobile phones and took readings on egg laying habits of female Aedes mosquito with over 180 Ovitraps at different locations over a year, with variations in rainfall, temperature and climate. The apparatus and analysis brought out several useful findings, shown in fig (1-4). For example it was found breeding activity of Aedes aegypti mosquito, a carrier for yellow fever and Zika viruses, peaks in September and is minimal in December months respectively, with the rate of egg laying and survival of larva found inversely proportional to intensity of ambient light.

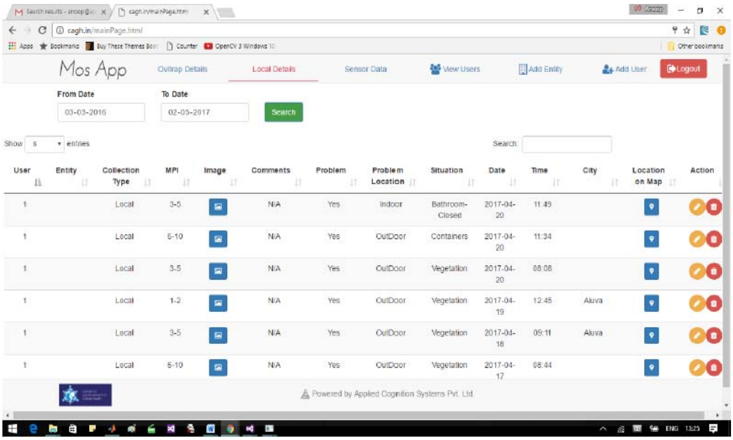

Fig. 3 User inputs logged to web through Mosapp with date time stamp

In particular, a significant correlation was found between the mosquito perceptions from crowd sourcing in Disapp to that formally surveyed by health workers using Mosapp.

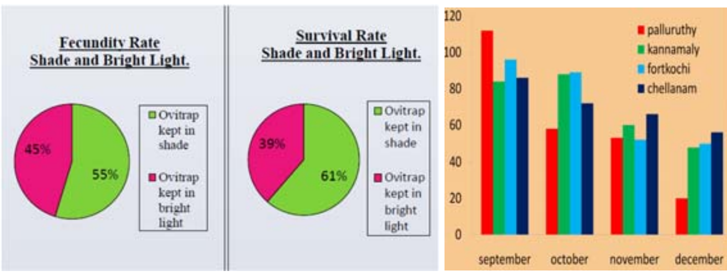

Fig. 4 Results correlating breeding to environment and season

The system can be readily extendable to track carriers mosquitoes of other diseases as well. It is being evaluated for low cost adoption on a mass scale for mainstream governmental use in India.

Case Study 2. ICT Enabled Monitoring of Vaccine Cold-Chain

Background: This initiative [5] was a collaborative study involving pediatric expert doctors, and Applied Cognition Systems private limited, Bangalore as technology partner and Hospital, Pharma distributor and retailer and clinic participation as vaccine supply chain partners in the study.

Most Vaccines become ineffective or adversely-effective if not retained within a specific range of temperature, humidity and light intensity even for a few minutes throughout the supply chain from Manufacturer to administering on a patient. Most vaccines have tolerance range of 2° to 8° Celsius, many of them sensitive to humidity >60% and some sensitive to direct exposure to fluorescent and/or sun light.

A World Health Organization survey [6] across 10 Indian States monitoring storage temperature over 138 476 hours showed 89% variation above 8°C limit and 58% variation below 2°C limit. Another study [7] illustrates that during transportation the occurrence of freezing temperatures was found to be 16.7% in developed countries compared to 35.3% in developing countries. These studies are pointing to the need for continuous monitoring with timely alerting for corrective intervention when container is in unsafe zone and escalation to respective management of response not being taken within a stipulated time limit. If such information is available to the consumer of the supply to check before accepting a delivery, they can reject containers that had unsafe exposure.

Several standards exist for vaccine storage, but due to lack of awareness, accountability and affordability many use household refrigerators where temperature band is much wider than stipulated 2°C to 8°C and do not track and correct it in time. A few log the data manually, but there is no aggregation and access to that information down the supply chain and lack of awareness in some cases leads to adhoc control measures (see Fig. 5).

Some provider have narrow band expensive Peltier based ice-lined-refrigerator (ILR) with temperature display on individual containers, but not humidity and light intensity. Therefore, even if one finds out a vaccine has gone bad, it is difficult to enforce accountability without a system to find why, when and where it went bad in the supply chain and prevent damage instead of after the fact discovery. This initiative is a cloud based centralized cold-chain monitoring system with such features and can scale to cover a large demography.

Fig. 5 Typical manual temperature log (left), examples of adhoc vaccine container arrangements sighted in pharma supply chain (right)

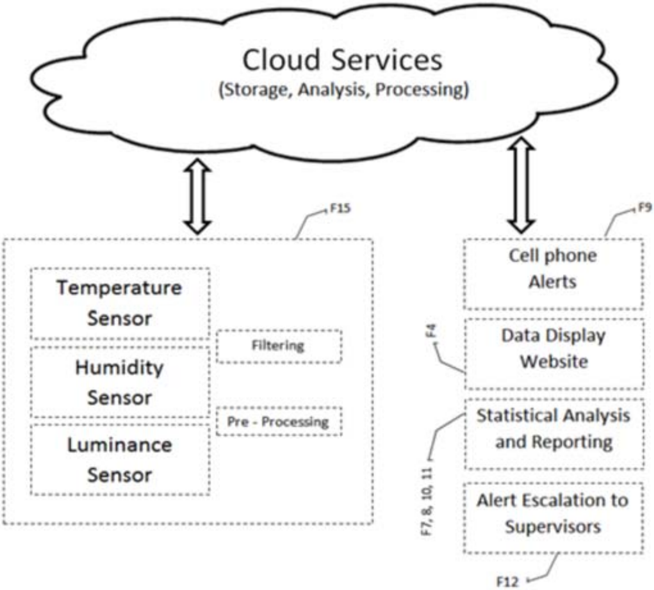

Fig. 6 CCMS functional blocks: Acquisition, Processing, Presentation

Method: The functional blocks of the system are as shown in Fig (6).The system employs device-end (DE) units to monitor the local environment within a container and flag, if it is in an unsafe zone beyond a threshold of time interval to a mobile internet gateway (MIG) unit. The MIG monitors flags from multiple DEs acquire the status, raise audio alert to supervisors in the vicinity, and propagate data to a backend cloud application. The backend system monitors data from multiple MIGs and issues alert messages to mobile phones of respective supervisors, escalate to their managers, if corrective action has not taken place and publish status report of one or more containers over a given period and region to mobile phone of authorized users along the supply chain. Before accepting delivery, a customer can check for containers that are flagged as unsafe in the system. Relevant geo-tagged statistics can be published from the data to establish a data driven accountability system in the supply chain. The apparatus consists of cloud-based data acquisition and processing system that connects to field units fitted within multiple remote containers as shown in Fig (7).

The field units have “Internet-of-Things (IOT)” interface enabled process-

Fig.7 CCMS Device end unit and Fitment

sor. The processor interfaces with sensors to measure temperature, humidity and light and digitize the sampled measurements every millisecond. The processor also passes the samples through a digital filter for noise reduction, checks the average reading over every minute against a safe boundary and sets the status flags accordingly. A mobile internet gateway app has been developed to connect with multiple field units over WIFI, acquire and stored the data with container ID, date time location stamp into a local file. It searches for containers flagging alerts and raises an audio alarm on the phone so that supervisors in the vicinity can attend to it immediately. It also sends SMS alerts to concerned supervisor’s mobile phone and relays the information to a backend web service using stored-forward mechanism whenever internet connectivity is available, for cloud based archival, analysis and presentation of data.

Observations: The geospatial information related to the acquired data was used to produce spatial maps of compliance among several stationary containers in a region, flagging status as shown in Fig (8), where reds are containers overshooting upper limits, greens flags are those within safe

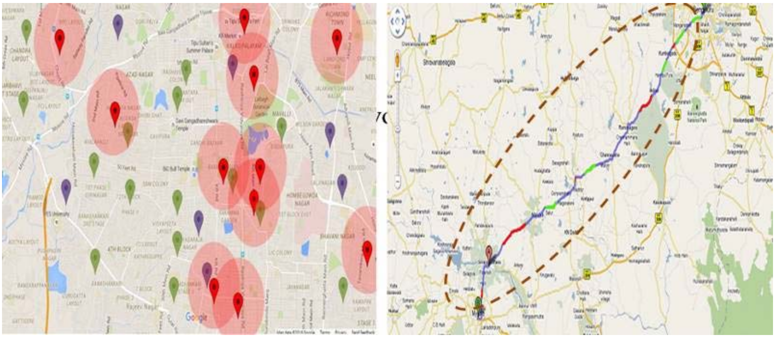

Fig.8 Geo-spatial maps of containers; stationary (left), transported (right)

limits and blue are those below the bottom of safe range. Further, geospatial maps of containers being transported were also inspected. Fig (8) indicating the status at various points of time along the path way traversed by the transporter, with red traces indicating unsafe conditions above upper limits and blue traces show conditions below lower safety limits, while the green traces indicating safe condition.

Red traces were commonly noticed in almost all trials while there were also instances where blue traces dominated the journey, meaning the container was over cooled, due to adhoc ice-packing around the vaccine packs. The condition could be traced to the specific containers among many being transported and further inspection showed that humidity and light intensity were not straying away significantly, but unsafe temperature exposure was common. The thermal drift in specific containers were plotted against the safety band with red dots, indicating measurements reported by supervisors using independent thermometers after getting alerted from the system. Subsequently long-term observations were conducted on specific stationery containers and statistical averages were used to indicate the situation before and after the implementation of the proposed monitoring system. The results clearly indicated reduction in outage after alerts to supervisors were introduced by the CCMS, as shown in figures (8-9), under conditions listed in the table on Figure 10. Voluntarily participating entities found it very useful to identify the root cause such as people not closing the container lid/door properly, power outages not attended to in time for switching to alternate supply, improper packaging or portable containers, etc., which can be corrected within a few iterations of management induced corrections in process and facilities.

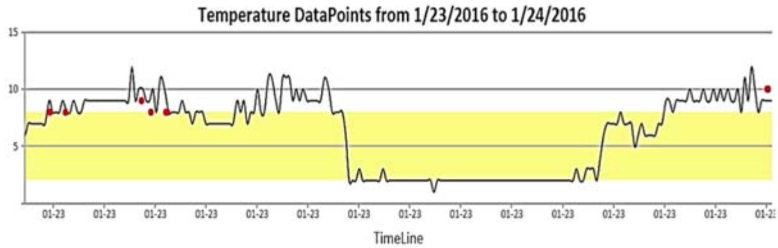

Fig.9 Thermal drift inside a well-equipped hospital container

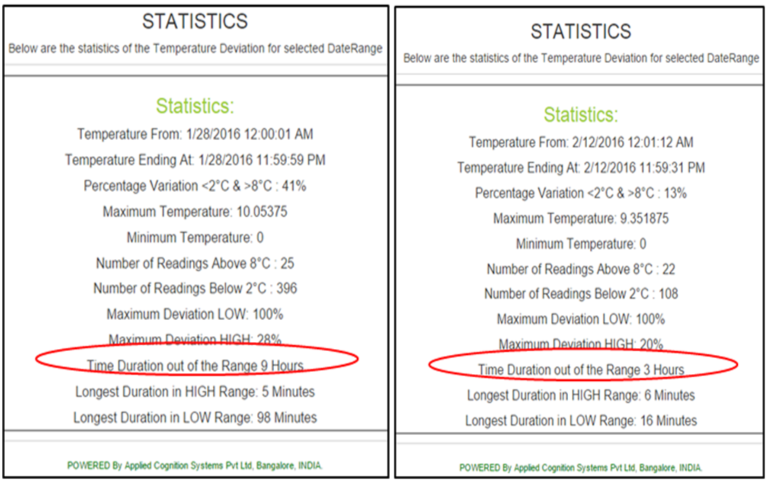

Fig.10 Statistical measurements of continuous monitoring of a container

The application of cloud based cold chain monitoring system (CCMS) has demonstrated advantages of real-time continuous tracking, geo and epoch tagging, automatic detection and alerting to supervisors of stationary and mobile containers located in distant places. The system could detect significant outages in real life situations even in well-equipped entities and demonstrated automatic improvement in management of containers when corresponding supervisory staff was proactively intimated by the system. The participant entities are willing to adopt the system into their process to ensure their goods are preserved and delivered safely to the customers. The solution is scalable into mainstream supply chain. In principle, the alerts generated in real time can also be fed to respective container cooler systems in a way as to achieve automatic closed loop control over thousands of containers to tune themselves to the safe temperature zone.

This work has demonstrated an effective monitoring system the corrective action is dependent on the corrective action the supervisory staff takes upon being alerted. A larger scale pilot in collaboration with the food and drug authorities of the government is being planned to substantiate the need for policy support for adoption of such a monitoring system across the supply chain.

Case Study 3: Cloud Based System for Tele-Yoga Training

Background: In this initiative [8], Maitri foundation, an institution having Yoga training and therapy experts at Bangalore, has used vClass to announce and deliver its Yoga training programs, including reading materials, online theory classes, practical training, self-assessment tests and follow up consultations integrated with ecommerce.

Yoga is an age-old practice in India not only as a physical exercise, but as a therapy and as a lifestyle for wellness. Training institutions face challenges in scaling their programs due to many reasons – lack of experienced teachers; lack of willingness of teachers to travel to remote areas; travel, accommodation overheads and inconvenience for remote patients and students to use urban training facilities; lack of electronic means to aggregate and train patients with similar problems, or students with similar interest in a cost effective manner. Efforts in developed countries to adopt tele-yoga in the aging communities has shown positive results [9]. However, a number of mobile apps such as Skype and WhatsApp, are being used typically for on-on-one sessions. This does not aggregate demand, and utilize teacher's time to reach hundreds of people in multiple locations simultaneously, with integrated scheduling, commerce, content ownership, assimilation and sharing as needed in institutional setting.

In this initiative, a cloud based tele-education platform, called v-Class developed by Applied Cognition Systems, addresses these gaps in enabling institutional yoga therapy to patients as well as teaching certification courses to students through formal study and exams. Using v-Class, Maitri Yoga foundation has conducted successful pilots with delivery of yoga training services and therapy services to patients and students in several remote locations simultaneously, in collaboration with local facilitators.

Method: The training entity enrolls expert teachers at different locations into a virtual team and organize remote training programs for different topics under one banner. It also enrolls facilitator entities that collect trainees into classrooms at distant locations into a network of classrooms. The training entity, the facilitator entity and empaneled teachers all share revenue generated from training at pre-agreed tariff rates. Facilitators can enroll students for specific classes by collecting charges from students and remitting relevant charges through v-Class's electronic payment gateway interface.

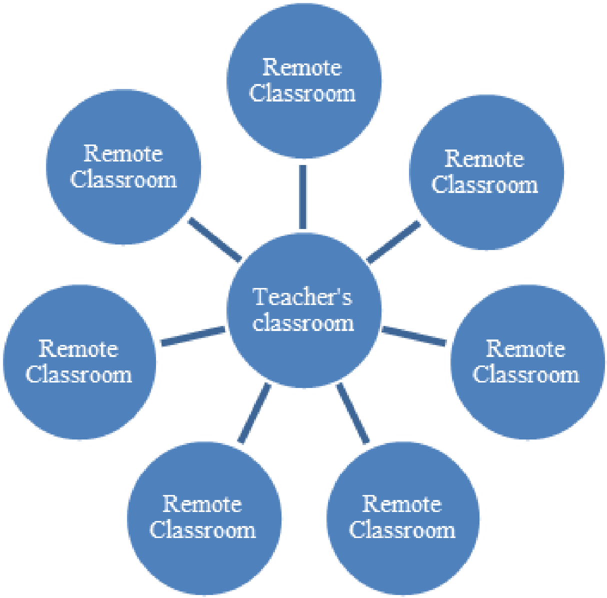

Fig.11 Typical E-classroom network

System sends automatic reminders of the schedule to and students on their mobile phones. When teachers start a session, the system automatically calls participant classrooms to join video conference. The students participate in remote classrooms can observe, listen and interact with the teacher virtually as an extended classroom, while the teacher conducts the session.

Apparatus: The Teaching and participant classrooms were provisioned with a Laptop with Chrome Browser linked to a HDMI TV/projector with 2MBPS dedicated Internet bandwidth. V-Class accounts for each participant institution and staff were created to enable them in organizing tariff-shared training from teacher's campus to students at facilitator campus through respective users' functional roles assigned in the system as follows:

1. Trainers: They can publish details such as topic, schedule, teacher's profile, pre-reading materials to all students and facilitators on v-Class website and conduct virtual classes. They can set exam papers and evaluate the answer sheets. They can also setup automatic evaluation patterns for objective question papers and get evaluation reports with their digital signature.
2. Demonstrators: During a training session, the teacher and demonstrator could be different people at different locations, the system displays video of both trainer and demonstrator in separate quadrants.
3. Administrators: They register teachers and facilitators, set tariff sharing patterns, announce class sessions and course packages consisting of several sessions and topics and fees on the website. They also generate management information system (MIS) reports (e.g., lecture volume by teacher, topic, center, day; performance rating from students of facilities, teachers and topics; revenue performance by topic, teacher and facilitator, etc.). They track and generate revenue and business intelligence reports and follow up with facilitators for payment collection.
4. Facilitators: They enroll interested students/patients by collecting fees and remitting the same into the v-Class Cloud e-commerce application. They also have access to join various sessions booked for their students. The system automatically tracks and initiates e-payment of facilitation charges from the collected fee remittance after a class session is over.
5. Students / Patients: They can check courses / classes available and book by making direct e-payment through v-Class system or cash payment to the coordinator. They can check class status and access pre-reading materials, attend classes and take up online tests and review results, send feedback about topic, lecture, etc. from their local training facilitator premises.

Observations: The system was used by Maitri foundation to simultaneously teach several students in remote classrooms. The students in such classroom can join the teaching session through video conferencing as shown in figure 12. A chat window enables students in any classroom to send queries and comments during a class session from the computer in their classroom, which reflects in chat window of all connected classroom PCs.

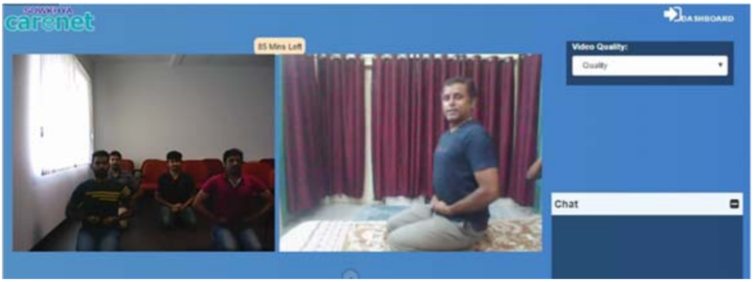

Fig.12 Training from teacher at Bangalore, to students at Manipal, India

The teacher can either view and answer the queries in the chat window itself or select the corresponding classroom to show in the video conference, so that all classrooms can watch and listen to the discussion of that classroom with the teacher. The teacher can also publish assessment question papers that students can fill with answers electronically from their mobile phones. The system can automatically verify objective answers against pre-defined answers and assign marks, and route subjective answers to examiners for evaluation and assignment of marks.

The system was also used to train multiple patients with similar problems from Maitri classroom, while patients were located at their own homes using their laptops.

Successful results have encouraged Maitri to begin empaneling expert yoga teachers from distant locations and offer several therapy yoga practice courses on a routine basis.

The system has not only saved cost, inconvenience and accessibility of good teachers to students and patients, but has paved the way for collaborative gain among thousands of yoga specialists who lack facilities to train hundreds patients/students in the same time as they would spend to teach a single candidate. Trials showed the system performed with high definition clarity in a training session with up to 16 live classrooms with about 4MBps bandwidth at teacher end and 2MBPS bandwidth at the classroom end.

The successful trials has also led to ongoing pilot runs with Red Cross Society of India, to train disaster management and first aid on a mass scale through its district-level facilitators across the state of Karnataka.

Case Study 4. Remote Attention System for Inpatient Care

This initiative [11] is driven by collaborating Hospitals as care provider partners and Applied Cognition Systems as technology partner to enable virtual presence of remote specialists in collaboration with local doctors as needed in emergency response, remote monitoring and real time consultation for management of patients admitted in wards and intensive care units (ICU) of hospitals.

Background: The current system affects the quality of life for doctors as well, as they are expected to rush back to the hospital on call even after returning home, even if it is middle of night, to inspect critical developments of patient's condition and decide further action immediately. The problem multiplies when doctors are consultants to multiple hospitals. Hospitals face scarcity of experts who can engage full time, especially when physical presence is required on demand. The shortage of specialist doctors has driven hospitals to look for alternative approaches such as the Tele-ICU, which is expected to reduced cost, increase resource utilization and outreach to a larger group of doctors that can be physically staffed into a hospital [12]. However, proprietary interfaces, protocols and formats of various bio-medical devices and expensive accessories make it significant additional cost and effort to integrate the information and bring it just outside the ICU to a nursing staff room. Although international standards such as DICOM have tried to bring a normalization in device interaction protocols, a majority of vital signs and video streams are not covered by this standard, and the majority of the non-DICOM compatible equipment already in the hospital is not going to be thrown away just to clear the way for TeleICU.

Another aspect of inconvenience in the hospitals at India is that the kin of the patient have to wait long hours to get a time slot to visit their patients in WARDs/ICUs turn by turn. Hospitals also want to avoid ICU visitors due to risk of secondary infections, disturbance, and cost of giving them sterilized wear. Hospitals also want to prevent Kin from crowding outside wards and ICUs blocking pathways and creating noise and emotional disturbance to others. Many Kin albeit having anxiety and concern, also find it practically difficult to commute every day in heavy urban traffic to visit the patient for a few minutes or travel from rural areas and stay in hotels and visit to know the status and give company to their patient. In the initiative, Applied Cognition Systems has collaborated with hospitals to use their cloud based Remote Attention System (RAS) to addresses all these challenges.

RAS enables doctors to remotely inspect and interact with patients, doctors and nurses at more hospitals than feasible by their physical visit. It also enables hospitals to bring specialists located at distant places virtually together as needed for joint assessment in critical situations. RAS facilitates

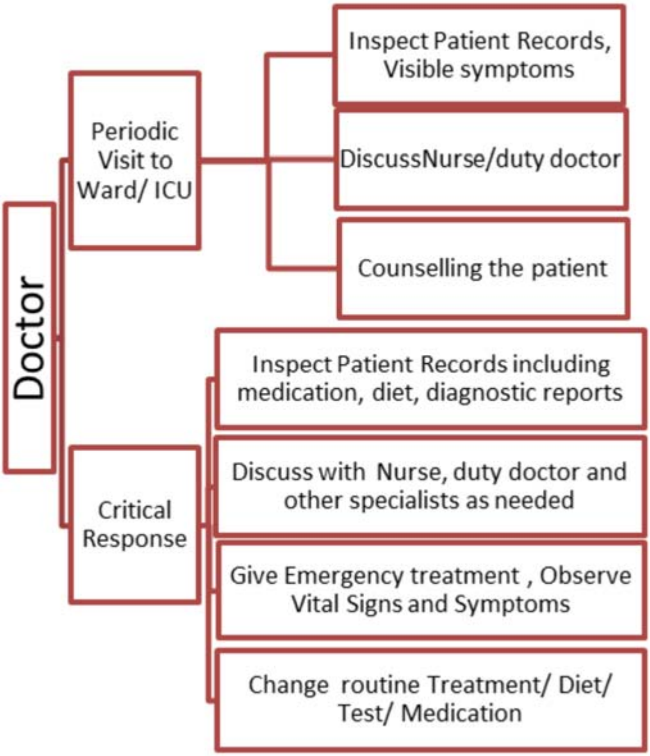

Fig.13 Typical activity in routine and critical patient management

Kin to visit their in-patients from remote places through their mobile phones, by appointment with the nurse/doctor attending to patient. All these virtual sessions can be optionally recorded for medico-legal purposes.

Method: RAS replicates on an electronic platform. The current manual workflow, dataflow and interactions are shown in Fig (13), between the doctors, patients, nurses. The ward/ICU nurses generally maintains a log of medication, diet, diagnosis, treatment, bio-discharge and other health indicators of the patient condition in paper records or in hospital information software and go around watching the patients assigned to them. On a daily schedule, the doctor visits in-patients, inspects the records, visually inspect /talk to the patients to assess the condition and advice for further action. In case of a critical development, the nurse calls the doctor by phone and informs symptoms, reads out vital sign indicators and history for the doctor to infer the situation and advice further action or decide to visit the hospital. If the condition needs multiple specialists together to decide the action, the nurse/duty doctor calls each of them for advice and then decides further action. This process need not change, but come easy and safe through electronic means.

Apparatus: As shown in Fig (14), the solution consists of a cloud-based application accessible over internet from mobile phones/tabs of authorized doctors, nurses and RAS terminals. Fitted onto each bed, the RAS terminals capture, record and stream video from cameras focusing on the patient and associated monitoring equipment. Using the backend application, the hospital admin assigns unique bed identification number (BID) for RAS terminals, mounted on each bed. The number is bind to the patient identification number (PID) of the patient in that bed, along with the staff identification numbers (SIDs) of the staff members (doctors, nurses) attending to that patient. The system assigns a virtual conference room for each RAS terminal. When authorized personnel join a conference room from their computer/mobile phone, the RAS terminal automatically streams the video, while the cloud server provides control synchronization. The implementation uses hyper text transfer protocol security (HTTPS) based secure data exchange with access control based on password, role and entity of user and web-real-time-communication protocols for signaling and video transmission with adaptive data compression based on available bandwidth.

The cloud system maintains session level persistence to ensure a live session does not abort because of a telecom dropout, but reconnects when connectivity is restored. All members, joining the conference, can interact with each other and with the patient and view the bedside monitor as well. The nurse / duty doctor can also show patient records in the conference room by screen sharing from a hospital PC that can access the hospital information system. Additional specialists can be invited to the video conference as needed to view the patient condition, records and measurements and discuss course of action. During the session, the nurse or duty doctor can take down specific instructions and enter them into the hospital information system from the bedside terminals, in addition to administering the patient as advised. The system generates transaction logs of information along with date time stamp and IDs of users, patient, doctors, etc., involved in the episode, as needed for billing and audit trials. Kin of the patient were provided with a mobile app that enables them to book tele-visit appointments with attending doctors/nurses. The system tracks the appointment slots and automatically reminds to join video conference sessions as per appointment schedule to see and if conditions are favorable, talk to the patient and the local nurse/doctor as well. Local nurse/doctor may cancel the session, if the patients or other patients are not favorable for such a conference.

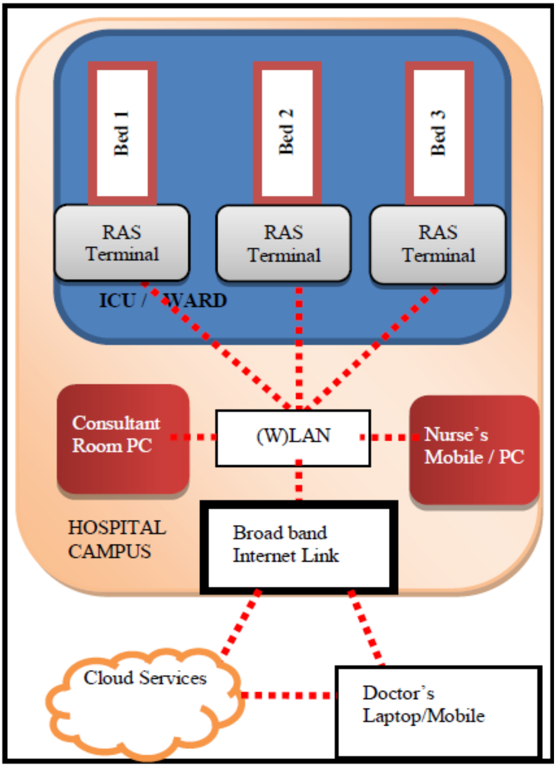

Fig.14 Remote attention system

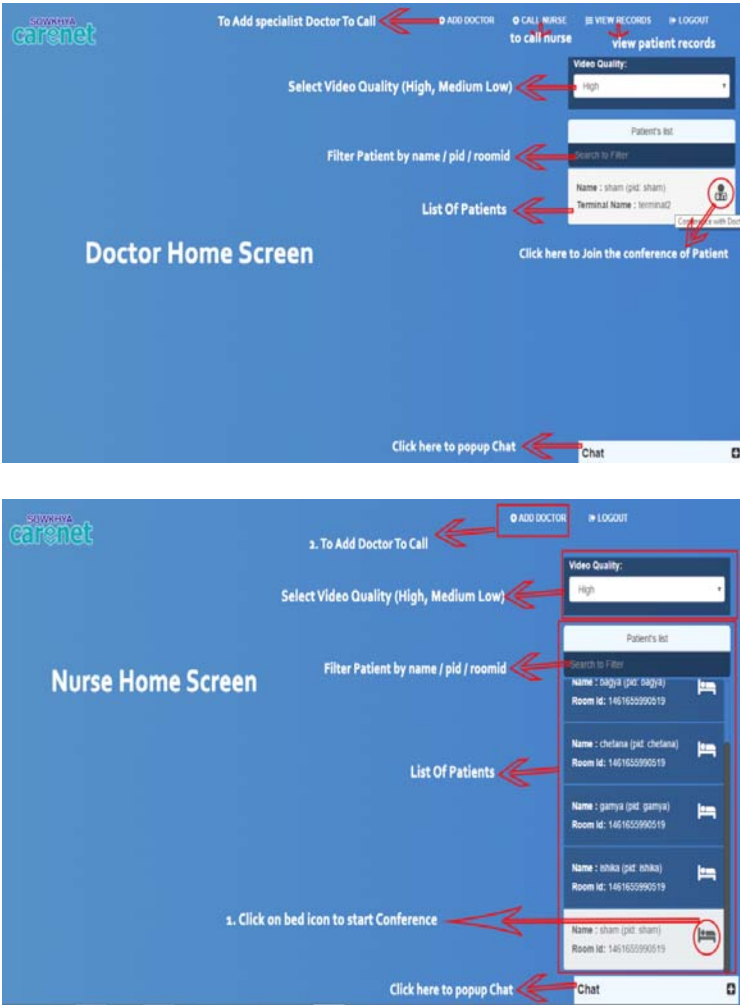

Fig. 15 Screens for calling and viewing patients, doctors, nurses

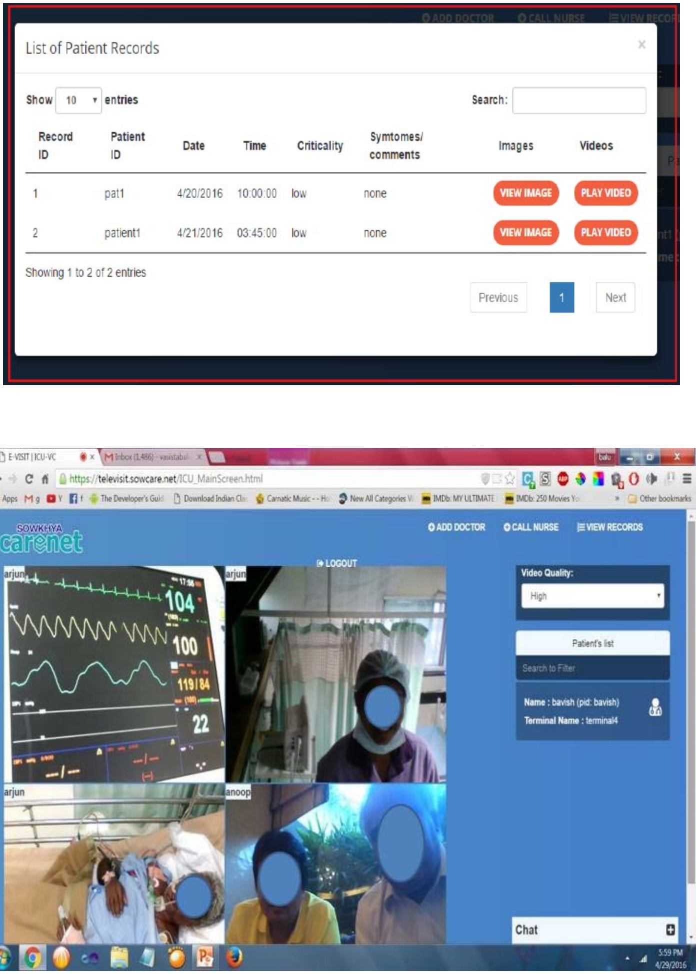

Fig. 16 ICU data Log (top) and real-time conference linking Patient, nurse, remote doctor and vital monitor

Test and Results: Pilots runs were conducted with collaborating hospitals and mock patients with RAS terminals was fixed onto corresponding beds. Over 30 staff members (doctors and nurses) were trained to use the system from their smart phones / tabs / Laptops. The nurse logged symptoms with comments in text, image or audio into the system. Various scenarios were tried out; one in which a remote doctor randomly tele-visits a bed without prior notice, another scenario where the nurse raises an alert to the doctor's smart phone, to tele-visit the concerned bed and calls into conference any other doctors as needed. The patient, the vital sign monitor readings, the remote doctor and the nurse were displayed on 4 quadrants as shown in Fig 16. On another webpage doctor could view the log entered by the nurse and during a conference, the nurse could also screen-share the patient's records stored in the hospital's information. The trials were also done with doctors at remote places and at odd hours of the night, and mock patients, with recording of the discussions where successfully played back later.

The system was also tested for tele-visit from Kin through appointment booking by electronic payment of a visit-fee. Automatic alerts on smart phones of ICU nurse and Kin at appointment time connected kin to attending doctor and see (and talk, if feasible), to the patient. High definition (HD) quality conference with jitter free streaming of image and video at latency <10 sec was achieved at 256 KBPs per channel, and scaled linearly with number of concurrent sessions on different beds. However, since not all beds are engaged in conference concurrently, the bandwidth does not scale linearly with number of beds.

The system was also tested by creating link-outage scenarios wherein the systems rejoin an existing session once connectivity was restored, while local recording of RAS terminal continued during the outage. Doctor's feedback was found welcoming the convenience, comfort, timely access to doctors and reduction of visitors in ICUs, the system could enable without compromising care or affecting current processes in the hospital or demanding steep learning curve to use the system.

Some doctors got clarifications on privacy and security of the data. Hospitals wanted to ensure recording was optional and enabled only on RAS terminals and not on any other user's machines. Patients and Kin were found readily acceptable to use this alternative as it helped reduce their anxiety and enabled them to give company to patients remotely. The proposed system has demonstrated bridging the gaps mentioned. It definitely provides a highly scalable and rapidly deployable means to enhance reach and relationship between doctors, hospitals, patients and their kin in moving from reactive to proactive care.

Acknowledgment:

The authors would like to acknowledge and thank all the collaborators within each initiative reported here for making available relevant materials

and sparing time to discuss and give insight into the issues they were addressing and the impact that their initiative could bring to the strengthening of the health system.

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Melanoma Screening Using mHealth & Telemedicine: Towards an Organized Service Working in an Effective Way

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Introduction

Early diagnosis of malignant melanoma (MM) is extremely important not only because success rates of recovering from MM are very high, if detected during the early stages of its development [1], as well as because a melanoma in an advanced stage of development is approximately 2200 percent more expensive to diagnose and treat than an early in situ melanoma [2]. Thus, it is widely accepted that the best way to deal with MM is trough prevention.

Follow protection rules regarding sun exposition and self-observation of skin lesions and moles are actions that would unquestionably protect people from this deadly form of skin cancer. The two major challenges are:

- Educate people to recognize skin lesions, moles and growths that might be suspicious for skin cancer;
- Organize a network of Teledermatology sites to evaluate suspicious moles and refer those situations for further investigation or removal by certified dermatologists.

To help people on that analysis, a mnemonic called the ABCDE test has been proposed by the dermatologists, which consists of analyzing the following characteristics:

A – Asymmetry;
B - Borders (irregular);
C - Color (variegated);
D - Diameter (greater than 6 mm (0.24 in), about the size of a pencil eraser);
E - Evolving over time.

Objectives

There is a clear potential for providing a Teledermatology Screening Service to deliver dermatologic expertise in a convenient and affordable way and mainly to the underserved regions due to the uneven regional distribution of dermatologists.

We propose a service that combines mHealth – through the SMARTSKINS solution, a mobile-based framework for risk triage and early diagnosis of skin cancers, with the active involvement of an online community of dermatologists – and Telemedicine through the screening of suspicious moles using a dermatology system known as Spectrophotometric Intracutaneous Analysis (SIAscopy). Besides the clear potential to empower and motivate the users to actively manage their own skin health status, this approach will also offer the opportunity to refer suspicious skin lesions to dermatology centers for removal and further investigation. (*SMARTSKINS: A Novel Framework for Supervised Mobile Assessment and Risk Triage of Skin lesions via Non-invasive Screening" is a joint project with INEGI-LAETA, Fraunhofer and IPO-Porto financially supported by Fundação para a Ciência e a Tecnologia in Portugal (PTDC/BBB-BMD/3088/2012).)*

The mHealth Component - SMARTSKINS

Smartphones appear nowadays as a very interesting tool to use in digital monitoring of skin lesions due to its increasingly better quality in image acquisition, portability and easy data transmission. Skin lesion evaluation can be optimized with a mobile application that allows the user to collect process and store information of skin lesions through its automatic classification using machine-learning approaches.

Furthermore, patient-oriented approaches are a new paradigm for skin lesion analysis. Thus, this solution aims to motivate and educate patients for the regular monitoring of their skin health status, as well as improving the communication between patients and dermatologists.

The final goal of the SMARTSKINS solution is to have a significant impact in early diagnosis of skin cancers, being composed by the three main components (see Figure 1):

1. Mobile Application for the patients;
2. Back-end Server that hosts the image processing module and database;
3. Web Interface for the dermatologists and system administrator.

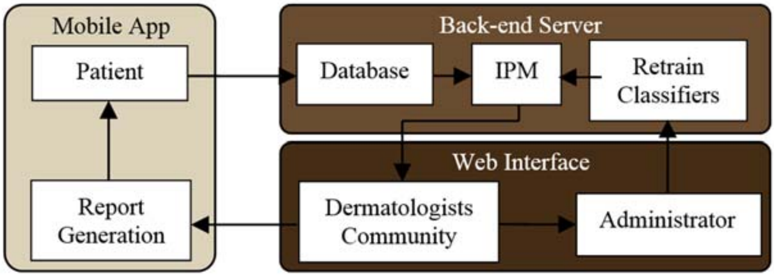

Figure 1. SMARTSKINS system architecture workflow. Using the mobile application, the patients can acquire and send a checkup of a skin lesion to the back-end server, where it is saved on the database and automatically analyzed. The system generates an analysis report for each checkup, which will assist the doctors in the risk assessment of that skin lesion. After the doctor validates the analysis, a report is sent to the patient's mobile application. The validated data is used to retrain the machine-learning classifiers used by the IPM [3].

Using the Mobile Application (see Figure 2), the patients can capture images of their skin lesions or load them from the mobile image gallery. Each patient can add several skin lesions, and each skin lesion can have several check-up images along time. For each skin lesion, the patient also indicates its localization and size, as well as some additional information to transmit to the doctor, like itching or redness [3].

(A) (B) (C)

Fig. 2. Mobile application screenshots: (A) Main menu for sign up or log in; (B) Send skin mole images and receive feedback from dermatologists of the submitted check-ups; (C) List all moles under regular monitoring and respective status.

After a doctor validates a check-up using the SMARTSKINS Web Interface, the system sends a report to the patient's mobile application. In this way, the patient can keep a record of the evolution of their skin moles, always under the supervision of a dermatology specialist [3].

The Telemedicine Component - SIAscopy

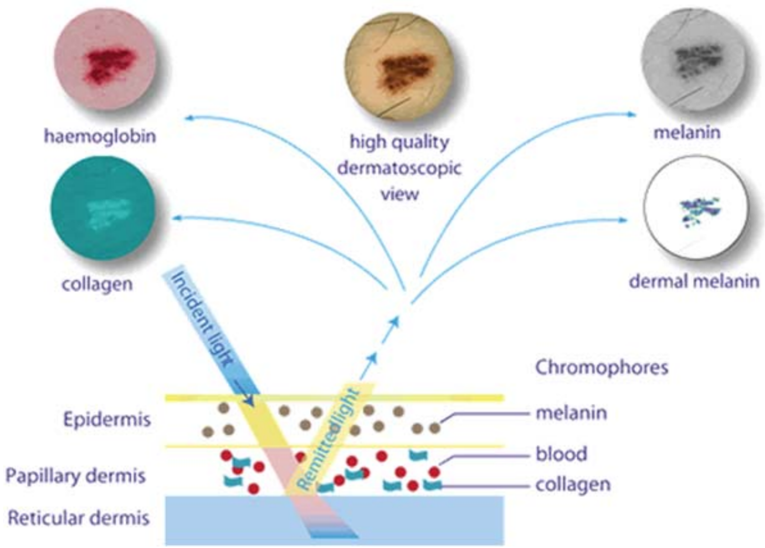

Fig. 3. Skin model structure used in SIAscopy. Four different primary wavelengths of light are shone into the skin in turn. An imaging chip is then used to record the light remitted from the skin at each pixel, giving an image representing the amount of light leaving the skin for each of the four wavelengths used. Cross polarizers are used to remove any scattering from the surface of the skin.

If a suspicious lesion is found using the SMARTSKINS solution, screening of suspicious moles is then performed using a dermatology system known as Spectrophotometric Intracutaneous Analysis (SIAscopy, Fig. 3) [4].

Due to the multi-layered structure of the skin, and because the most prominent chromophores have slowly varying spectral properties, it is possible to generate models which can predict the method of light transport within skin. This allows analyzing the skin using broadband spectrophotometric techniques.

Four different primary wavelengths of light are shone into the skin in turn. An imaging chip is then used to record the light remitted from the skin at each pixel, giving an image representing the amount of light leaving the skin for each of the four wavelengths used. Cross polarizers are used to remove any scattering from the surface of the skin.

These images are fed into the SIAscopy algorithms, which compare them to a mathematical model of the skin. The outputs of this algorithm are 4 images depicting the concentration of hemoglobin, melanin, collagen and dermal melanin within the area of skin imaged.

The Dermatologist will then be able to analyze the skin lesion in a high resolution color image and also evaluate the approximate composition of the mole showing the concentration of hemoglobin, melanin, collagen and dermal melanin within the area of skin imaged.

Results

This paper proposes the combination of two specific mHealth and Telemedicine solutions to improve skin cancer screening. Regarding the mHealth component, preliminary results for the mobile monitoring of screen lesions were reported by FhP-AICOS on a recent study [5], where an image processing and analysis methodology using supervised classification was presented. This methodology independently assesses the Asymmetry, Border and Color criteria score according to the ABCD rule, as well as the Overall Risk of skin mole images acquired using mobile devices. A mobile acquired image dataset of 80 images (manually annotated by a specialist) was used to test the proposed approach and accuracy rates of 73.8%, 76.7%, 68.8% were achieved for the estimation of the ABCD score of Asymmetry, Border and Color criteria, respectively. Moreover, the automatic Overall Risk assessment achieved 86% of sensitivity and 73% specificity.

In terms of the Telemedicine component, the Teledermatology supported by the SIAscopy system was developed by Screencancer. It is used in Norway within the Boots pharmacy network since 2010 and is recently expanded to the UK and Sweden. In Lisbon, we have started a pilot that enrolled 72 individuals with skin lesions (Fig. 4). From these base 116 moles where analyzed but only 91 where according to the ABCDE rule. From this sample 5 moles where considered potentially malignant and referred for removal. All of them where Malignant Melanomas in early stage. Individuals had no previous knowledge of the way to perform self-analysis and it was only at the moment of testing that they get acquainted with the ABCDE method.

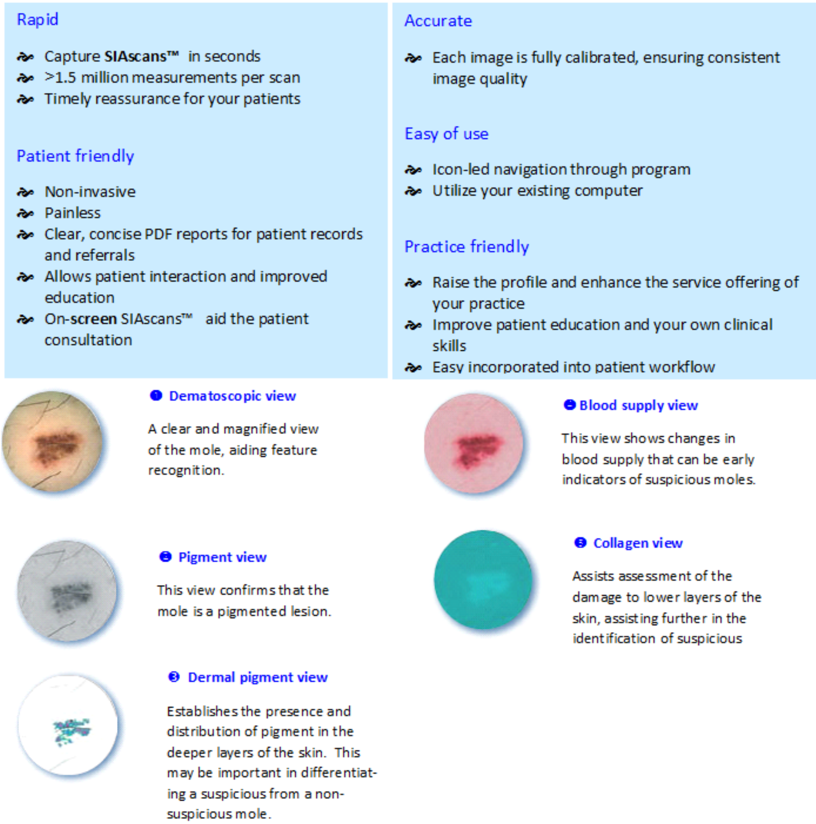

Fig. 4. Each SIAscan is a bitmap representing the concentration of each chromophore on every pixel. There are more than 1.5 million measurements given from each scan. Contact SIAscopy requires contact with the skin, and measures the skin over a diameter of 11 mm.

Below we present one real situation of a positive scan for melanoma (see Figure 5):

1. Male, Caucasian, age 45, no family history, no major sun burns reported in childhood;
2. SIAscopy Screening a suspicious lesion as per ABCD evaluation;

3. SIAscopy result was positive recommending urgent excision;
4. Result after Histopathology was confirmed Malignant Melanoma with no angio-invasion;
5. Very good prognostic of TOTAL REMISSION.

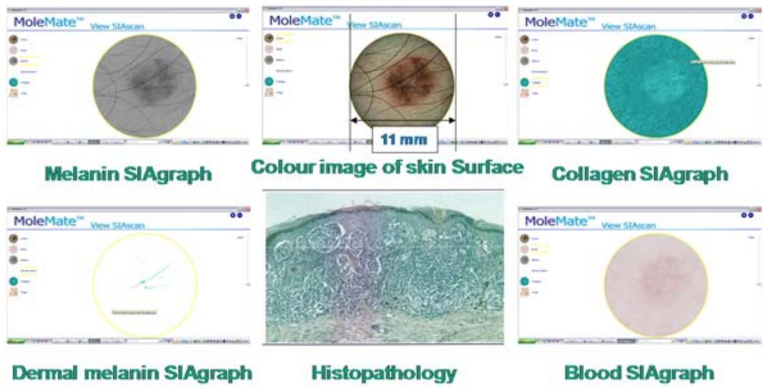

Fig. 5. One real situation of a positive scan for melanoma using the SIAscopy system confirmed by Histology of the mole that was removed with a wide safety margin.

Conclusion

The main objective of this work is to establish a combination of techniques to fight MM. Thus, we propose merging the usage of mHealth and Telemedicine solutions to improve skin cancer screening. The data gathered on the Lisbon site using the SIAscopy system lead us to conclude that people need some help to distinct dangerous skin lesions that require immediate attention from the lesions that do not show malignant characteristics. Thus, the combination of these two techniques will therefore enable a wide utilization of a mobile tool that performs a first evaluation. The result will then prompt for subsequent action. A referral via Teledermatology is then done, if a mole is considered suspicious, allowing easy access to a Dermatologist analysis and further management.

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Women's Health Wearable for the Developing World

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Attacking a Health Danger Bigger Than Tuberculosis, Malaria and HIV Combined

One-third of the humans on earth — more than 2 billion people — need to light a fire in order to cook. That typically means burning wood, charcoal or animal dung indoors. In addition, that also means toxic carbon monoxide and particulates inevitably spew into kitchens and inside living spaces.

This little-known but massive global health scourge — officially called household air pollution — contributes to 4.3 million deaths every year, according to estimates by the World Health Organization (http://www.who.int/indoorair/en): "*In poorly ventilated dwellings, smoke in and around the home can exceed acceptable levels for fine particles 100-fold. Exposure is particularly high among women and young children, who spend the most time near the domestic hearth*". That's a staggering number: toxic fumes from cooking fires trigger more deaths than tuberculosis, malaria and HIV combined.

Using Technology to Warn of Carbon Monoxide - Visual and Spoken Alerts

Grameen Intel Social Business (GISB, http://www.grameen-intel.com), a joint collaboration between Intel and the Bangladesh-based nonprofit Grameen Trust, develops technologies that address major social issues facing billions of people in the world's developing nations. The vision of GISP is to develop affordable technology solutions to connect and improve people's lives around the world. More details are available at http://www.grameen-intel.com.

In small villages across India and Bangladesh, Grameen Intel is piloting a unique health wearable — it's a brightly colored bangle — with a tiny built-in carbon monoxide (CO) sensor (Fig. 1-3).

Fig. 1: A woman in India cooking over a fire inside her home

Fig. 2: The carbon monoxide detecting bracelet, field tested in India

Fig. 3: Health wearable bangle developed by Intel

Fig. 4 Light and sound alarm

When the sensor detects carbon monoxide at a dangerous level, a red LED flashes. The bangle also produces a voice warning, customized to the wearer's language, to open windows, open doors or get outside (Fig. 4).

Women and expectant mothers in the developing world are at an especially high risk from foul indoor air. Women typically spend more time than men indoors or in kitchens. Babies can suffer low birth weight or other serious health complications from the effects of breathing indoor fire cooking fumes.

The bangle is currently called COEL for Carbon Monoxide Exposure Limiter.

Water resistant and made of molded gold, green or red plastic, its internal battery lasts for 10 months. It can be programmed to "speak" about 80 pregnancy wellness messages (in addition to CO alerts), and stores 32 megabytes of data. The device is not connected to the internet in order to maintain a lengthy battery life.

After initial trials in India, the Grameen Intel team in Dhaka will distribute more than 5,000 of the bangles to women in rural Bangladesh.

"It's beautiful… nobody would suspect that you're wearing a piece of high-tech," said Professor Muhammad Yunus. The Bangladeshi Nobel Peace Prize winner pioneered microcredit and microfinance for poor people in the developing world and founded the Grameen Bank.

As part of a commencement address in June at the University of California at San Diego, Yunus told students that he has been "very worried about maternal death in Bangladesh," and that he has been looking to Grameen Intel to find ways for applying technology to tackle the problem.

It is almost certain that in the face of 4 million lives lost annually due to indoor fire fumes, the benefits of the ultra-low-cost COEL wearable will be felt by people all across the developing world.

Diagnosis and Treatment of Diseases

Accountability in a Sub-Saharan Hospital: Impact of Use of ICT Tools at the Gabriel Touré Hospital of Bamako

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Introduction

The University Hospital Gabriel Touré is a third level Hospital of the health pyramid of Mali. As such, it is one of the largest hospitals in terms of offering tertiary care in the national health system. Added to this is its central location and proximity to the people of the Malian capital Bamako. These factors make the hospital the most frequented and most solicited by citizens of the Republic of Mali.

As part of an efficient operation and providing quality service to the public, senior management of the hospital wanted to achieve concrete improvements of the working environment for the benefit of its employees and users actions. However, it was quickly confronted with problems of availability of quality information necessary for the proper control of the institution.

The most pressing problems were the lack of reliable information on the situation of income and the exact number of operational human resources at the hospital. Added to this, there was a crisis of confidence between the hospital staff and management, on one hand, and on the other hand, between the users of public hospital and healthcare professionals of the institution. It is in this context that the senior management of the institution initiated the process of computerization of the entry-office and biometric census of hospital staff by using the expertise of the National Agency for Telehealth and Medical Informatics (ANTIM) because of the mission entrusted to this structure by the Ministry of Health.

Methodology

The project was realized by ANTIM, focusing on discussion and including involvement of various stakeholders in the hospital. The most senior leaders of the hospital accompanied the process of performing an audit of existing information systems to determine the needs of all stakeholders and finally propose a technological solution taking into account all these factors. This allowed the implementation of a hospital information system software package called OpenClinic [1] for fund and human resources management.

Results

OpenClinic became operational on 29 January 2013. Financially, it was noted that from its implementation, it improved significantly the revenue of the hospital [2-4].

In terms of direct revenue (payment by patients, cash directly perceived at checkout) without insurance and cesarean reimbursement, the hospital recorded after ten months of operation 446054837 XOF. This equates to a monthly average of 44605483 XOF against 35090725 XOF before. *(Note: The West African CFA franc (code: XOF) is the currency of eight independent states in West Africa: Benin, Burkina Faso, Guinea-Bissau, Ivory Coast, Mali, Niger, Senegal and Togo. The acronym CFA stands for Communauté Financière d'Afrique ("Financial Community of Africa") or Communauté Financière Africaine ("African Financial Community".)*

It should be noted that the hospital had previously recorded 18,497,590 FCFA in December 2012 and 35,490,000,665 CFA francs in the month of January 2013.

Table 1

Feb 2013	Mar 2013	Apr 2013	May 2013	Jun 2013
50,540,965	68,485,395	64,204,959	62,402,837	61,804,855
Jul 2013	Aug 2013	Sept 2013	Oct 2013	Nov 2013
44,014,080	47,777,350	59,670,480	64,792,390	63,293,825

Table 1 shows the evolution of direct revenue (perceived directly at the patients' checkout) without insurance reimbursement and cesarean per month at the beginning of the implementation of the software.

Table 2

Feb 2013	Mar 2013	Apr 2013	May 2013	Jun 2013
56,105,550	75,494,950	67,981,500	60,911,550	67,377,900
Jul 2013	Aug 2013	Sept 2013	Oct 2013	Nov 2013
57,623,450	63,580,350	74,266,750	74,761,450	74,583,500

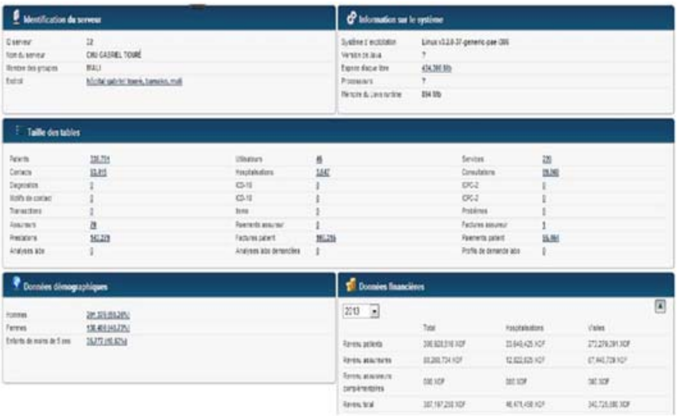


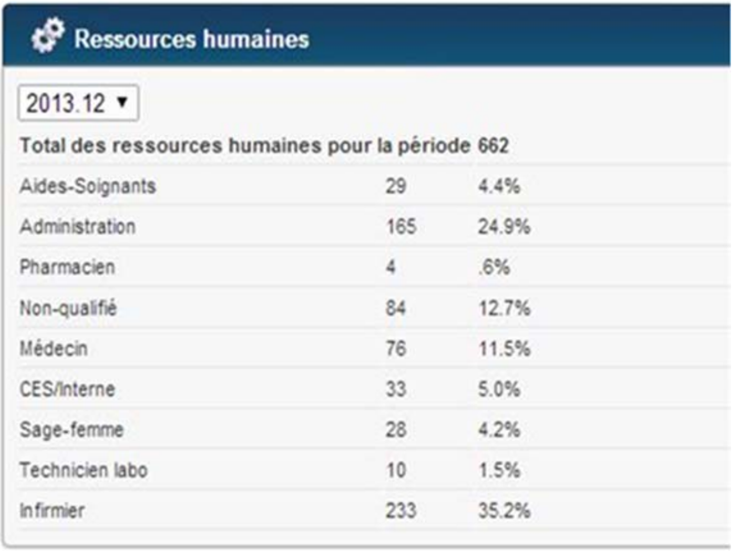
Fig. 1: Technical and Financial data dashboard

Table 2 shows the evolution of total revenues of the hospital including all insurance, i.e. Compulsory Health Insurance (AMO), Mutual, Hospital's Half price, Free of charge care for hospital staff, since the implementation of the software. The software also gives the possibility for the hospital management and health authorities to monitor financial results in real time thanks to the interface of the national health data repository (Global Health Barometer of Mali).

In terms of human resources, it was noted that the services responsible for staff at the hospital had too divergent information; the census has resolved definitively this issue and has allowed producing secured badges for staff.

The biometric census of the entire hospital staff in OpenClinic software showed that the hospital has only 648 employees instead of 811 provided on the list of discounts. The operation allowed removing 163 fictitious employees from the list of discounts.

In addition, the installed system manages Compulsory Health Insurance (AMO) patients, this through authorization mechanisms managed directly by agents of the National Health Insurance Fund (CANAM) in the space dedicated to this purpose. This allows editing invoices that integrate CANAM's logo for any insured AMO patient; reducing significantly fraud attempts to health insurance. Data on services provided by the AMO patients are sent every night, at midnight, by e -mail to CANAM and to the direction



Ressources humaines

2013.12

Total des ressources humaines pour la période 662		
Aides-Soignants	29	4.4%
Administration	165	24.9%
Pharmacien	4	.6%
Non-qualifié	84	12.7%
Médecin	76	11.5%
CES/Interne	33	5.0%
Sage-femme	28	4.2%
Technicien labo	10	1.5%
Infirmier	233	35.2%

Fig. 2. Hospital human resources dashboard

of the Hospital Gabriel Touré. This reduced significantly the misunderstanding between CANAM and hospital's management, concerning invoices. It was also highly appreciated by doctor’s controllers of CANAM, who saw their work greatly simplified by data availability online and in CSV (Comma Separated Values) format, ready to be analyzed in software like Excel.

All these data can be queried at any time by leaders with a security code that gives them access to a dashboard containing different modules appropriate to their responsibilities. The dashboard in addition to provide the opportunity to obtain statistics or generate graphics, also automates a large number of operations as centralized printing of identification cards or transfer data coverage and disease billing between providers and insurers (Fig. 1-3).

Outlook

The outlook is to quickly activate and configure modules on medical

Objet The Global Health Barometer - TEST AMO extract CHU GT
De <chugt@globalhealthbarometer.net>
À <canam@globalhealthbarometer.net>
Date 2013-02-19 01:00

Ministère Santé
webmail

- exportAMO.csv (14 ko)

```
Message de test avec extraction de données de facturation pour CHU GT en annexe.
- Période de facturation couverte: du 18/02/2013 06:58:03 au 19/02/2013 01:00:02
- Nombre de prestations facturées: 90
- Montant total des prestations: 330800 XOF
- Montant total à charge de l'AMO: 231560 XOF

Colonnes de la table en annexe:
- PREST_ID: numéro unique de la prestation facturée
- PREST_DATE: date de la prestation
- CONTACT_TYPE: C=Consultation, H=Hospitalisation
- CONTACT_ID: numéro unique de la consultation ou de l'hospitalisation
- CHUGT_ID: numéro d'identification interne du bénéficiaire au CHU Gabriel Touré
- AMO_ID: numéro AMO du bénéficiaire
- AMO_STATUS: affiliate=Adhérent, child=Enfant, partner=Conjoint, parent=Parent
- AMO_SOURCE: INPS ou CMSS
- PAT_LASTNAME: nom du patient
- PAT_FIRSTNAME: prénom du patient
```

Fig. 3. Example of automatically generated message with the CSV file

patient record, pharmacies and laboratories within the UHC-GT. In other words, it is to make available the system to the physicians and other professionals (nurses, midwives, laboratory assistants, technicians ...) in the box of consultation and hospitalization services with electronic publishing orders (sheet of electronic care). This will significantly reduce fraud to care sheets, which tend to become widespread in health institutions.

Conclusion

The implementation of the modular hospital information system OpenClinic at the University Hospital Gabriel Touré has improved substantially the revenue of this institution.

In addition to this improvement, the dashboard was the most appropriate to implement. Because it allowed the decision-makers to better manage the hospital based on verifiable and proven data.

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Integrated Telemedical System for Non-invasive Early Diagnostics of Endothelial Dysfunction with Specific Focus on Diabetic Patients

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Introduction

Cardiovascular diseases are the most common cause of death and physical incapacity in many countries, with vascular obstructive stenosis affecting cerebrovascular, coronary and other arterial territories. High cardiovascular risk people, like smokers or those suffering from diabetes mellitus are victims of lower limbs arterial obstructive disease, which courses a long period in absence of both symptoms or clinical evidence. Early stage diagnosis, obtained through non-invasive strategies have been proposed as a means of diagnosing incipient vascular occlusion.

Since 2012, as a result of public private partnership between:

- A regional hospital in Zdar nad Sazavou (22 000 inhabitants, central Czech Republic, one of the highest incidence of diabetes mellitus, diabetic foot and related lower limb amputations),
- Vienna Point – Science and
- A private company Advanced Medical Solutions

a preventive telemedical program was prepared, implemented and put into operation with the below defined objectives and results.

Objectives

Generic objectives:

1. To analyze the applicability of a noninvasive diagnostic strategy for the early detection of arterial flow reduction in a rural population;
2. To introduce an integrative telemedicine platform allowing diagnostics, data storage, monitoring of patients in the natural environment and transmission for specialized second opinion;
3. To introduce a system of therapy adherence support;
4. To introduce a long term sustainable preventive program;
5. To promote technical qualification of remote professionals of health sector in the field of new technologies.

Specific Objectives:

1. Evaluate a population of more than 1.000 adults from the region with specific focus on the following target groups and priorities:
    a. Elderly populations;
    b. Diabetes mellitus + other major metabolic risk factors;
    c. Family medicine.
2. Monitor defined perfusion indicators in the natural environment of the patients with the aim to improve the therapy effectiveness thanks to personalization and updated adaptation.
3. Prepare and introduce a therapy support system.

This initiative permits us to:

1. Introduce an innovative telemedicine platform allowing data collection, transmission and storage for subsequent analysis and report by specialists and, when needed, specialized second opinion;
2. Investigate the applicability of a systematic, well-structured and non-invasive screening to support the early identification of atherosclerosis, peripheral arterial flow reduction and diabetic foot;
3. Encourage and promote technical qualification of local health professionals supported remotely by specialists – angiologists, diabetologists, cardiologists - in the investigated areas enabling an effective screening using these new technologies;
4. Introduction of new, more efficient therapies and reverse the progression of the specified disease.

The screening techniques used in this study is also evaluated in terms of specificity and sensitivity to stratify the patients that need further evaluation leaving the others, with no sign of subclinical disease, outside the health system, reducing the waiting lists and demanding pressure for healthcare services in times of scarce resources.

Methods

The applied methods and equipment are focused on Peripheral Artery Disease (PAD) screening, using Computer aided occlusion Plethysmography, and evaluation of the onset of PAD, avoiding premature amputation of toes and lower limbs.

The device is designed for the screening and evaluation of the quality of perfusion on the periphery, based on lower limbs. The system allows a complete arterial and venous diagnostics, based on proven protocols elaborated in accordance to applicable guidelines. The conception of the system allows an easy and automated procedure to be effected by a nurse or basically trained healthcare personnel without the presence of expert angiologist or doctor. The preventive program is based on the following procedure:

1) *Measurement:* Patients were measured by a nurse, without the presence of doctor, using the Computer aided plethysmography developed by Advanced Medical Solutions. The results of the measurement were sent together with the basic anamnesis to the Telemedical center for evaluation.
2) *Evaluation:* The evaluation of the data was effected by expert angiologists who provided also the indication for further procedure and divided the patients into the following groups:
    a) Patients with physiological parameters without detected pathology;
    b) Patients with border values or detected risk factors however without immediate risk;
    c) Patients with pathological values or detected immediate risks requiring acute further procedure. Currently the nurse is already able to recognize the pathological alterations and her informal evaluation is in tune with the expert evaluation made by angiologists.
3) *Verification with golden standard method* - ultrasound:
   All patients with identified alterations and pathologies, based on defined measurement, were indicated for deeper evaluation based on ultrasound, which as a golden standard and allows to evaluate the sensitivity and specificity of the methodology.
4) Preparation and introduction of therapy adherence support program.

In September 2012, the system was first installed at the regional health center in Zdar nad Sazavou. After an initial pilot project and training, a long term preventive was started on a sustainable basis. The core focus of the method is to provide an early and non-invasive diagnostics of the peripheral perfusion, which allows to evaluate the quality of the arterial, venous and lymphatic function and to detect the level of cardiovascular and metabolic risk factors.

Results

The preventive program was successfully implemented in Zdar nad Sazavou and is currently operated on a sustainable basis with the capacity of 10 patients a day per measurement spot. After the initial setup and training, there were diagnosed 1791 patients, 962 women and 829 men (Fig. 1-3). The basic characteristics of the patients are provided below. Based on the anamnesis the patients were divided into the following groups:

- Healthy without symptoms;
- Diabetes Mellitus I;
- Diabetes Mellitus II;
- Symptomatic patients, e.g. suffering from pain while walking (See Table 1).

The results of the Computer aided plethysmography diagnosis are given in the Table 2. Patients were divided into 3 major groups:

- Healthy – 148 patients = 56 women + 92 men;
- Suspicion – 1419 patients = 807 women + 612 men;
- Pathology – 224 patients = 180 women + 44 men.

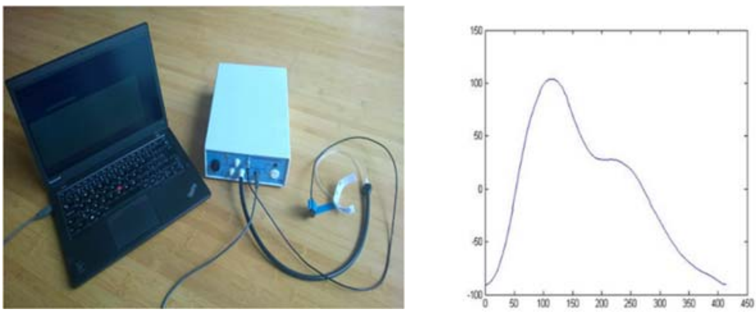

Fig. 1. The equipment and normal pulse wave

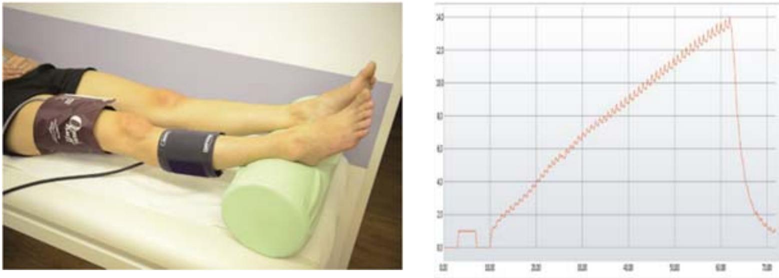

Fig. 2. Measuring arteries quite

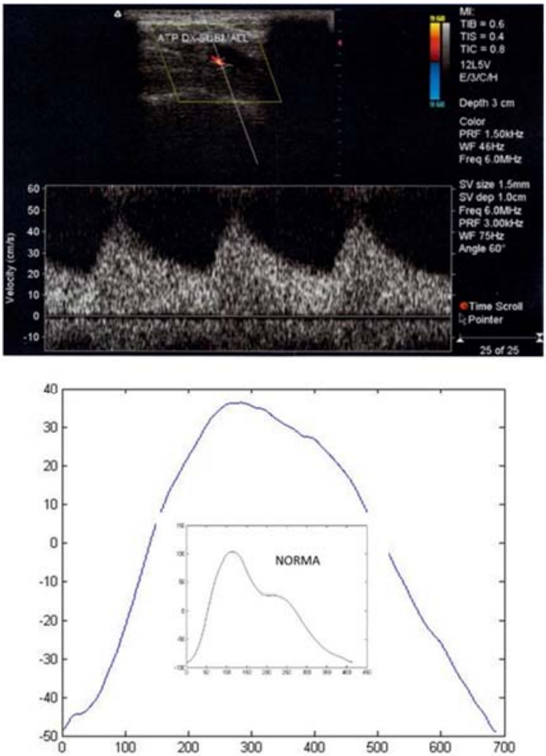

Fig. 3. Intermediate alteration of arterial flow

Risk factors detected with the plethysmography diagnosis - evidenced as "abnormal peripheral perfusion indicators, e.g. arterial capacity and altered arterial waves" - were detected in slightly above 79% and pathological values above 12%. This relatively high incidence of detected suspicion and pathology is influenced by the group of patients with high presence of diabetes and symptoms. In total, there were evaluated 10 indicators related to the peripheral perfusion and the arterial wave analysis. The difference between the normal values and those altered, corresponding to patients with detected risk factors, exceeded 50% in some cases.

A more serious alteration of the peripheral perfusion was detected in 12% of all patients with an indication for immediate intensive therapy. In this group of acute patients, there are 3% with immediate risk of limb loss, which was avoided, thanks to the program.

Based on the statistical evaluation of the data the sensitivity exceeded 92% for the peripheral arterial disease.

In addition to the limb loss avoidance, the program also allowed the application of non-invasive and less burdening physiotherapies, designed for the application in the rural areas without presence of expert doctor.

Currently we evaluate the potential of using micro-invasive therapies, based on stem cell procedures that would allow providing a new level of therapies available in rural areas.

Based on current results the program led not only to an elimination of the lower limb non-traumatic amputation in the area but also has very positive economic results that led to an overall reduction of costs by more than 25%, thanks to reduction of more serious and invasive treatment and introduction of less invasive approaches including therapy support system.

Table 1

Group	Age	Healthy	DM I	DM II	Symptom.
Women	17-92	35	0	245	682
Men	12-91	42	5	356	426

Table 2

Group	Healhty	Suspicion	Patology
Women	56	807	180
Men	93	612	44

Discussion

Early detection of altered arterial flow indicators will help in the prevention of cardiovascular disease and avoid physical incapacity due to premature limb loss by early introduction of treatment interventions. The patients with altered values of the peripheral perfusion, detected during the program, are given a better chance to improve and reverse the corresponding pathological processes. That can be especially valuable when applied to underserved areas of the globe, where specialized vascular evaluation facilities are, for obvious reasons, unavailable. Through the application of a low cost and easy to use computer aided arterial plethysmography method, preclinical vascular disease can be anticipated to a population living in remote areas, warning the need for immediate complementary diagnosis and effective therapy.

Individual and social benefits are expected to be confirmed through long term evaluation of this strategy, deserving its application in a larger setting of patients. During the program there were also identified several non-invasive and micro-invasive therapies, which might be used in rural areas with the aim to assure a comparable level of care to major health centers.

Investigations on Veil Psychology for Telemedicine System Acceptance in South Punjab, Pakistan

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Background Information

Mayo hospital is the oldest and biggest hospital of Pakistan with the capacity of 2300 beds. There are more than 40 departments in it and is attached to King Edwards Medical University (KEMU), one of the most prestigious and oldest medical learning institutes of Asia, established in 1870.

At Mayo Hospital, the telemedicine project was launched by the Federal Ministry of Information and Technology in 2008 and became operational in 2009. The Telemedicine Department is one of the three hubs established in Pakistan. Hurdles in communication between the psychiatrists at hub and patients at remote locations created problems in tele consultations, which needed to be analyzed.

The veil (*niqab*, *chadar* or *burqa)* in the Muslim community may vary from community to community. Historically, the influence of old Arab, Iranian and various sub continental communities established different concepts and limits of veil. In Pakistan, south Punjab has a unique culture, as it shares historical, social and cultural values with Arab, Iranian and other sub continental cultures. It is for this reason all types of veils are practiced in this region [1].

The Veil often influences access to resources, opportunities and other pursuits for women. The present studies were focused on the instrumental constraints of veil, in which the veil [3] affects communication between the expert at hub and patient at remote. In general, shyness is the most common factor while communicating with an unrelated male and is made worse by the presence of a camera [4]. It is a serious concern, which hinders with the social interaction [5].

The present studies highlight the nature and intensity of communication problems at the consultant's hub. Discussions regarding the psychological aspects of this problem are complex in nature and require extensive studies to understand the problem, before any solutions can be suggested. This study was conducted with the goal to enhance the Quality of communication through the telemedicine system and understand the cultural obstacles that hinder that quality.

Investigation Protocols

Information Collection and Feedback System

The information was gathered from patients and operational staff at remote stations through informal discussions, formal tele meetings and questionnaires. Operation staff at seven remote centers was trained to fill up the questionnaire in light of site-specific norms and customs. Patient views and feedback on questionnaires were documented focusing on age, financial group, and matriarch vs patriarch family structure as well as patient's influence in the micro ecology of the family.

Distribution of Structured Questionnaire at the Hub

A structured questionnaire was distributed among the tele-consultants at the Hub stations, in which they were asked to record the types of hindrances they faced during consultations such as sound quality, body language, communication issues, language, patient behavior, issues due to veil.

Psychological Observations at Both Ends

A team of clinical psychologists was included in the final phase of the study.

They were asked to observe both patients at the remote end and doctors at Hub station. The specialists observed the irritation level of doctors and patients at both ends, language issues, anxiety level of the patients, negative family influences during the consultation, and the veil of patients influencing communication.

Results and Discussions

Between 2008 and 2013, the cultural psychology of 7452 patients (3369 Male and 4083 female) at seven District Head Quarter Hospitals (DHQ) was studied through structured questionnaires and informal discussions. Information related to the socio economic and cultural background along with the living conditions were collected (Table 1). Parameters of patient satisfaction, fear associated with new technology, irritation levels of patients, facial expressions, and intimidation factors were documented by the psychologists.

Table1: Patients observed for veil issue

Station	Total Patients	Patients with veil issue	Went without consultation	Patients with reservation
Gujrat	889	19	2	17
Rajanpur	1089	141	34	107
D.G Khan	881	86	18	68
Jhang	428	28	3	24
Khushab	384	31	2	29
Attock	372	13	2	11
Sahiwal	40	40	0	0

Issues due to Veil

During the live tele-consultation sessions, we observed that the veil, in one form or another, was creating problems during the consultations. The doctors at hub experienced irritation, voice distortion, misleading, and murmuring.

This was particularly problematic for dermatology and psychiatry consultations since the veil hindered the necessary examination of skin and facial expressions.

Similarly, in medicine and surgery consultations the veil created hurdles in body inspections. In the presence of a dominant female, the young patient resisted examination from the doctor (Table 2).

Table 2: Issues recorded due to veil

Station	Freq.	Issues recorded due to veil during consultations				
		Voice Distor-tion	Murmur-ing	Irritat-ion	Time wastage	Mislead-ing diagnosis
Gujrat	19	3	2	5	2	5
Rajanpur	141	34	23	19	14	17
D G Khan	86	26	19	7	7	9
Jhang	28	5	9	1	4	5
Khu-shab	31	2	1	7	12	7
Attock	13	0	1	3	5	2
Sahi-wal	40	0	0	0	0	0

Problems Observed Due To Veil during Consultation

Because of the mouth being covered, a patient's attempt at communication is perceived at the other end as murmuring. This causes frustrations at both ends as the patients are asked to repeat their statements several times resulting in time wasted at both ends, when consultants fail to accurately comprehend their patient's concerns. Furthermore, the absence of visible lip movements also complicates consultant's attempt at establishing a complete understanding of their patient's problems, resulting in the communication gap widening. Miscommunication not only wastes resources as well as time, it also increases the risk of a misdiagnosis. At times, the psychiatrist was unable to understand patient rushes through the diagnosis, while missing key factors that should have been taken into consideration in order to provide the patient with the best treatment for their specific and unique needs. There were also incidences when patients left the session without a diagnosis or treatment plan due to their apprehension of the camera or the providers request for physical inspection (Table 3).

Table 3: Frequency specialties suffered due to Veil Issue

Age group		13-20	21-30	31-40	41-50	51 & above
Consulted without veil issue		1731	1032	926	318	73
Frequency of veil issue patients		142	94	46	26	9
Specialties affected due to veil issue	Dermatology	118	76	31	19	7
	Psychiatry	8	9	5	3	1
	Medicine	16	7	7	3	0
	Surgery	0	3	3	1	1

Fear Factors for Veiled Women in Tele-Consultation

Fear is the dominant factor documented for veil related problems during consultation. This fear was influenced by security concerns, religious concerns, mistrust of unrelated male providers, misuse of their images, invasion of privacy, social taboos, shyness, cultural norms, the presence of a dominant family figure, and above all - camera Phobia (Tables 4 and 5).

Table 4: Factor dominated the veil issue

Station		GUJ	RJP	DGK	JH	KSH	AT	SW
Frequency of veil issue		19	141	86	27	31	13	0
Factor which dominated the veil issue	Religion	3	23	19	1	4	4	0
	Security	2	18	11	2	7	3	0
	Mistrust on staff	6	21	23	8	11	4	0
	Dominate / interpersonal factor	5	47	19	12	4	2	0
	Camera phobia	2	26	9	3	3	0	0
	Society phobia	1	6	5	1	2	0	0

Table 5: Veil Issue age group

Age group		13-20	21-30	31-40	41-50	51 & above
Consulted without veil issue		1731	1032	926	318	73
Frequency of veil issue patients		142	94	46	26	9
Social group	Poor	83	46	23	11	2
	Mid Class	37	36	16	4	1
	Rich	22	12	7	11	6
Did not consult		23	18	12	7	1
Consulted with reservation		119	76	34	19	8

Addressing the Issue

Veil is a cultural, social, and religious subject. During the consultations it was observed that veil was practiced by every social class.

- The department of telemedicine and DHQ Hospitals assured patients of the security of female patients and protection of their data. System administrators were made responsible for any leakage, misuse and/or theft of data. They were also responsible for the privacy and honor of the patients.
- Gender segregated clinics for dermatology, psychiatry, and medicine were arranged, in which female doctors were called for consultation. The presence of female providers was ensured at remote stations during clinical examinations.

- Briefings were given to religious heads in the area about the utility, convenience, and advantages, associated with the system, and assurances were issued regarding religious and cultural values being protected and honored by all staff members. The religious heads were urged to propagate and develop a positive understanding of the system for their people.
- The equipment is also updated over the years to ensure the highest quality sound and video to be transmitted and enhanced to compensate for low murmuring voice.
- Follow up reports were collected to determine the success of these interventions. It was confirmed from these follow up reports that the above-mentioned interventions proved effective in providing veiled women with completed consultations and treatments.

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Modelling the Implementation of Teledentistry for Rural and Remote Pediatric Patients in Victoria, Australia

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Introduction

In the Australian state of Victoria, whilst publicly funded dental services are available, there are strict eligibility criteria and considerable waiting lists, especially for specialist dental services. Teledentistry (TD) has the potential to improve access to quality services that patients previously deemed inaccessible, in addition to reducing travel time and costs for those currently accessing distant services.

Victorians in rural and regionals centers travel further for dental visits and are less likely to have seen a dentist than those in metropolitan centers [1]. A substantial portion of Victorians (25%) travel long distances to attend these appointments.

The implementation of TD can potentially remove access barriers to specialist dental care, which exist in the current service delivery model, where geographical distance and limited local resources result in a lack of dental specialist services in these areas [2, 3].

The Royal Children's Hospital Melbourne (RCH) Department of Dentistry provides the majority of specialist dental services for children and adolescents in the management of Cleft Lip and Palate (CL&P). The CL&P Scheme is a Federal Government initiative that compensates registered patients with specified treatment costs associated with this condition. These services include pediatric dental examination and limited treatment, including orthodontic and surgical treatment deemed necessary for the management of CL&P.

For rural and regional patients management may involve multiple trips to RCH, which are time consuming and costly, and can be a source of frustration for the patient and parents. A significant proportion of these appointments are to monitor and review the patient's oro-dental development, which may not require hands-on examination by the specialist. Teledentistry may provide an alternative method to a traditional consultation. Patients could be monitored and reviewed remotely rather than the current practice of face-to-face consultation at RCH.

A field study was organized to demonstrate that TD can improve access to specialist dental care, and can bring savings in terms of time, stress and money from avoiding travel to the RCH for consultation [2]. An alternative model to traditional oral health examination to assist in the provision of regular and timely oral health examinations and assessments was tested using trained intra-oral camera operators and assistants in the first instance and specialist oral health support to the local health care facility, when the required treatment need is identified. This would mean that RCH could increase its capacity to provide dental services for minimal extra infrastructure costs.

The approach utilized three general dental practitioners (one each in Rosebud, Shepparton and Geelong) trained to use the TD equipment, they used intraoral cameras locally, with off-site pediatric dentistry consultants at the Royal Children's Hospital and the Melbourne Dental School conducting virtual dental examinations. The general and specialist dentists collaborated to develop a treatment plan for each patient and arrange for specialist dental services at a tertiary level hospital, as required [2].

A total of 43 patients, aged between 2 and 18 years, participated in TD consultations with cleft lip and palate specialists and orthodontists based at the Royal Children's Hospital. The majority of the consultations (57%) resulted in the avoidance of travel to the RCH. These patients were given a follow-up visit with the specialist in 6 to 12 months' time [2].

When asked about their overall experience, the majority of the parents were very satisfied or satisfied with either the remote dental examination, the review of the dental needs by the remote dentist or the format of the remote examination. Two thirds of parents commented that the most valuable element of the remote examination was avoiding the need for difficult and expensive travel to Melbourne; with one participant commenting that "Not needing to take the day off to drive to Melbourne for a 5-minute appointment" was a benefit [2].

The study demonstrated that TD could be a highly effective mechanism for enhancing early diagnosis and referral for patients who otherwise might not receive care. This field study also provides initial information on potential broader community benefits of the approach; its level of acceptance by patients and professionals working with children; and the level of convenience for both the family and the pediatric dental specialist.

The findings of this project were used to undertake economic modelling to determine if the TD approach is cost-effective in comparison to the traditional model of oral health examination. As part of that larger study, this study aims to determine the potential clinic time saved of implementing TD at the RCH for rural and regional patients.

Methods

A model-based analysis was conducted to determine the potential clinic time saved of implementing TD at the RCH Department of Dentistry. The model was developed by outlining the hypothetical implementation and operation of TD to provide teleconsultation for certain appointments that are appropriate for TD in this population group.

Under the TD model, eligible patients would present to their closest TD-enabled Community Dental Clinic (CDC) for a TD consultation instead of a face-to-face consultation at the RCH. The hypothetical TD model was constructed by choosing the TD-enabled CDC's. This was chosen based on regional classifications used by Dental Health Services Victoria (DHSV), whereby dental services are provided in CDC's throughout metropolitan Melbourne and rural Victoria. Two centers in each rural region were chosen based on population centers and centrality within that zone (i.e., Belmont; Warrnambool; Ballarat; Horsham; Rosebud; Morwell; Bendigo; Mildura; Shepparton; Wodonga), and two additional centers (i.e., Craigieburn and Pakenham), as a large number of patients were located close to these areas.

Population

The population chosen to be analysed in this model were Victorian rural and regionally-based patients who attended RCH from the 1st January to 31st December 2014 for specialist pediatric or orthodontic consultation and assessment under the Medicare CL&P scheme. From dental records at RCH, eligible patients include those patients registered under the Medicare CL&P Scheme [4], who lived in rural and regional areas as defined using Australia Post criteria [5].

Timely appointments were chosen as the outcome. Data regarding the timeliness of each appointment was collected from assessing each record of those who, under this model, would receive a TD consultation. The date of the consultation was noted and the record was assessed retrospectively to determine when the patient's last consultation was, if there was a suggested recall noted and if the patient had presented back to RCH within an appropriate time of this schedule. If the patient was seen within two months of the suggested recall, then the patient was deemed to have received a timely consultation. If the patient did not present within two months, it was recorded as a late appointment. If there was no suggested recall, a one-year recall period was assumed.

The potential clinic time (days) saved at the RCH by introducing TD was calculated using the assumption that each consultation is 45 minutes long and the chair is operational for 7.5 hours a day.

The RCH and University of Melbourne human research ethics committee granted ethics approval for this project.

Results

Of the 1439 consultations at the RCH under the CL&P Scheme in 2014, 673 were for the rural and regional population. Of those, 367 (54.5%) TD appropriate appointments were conducted at RCH; 267 patients presented for a specialist pediatric dental consultation only; 32 for an orthodontic consultation only, and 68 for both specialist paediatric and orthodontic consultation.

After calculating average distances based on postcodes, 275.3 clinic hours (i.e., 5.3 hours a week x 52) or 36.7 clinic days, would be saved under the TD model (Table 1). This time represents the potential clinic time freed up at the RCH that could be used to increase the current capacity of the RCH Department of Dentistry. This amounts potentially to an extra half-day clinic per week being available, effectively increasing the capacity for service provision at the RCH Department of Dentistry.

Table 1. Saved time in Clinic

	Total TD consults
Saved time in Clinic (hrs)	275.25 hrs
Time in Clinic Saved (days – 7.5hrs/day)	36.7 days

Regarding responsiveness of the consultations in this dataset, 65.7% of appointments were considered timely. Those who did not attend on time lived further away from the RCH than those who did attend their appointment on schedule.

Discussion

The present findings are important in establishing evidence supporting the use of TD as a viable option for the delivery of oral health services. A conservative analytical approach was taken, and some assumptions made may underestimate the true time saving for RCH consultations.

One of the notable benefits of TD is that it can increase the capacity of the RCH Department of Dentistry without adding additional dental chairs. An extra 5.3 hours a week of clinic time available to see patients is noteworthy especially when demand for services are increasing and government resources are limited. This outcome strengthens the case for TD to be implemented at RCH.

A pragmatic design was taken in modeling this study, which was based on a pilot study, providing a more realistic scenario and more results that are credible. Despite this, we may have underestimated the use of TD. The population that the RCH Department of Dentistry services extends beyond those eligible on the CL&P scheme to patients who are eligible under the public dentistry schedule. According to the RCH Department of Dentistry, approximately 25% of patients are seen through the CL&P scheme, with the remainder subsidized under DHSV public eligibility guidelines. This underestimation only strengthens the case for TD. Further research of the entire RCH patient database is needed to estimate the number of appointments that could be TD appropriate.

The outcome measurement used in this study gives an indication of health service utilization to determine if access to care can be improved with the provision of TD. No clinical outcome was used in this study. Previous studies have also included inappropriate referral rates and failed appointments as an outcome measurement [6]. TD could be used to improve clinical outcomes such as rate of inappropriate referrals to the RCH and hence, extending the use of this technology beyond teleconsultation. Investigation into how TD could be used in the current referral system to improve inappropriate referral rates could help strengthen the case for TD to be used in at the RCH.

There are a number of limitations of the present study. Firstly, this study was based on a hypothetical model for implementation of TD. Whilst the present results are robust, there may be unknown factors that may influence the real life operation of TD and thus the rate of timely appointments.

The model assumes that patients would prefer a TD consult, but the reason for acceptance of TD by patients is unknown with some potentially preferring a face-to-face consultation instead, despite the possible transport costs and time saved. Consistently, present finding indicated that those who tend to find it more difficult to visit the RCH for their scheduled consultation tend to live further away. However, some patients or parents may prefer to have a face-to-face consultation and willing to take the time and pay the extra costs for the opportunity to travel to the city.

Whilst there were criteria used to indicate suitability based on the pilot study and expert opinion, there may be some cases deemed unsuitable for TD that were not considered. Further investigation regarding both the reason for patient acceptance of TD and clinician preference regarding what is appropriate for TD would be beneficial to assist in determining a more accurate number of possible TD consultations.

Further analysis could help policy makers and researchers to better understand TD and make more informed decisions regarding health service delivery. Specific areas of further research include determining an approximate monetary value for a TD item code for health service reimbursement and performing probabilistic sensitivity analysis to better test the robustness of our model.

TD is about the provision of access to oral heath to populations who otherwise might not receive oral health care. Access to health care is a basic human right, by facilitating access to technology and information, TD has proven to be a means for enhancing oral health status, social participation, and the quality of life of the population. Consequently, e-Oral health is essential for achieving the UN Sustainable Development Goals (SDG) [7] particularly SDG3 ("Ensure healthy lives and promoting well-being for all at all ages"). However, almost all of the other sixteen non-health goals are directly related to health or will contribute to health indirectly [8]. Thus, at its most basic level, it makes oral health part of the SDGs, as there cannot be health without oral health. Oral health programs are essential for countries' ability to maximize the impact of the health sector in reaching national health objectives and/or priorities, and meeting health and social challenges.

Conclusion

Information and communication technology (ICT) is changing how health professionals work, acquire knowledge and training, communicate with patients and with their professional network, share knowledge and conduct research and evaluation. Increased use of ICT for health purposes will have impact on the patient, the provider, and health authorities. Future emphasis should be on how these experiences and knowledge can be translated into action to improve health, thus suggesting areas of integration and where new directions for research in oral health promotion.

The present study identified that there is potential for the RCH Department of Dentistry to increase productivity with the implementation of TD without needing to build additional dental surgeries. Whilst there are some study limitations that should be considered, there is credible evidence that this is a conservative model and it is likely that the TD could free more time for patients living remotely requiring consultations at RCH. This study provides evidence supporting the use of TD for appropriate specialist dental consultations.

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Telecardiology Project of Rio Grande do Sul State, Brazil: Mistakes and Lessons from the First Years

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Introduction

Cardiovascular diseases impose major risks to human health, with coronary arteries stenosis and occlusion being responsible for a large number of deaths and physical disabilities. The immediate electrocardiographic (ECG) diagnosis, a key to successful treatment of heart attacks [1], is not available in small towns, remote or rural communities, particularly in countries characterized by large territorial areas or who exhibit low socio-economic condition.

Since 2008, the implementation of a public telecardiology project (Tele-ECG RS Project) started in the state of Rio Grande do Sul (RS), the southern Brazilian state - 11 million inhabitants, under the coordination of the Instituto de Cardiologia do Rio Grande do Sul (ICFUC-RS) [2]. Both the Brazilian federal and RS state government financially support the project. The method consists of:

- Immediate Tele-ECG diagnosis on a 24/7 basis;
- Medical counselling via videoconferencing facilities (second opinion in cardiology) and
- A telecardiology training program (presence mode activities and periodic web conferencing lectures).

Currently the Tele-ECG RS Project (Phase I – 2008-2010; Phase II - Mar 2011-Dez 2016) includes 37 remote villages and a telecardiology Unit, from which 151860 Tele-ECGs were analyzed. In the course of this project, it was necessary to promote technical and operational adjustments as well as of overcoming obstacles of various natures, whose main facts and solutions are described in this article.

Objectives

This study aims to:

- Report major mistakes made during both the implementation and operational phases of the telecardiology project;

- Describe some solutions and technical alternatives to the identified barriers, including the adoption of new strategies for the upcoming expansion of the project.

Methods

The staff of the Tele-ECG RS Project - nurses, medical doctors, IT experts and administrative personnel - was in charge of reporting all issues that could somehow jeopardize the smooth progress of the project, at the same time providing some input about potential solutions and alternatives to the identified barriers and mistakes. Aspects related to the Tele-ECG equipment (computers, Internet access, local room facilities, ECG operation), methodology of qualifying sessions (face-to-face and multi-seat web-based sessions), video consultation method and administrative issues were targeted (Figure 1).

Fig. 1. Training Sessions

Results

From 2008 to December 2016, 151860 Tele-ECGs were analyzed, including:

- 82614 males (54,40%), representing 12604 acute cases (8,30%),
- 89749 chronic and/or nonspecific (59,10%) cases,
- 47.077 normal (31%) cases and
- 2.430 cases with technical interference (1,60%) (Figure 2).

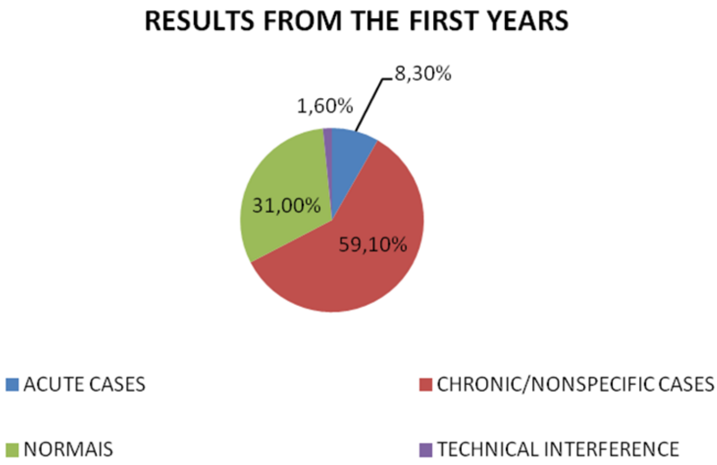

Fig. 2. ECG diagnosis from the first years of project

In that period, several relevant technical, administrative, operational issues and obstacles were identified. Together with respective potential solutions (PS), these aspects are listed hereunder in accordance with its technical characteristics:

1) Delay in equipment acquisition and installation, resulting from bureaucratic and local administrative difficulties.
   PS: Maintaining frequent contact with local health authorities, following in advance the process of acquisition of all required equipment. Thus, the training phase only happens when institutions are fully equipped, thereby allowing remote professionals to receive in due time the final training session - full module - in their own health institution.
2) Technical issues related to ECG patient's connecting cable.
   PS: Acquiring an additional ECG cable for the connection between the patient and the digital ECG machine, avoiding prolonged interruptions when necessary to make technical repair. This is important because this component of the ECG machine suffers damage to its structure due to frequent handling in the emergency room. It is recommended to provide two ECG cables as part of the initial budget of the Tele-ECG project.
3) Inadequate local infrastructure in the ECG room, including the unavailability of stable access to the Internet.

PS: It is recommended the adoption of a standard contract through which the local health authority confirms that minimum technical requirements are available for installing and for operating the TeleECG system at a local level, in accordance with the technical standardization of the project. It should mention the provision of stable Internet access, the availability of protective tool against electrical discharges as well as no-break devices.

4) A lack of skills concerning telemedicine standards and Tele-ECG systems utilization.
PS: Considering that, this was the first public telecardiology project in RS state, training activities - face-to-face and web based - included basic lessons on the theme of telemedicine and eHealth. Specific training activities towards the utilization of the Tele-ECG method included: adequacy of room environment (temperature, comfort of the patient in the exam room), proper placement of electrodes, basic skills on tele-ECG software operation and dealing with simple digital technical issues and, identifying and prioritizing transmission of urgent exams as a means to accelerate the delivery of urgent reports.
5) Performing a single training session in remote health institution did not result in providing adequate training.
PS: The initial training of remote teams was expanded to two sessions, including an initial class held at the headquarters of the eHealth Centre of Instituto de Cardiologia do RS (ICFUC-RS) in the state capital, also maintaining a second round of training activities conducted in the remote town. Moreover, it has become mandatory the presence of doctors (2 or more), nurses (2 or more) and IT experts (1 or more) of each municipality, with individual sessions organized for each institution. This strategy, applied since 2011, ensures that professionals receive at least 8 hours of training activities, becoming informed about the entire concept of the telecardiology project.
6) Busy staff and insufficient motivation to attend training sessions.
PS: The shortage of health professionals in remote institutions is a limiting factor for attending periodic web-based training activities, so that those web conferencing sessions initially conducted every 21 days, have been rescheduled as monthly sessions. Besides, a new platform that allows recording the webinars - Microsoft PowerPoint (PPT) files plus respective audio - was incorporated to the program, making it possible to retrieve its whole content. Monthly sessions transmitted via multipoint web conferencing were readapted so that to include themes relevant to the practice in cardiology as well as to other health issues of interest, also addressing topics suggested by the

professionals of remote institutions like: influenza, infectious diseases, diabetes therapy, stroke, atrial fibrillation, acute myocardial infarction, as well as classes on administrative and regulatory aspects related to the Tele-ECG RS Project (reports, filling out standard forms, etc.).

7) Low utilization of video consultation method (second opinion), with preference for phone calls.
PS: The video consultation method was considered a more complex tool, with preference being given to the use of mobile phones that are now part of everyone's life, available to all team members even inside the emergency rooms. The video consultation tool is being modified so that it becomes easier to use, turning it accessible on the computer screen immediately after each urgent ECG analysis.

Discussion

Identifying and dealing with major obstacles to the operation of the telecardiology project of RS/Brazil is expected to contribute to the adoption of appropriate strategies towards the future of the project. In spite of performing some technical adjustments that included rebuilding the video consultation platform and managing administrative issues, giving special emphasis to the improvement of the educational program is a priority [3]. Focusing on the provision of a specific and detailed training program as part of the implementation phase seems to be a key component regarding eHealth project's successful operation and sustainability [4]. Long distances, absence of local long term educational programs, economic restrictions and, particularly, the importance of keeping in close contact with remote professionals of health sector are all relevant aspects that justify conducting a long term web-based educational program bound to eHealth and telemedicine initiatives [5].

Conclusions

The implementation and sustainability of innovative eHealth and telemedicine projects imposes the need to tackle and overcome unexpected barriers, as well as being able to learn from our own mistakes. Identifying, reporting major issues and presenting these results to the scientific community can be of great value, thus contributing to a better walk without the need to reinvent the wheel.

In our view, investing in continuous education of remote professionals deserves occupying a chair in the first row as a key element for the sustainability of eHealth services, mainly when developing countries and huge territorial areas are part of the scenario.

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TeleDOT: Directly Observed Therapy for Tuberculosis using Telehealth Technology

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Introduction

Tuberculosis (TB) is a serious and potentially life-threatening disease but one that is highly treatable. The treatment involves TB cases taking multiple antibiotics every day for at least six months and, in multi-drug resistant cases, up to two years. As the treatment involves several medicines, which may be not well tolerated by the client, and the treatment is required over a long time when the client may no longer have any symptoms or be infectious, there is a high risk of poor adherence. Poor adherence means the client fails to take the right medicines, in the right dose, at the right times, or fails to complete the whole course of medication, resulting in treatment failure. Inadequate or partial treatment of TB increases the risk of development of new drug-resistant strains of TB, as well as not achieving a cure for that individual's TB, which then poses a potential risk to others in the community.

The World Health Organization recommends Directly Observed Therapy (DOT) as the most appropriate way to treat people with pulmonary TB. [1] This means that a trained health care worker observes the patient swallowing every dose of their TB medicines. The New Zealand Ministry of Health issues guidelines [2] for the control of TB consistent with international guidelines prepared by the World Health Organisation.

In Auckland, Public Health Nurses (PHNs) from Auckland Regional Public Health Service (ARPHS) manage the care and treatment of TB clients in the community, which includes visiting patients (usually daily) to provide DOT, monitor for side effects and give support and encouragement. According to the 2013 census [3], the Auckland region has a population of 1,415,550 which is 33.4% of the total New Zealand population. By 2017, it was estimated to have risen to over 1.6 million people spread over 4,894 sq. km (1890 sq. miles) [4]. An average of 160 TB cases are notified each year and at any one time, approximately 100 clients are on treatment for TB. DOT is extremely resource and time intensive. Auckland's wide geographic area and traffic congestion means it is not possible for every client with pulmonary TB to receive DOT. The public health nursing workforce within the Communicable Disease Control (CDC) team at ARPHS delivers on a variety of communicable disease control initiatives while continuing to provide DOT for TB clients. This has proven to be challenging when large scale contact tracing is required during outbreaks and operating the service within the context of ongoing fiscal restraint. Until 2012, there was the capacity to provide DOT to only 30% of all active TB cases. In 2013, PHNs began providing virtual DOT using telehealth technology, which was referred to as *TeleDOT*. This article outlines the journey from the foundation project to the current TeleDOT programme.

Foundation Project - The Beginning of Something New

In 2013, Auckland District Health Board (ADHB) provided funding to develop telehealth initiatives. ARPHS developed a business case proposal for a foundation project using telehealth technology to increase the number of TB clients receiving DOT in the greater Auckland area. The proposal was supported by and based on two TB Telehealth DOT programmes, one in South Australia [5] and the other in Washington State, USA. [6].

The Telehealth Programme Manager for ADHB provided a huge amount of support and information and with technology delivered by Vivid Solutions Limited, (ADHB's video conferencing services provider) the TeleDOT programme was established. The aim of the TeleDOT programme was to increase the proportion of clients receiving DOT within current staffing levels by taking a client-centred approach using Telehealth technology.

A TeleDOT governance group and working group were established and a project manager was appointed. Regular monthly planning meetings were held using rigorous project management principles and robust documentation. Policies and resources, including user protocols and working documents, were developed. Negotiations with Vivid Solutions resulted in the provision of secure videoconferencing via video-telephone (hardware) installed in the clients' home.

In April 2013, after five months of preparation, the foundation project was ready to enroll clients. Screening criteria was developed for clients prior to enrolling them. To be eligible for TeleDOT clients were required to have received face to face DOT for two weeks, be on a stable drug regimen, understand the need for, and adherence to TB treatment, be reliable and able to use the telehealth equipment. PHNs identified suitable clients, who were provided with written and verbal information about the programme, and written consent was obtained from each to participate in the TeleDOT foundation project. Initially staff used a desktop videoconferencing unit, and clients used video phones installed into their home to communicate. However, it became apparent early on, that installing videophones into clients' homes was not sustainable as it involved coordinating several people on site at the client's home, which was difficult, time consuming and installation of hardware and communication lines were sometimes a challenge. When access to the Polycom Real Presence software became available, the programme moved to using this with the PHNs downloading it onto the client's personal computer during a home visit. This required an account to be created for each client but proved more cost effective than the hardware option.

The TeleDOT foundation project ran for 7 months and during this time 10 clients received DOT remotely. Evaluations [7] of the study were completed, using a variety of methods capturing qualitative and quantitative data. In summary, TeleDOT was popular with the clients and was an effective, efficient and sustainable means of providing DOT. A 10% increase in the number of clients receiving DOT was achieved within existing staff resources. Things that contributed to the success of the foundation programme included:

- ARPHS was open to innovative new ways of delivering healthcare and was prepared to provide ongoing funding.
- ARPHS management supported the foundation project and understood that, while most staff were carrying on doing business as usual work, there were also some opportunity costs at having the foundation project running at the same time.
- The workforce culture supported staff to be innovative and enthusiastic. Staff who adapted well to change and were prepared to cope with some of the uncertainty and constant refining were selected to participate in the foundation project.
- The study was developed using 'best practice' project management guidelines and documentation.
- It was scoped properly, based on evidence and research and had regular internal and external evaluation.
- Continuous improvements were built in along the way so that when the foundation project finished, there was a smooth transition into a business as usual rollout.

Business as Usual

In December 2013, the foundation project was transitioned to business as usual. The governance group and working group continued to meet on a regular monthly basis to discuss progress, problems and risks. The goal was to increase the number of TB clients receiving medication by TeleDOT by a further 10% by June 2014.

A Public Health Nurse (PHN) took over responsibility for co-ordination and promotion of the programme. The process of change from the way things have traditionally been done can be difficult for some people to embrace. Encouraging the multidisciplinary team to embrace this new way of DOT required change management strategies to be employed with promotion and support paramount. The PHN co-ordinating the programme did this by:

- Including TeleDOT updates and progress reports in the weekly PHN email communications.
- Providing a regular ten-minute progress report at the monthly PHN meetings and inviting one PHN to give a brief account of their own and their client's experience of using TeleDOT.
- Being available ad-hoc and at short notice to provide guidance and support for any questions or issues the team raised.
- Developing a simple instruction manual for each PHN on setting up their client for TeleDOT; although these quickly became redundant because technology changed so rapidly that the process for setting up a client on TeleDOT did not remain constant for long.
- Running teaching sessions for staff on how to use TeleDOT, including both one to one as well as group sessions on an 'as needed' basis.
- Acknowledging any problems and system failures, which inevitably arise with technology, especially in the start-up phase, and responding to these quickly to provide resolution.

Initially TeleDOTs were a Monday to Friday only service, but were quickly able to be expanded to include weekends. Clients who did not own a computer, laptop or iPad/tablet were initially excluded from participating in TeleDOT. To overcome this social-economic barrier and digital divide, ARPHS purchased eight iPads with data cards to loan to clients to enable them to receive TeleDOT. These were quickly deployed.

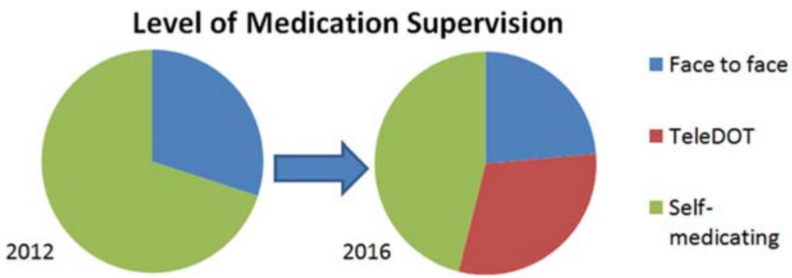
However, with rapid changes and constant updates to technology, within a year, smart phones had become much more common place and they generally included high specification camera technology. By the middle of 2014, downloading the application onto clients' smart phones had commenced. This proved convenient and popular with clients, as their phone is something they carry with them all the time. Data and internet connectivity, using Wi-Fi or 4G was essential for them to be able do their TeleDOT. However, occasionally clients on a prepay plan or limited Wi-Fi ran out of data and were temporarily unable to do their TeleDOT. This was easily rectified by providing them with a prepay top up card for data only.

Technological Advancements

From the middle of 2015, more cost effective TeleDOTs were achieved with a move to web browser access to a secure Virtual Meeting Room (VMR). This negated the need for each client to have an account for the Real Presence software and reduced the cost of TeleDOT delivery even further.

Initially TeleDOTs were viewed via the VMR in real time with both the client and the PHN accessing the VMR concurrently to interact in the same manner they had with the software. However, some clients preferred to take their medication at a time when a PHN was not available, so recording options available in the VMR were explored and proved very successful with the PHN downloading and viewing the recording. Technology advanced very quickly and by May 2016, many clients transferred to this asynchronous recording option for TeleDOT. This proved a great success as it allowed clients the convenience of conducting TeleDOT on their own schedule with the nurse reviewing the recording at his or her convenience.

In May 2017 27 (33%) of TB clients were using the recorded TeleDOT option. The number of clients with active TB receiving DOT increased from 30% in 2012 (prior to TeleDOT) to 60% without any additional staff resource. Since the introduction of recorded TeleDOT we have reduced the weekend staff requirement. Ongoing technological developments have meant the cost of delivering TeleDOT has consistently fallen since TeleDOT commenced.



Clients generally prefer TeleDOT to traditional face to face DOT because it is far less intrusive than a health worker entering their home each day and they have greater flexibility of the time and place they take their medication (e.g. with access to an internet connection they can travel or go to work and still receive DOT).

For the CDC team, TeleDOT has resulted in less time sitting in a car travelling to clients' homes, allowing more time to concentrate on the responsibilities associated with case management and contact tracing of TB cases as well as other communicable diseases in the Auckland region.

Lessons Learnt

- Opportunities exist for the healthcare sector to embrace technology to improve the quality of patient care and reach greater numbers of clients within the context of a challenging economic environment;
- A flexible, enthusiastic 'can-do' attitude to continuous developments in technology is necessary to keep pace and adapt to change;
- Availability of Information Technology (IT) expertise is critical to guide and support staff as they learn to use telehealth technology.

Summary

The TeleDOT project demonstrated the potential for technology to improve treatment delivery to TB clients and achieve sustainable cost and other resource efficiencies for ARPHS. Nurses play a key role in driving the use of emerging technologies, which improve service delivery models, while achieving positive outcomes for clients and the public health workforce. The need to continuously improve the quality and efficiency of client care within the context of a challenging economic environment drives the adoption of new technologies. Telehealth has potential for use in other areas of healthcare and the TeleDOT programme has provoked interest from a variety of healthcare services across New Zealand. This type of technology can support service delivery for many other healthcare services.

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The Medical ICT Utilization from Perinatal Telemedicine in Remote Areas: Ready to Implement Japanese Solution

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Background and Issues

In Japan, there is trend to reuse data, which is gathered in hospitals and clinics to make use of patient diagnoses by using accumulation case data. The history of medical ICT has begun from electronic health records in hospitals, and then it has expanded to various types of regional medical alliances since 2000. The hospital is able to manage and obtain patients' test results, diagnoses, images and prescriptions by using electronic medical record system.

The regional medical alliances, and the networked hospitals make it possible to share patients' data and able to reduce medicine duplication or duplicate examination of patient who has visited from different hospitals. According to the common data, high-risk patient can be transferred to a higher-level hospital immediately. The higher-level hospital is able to prepare to accept the high-risk patient, examining the data of previous hospital.

The important role of telemedicine is sharing the medical information between doctor and patient, and utilizing health data of patients effectively. If patients want to improve their own condition, they recognize what is required for them to get better themselves by selecting telemedicine system. We are providing services in this domain and this contribution describes the experiences for introducing telemedicine technology in the field of perinatal medicine in rural and remote areas.

Perinatal Telemedicine System

The perinatal electronic record is the key technology of this telemedicine system. It is quite different from the general electronic medical record (EMR) or other departments EMR, because the perinatal EMR has to accumulate the data of two lives, mother and fetus.

The related laws and regulations of obstetrics and gynecology department are also different from others. Considering those differences, the perinatal

EMR is worthwhile and perinatal care technologies would have valuable implications to medical ICT as a whole.

There are three types of specialized perinatal EMR;

- For hospitals,
- Clinics and
- Perinatal telemedicine.

For hospitals, it has an excellent high-risk management function for the Perinatal Maternal and Child Medical Center, the tertiary hospital. Secondly, for clinics, it can manage every system of the hospital as an EMR. It is also easy to find any risks of pregnancy. All of the specialized perinatal EMR has a list of prenatal checkup screen. Maternal basic information and the prenatal checkup data for each pregnancy can be observed. It comes with screens exclusively for obstetrics and gynecology, which can register medical information of prenatal checkups and health guidance. Clinical information, which cannot be found on general EMRs, can easily be recorded. It also has computerized formats, which is specific to obstetrics and gynecology

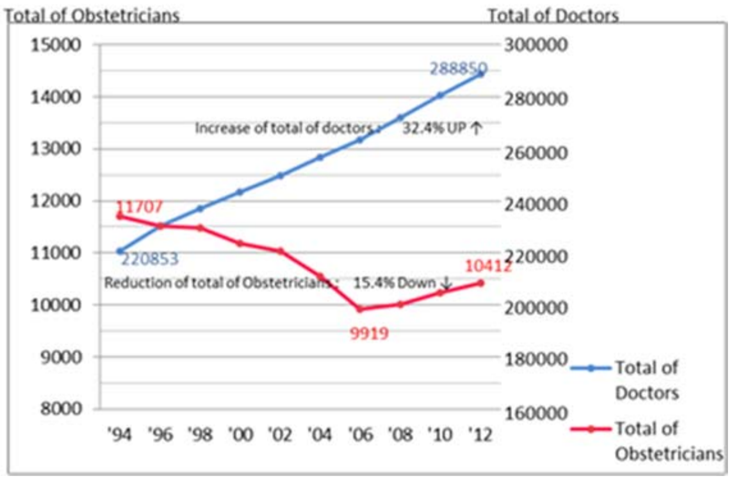

Fig. 1: Total number of obstetricians

including the pregnogram and partogram. The specialized perinatal EMR is possessed with authenticity, visual readability, and storability.

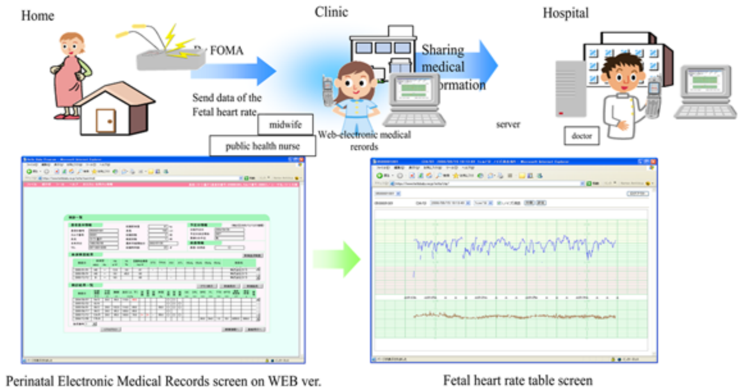

Fig. 2: Perinatal Telemedicine System

The number of obstetricians and gynecologists has decreased dramatically from 1984 to 2006 compared to other departments of doctors (Figure 1). This caused due to the large number of obstetric litigations sued by patients and the increasing number of women doctors who discontinue work after marriage.

In remote areas such as islands and mountainous areas, social issues are arising as no obstetricians work in hospitals. Such social phenomenon is noticeable from 2004 to 2006 and this is continuing. The perinatal telemedicine system (Figure 2) was developed in 2006 and connected the core hospital to the maternity center where there are no medical specialists.

The distant medical doctor is able to examine the information entered by the midwife at the maternity branch. The perinatal telemedicine system is composed from the data center server system, ASP perinatal electronic medical record and mobile CTG, the medical equipment that measures the mother’s contraction and the baby’s heart rate. It can also connect diagnostic imaging system as needed. ASP perinatal electronic medical record and mobile CTG are placed together in the core hospital, clinics and the maternity center respectively, and all data can be shared mutually. Medical specialists, general physicians and midwives share the real-time medical information, depending on the risk of the patients and able to examine their condition together. The patient can receive the appropriate advice from a medical specialist utilizing telemedicine.

Initially this perinatal telemedicine system was introduced to Tono city, Iwate prefecture, where there were no obstetricians. Pregnant women were in need of a perinatal checkup once a month or more frequently, however, for women living in Tono, this meant a long 50 km drive to the main hospital on mountainous roads. Facing this problem, a medical center called Net Yurikago (cradle) was built in Tono city in 2007. At this maternity center, pregnant women in Tono city are able to have regular checkups provided by midwives. If the pregnant women have any worries or concerns, she can speak to a doctor via the Internet.

After introducing the perinatal telemedicine system in Tono city, it has also been implemented in Hokkaido, Okinawa, and on Amami-Oshima Island. After the International Conference held in 2011, it was introduced in Phitsanulok region in Thailand. At this time, it used a server, which was located in Japan, however, medical specialists in Phitsanulok wanted to locate the servers in their own country, in order to store the medical information collected. Following the case of Phitsanulok, the server was introduced in Chiang Mai, Thailand for JICA grassroots project of Kagawa Prefecture. In the same year, this system was introduced in Lao People's Democratic Republic, including the server. In that same period, an advisory committee was set up in Iwate Prefecture in Japan. They discussed a regional alliances system that covered not only telemedicine, but also perinatal emergency and personal health care. This meeting comprised of eminent panelists from industry, government and academia.

Application to the Perinatal Regional Alliances "Ihatov (Utopia)"

"Ihatov" [1] is a perinatal medicine information network system for pregnant woman, which allows hospitals and municipalities to build a good relationship during the pregnancy period. Pregnant women can maintain the relationship even after delivery and if the pregnant woman decides to return to her hometown to give birth at the parents' home, her nearest clinic can check her medical information in advance (Fig. 3).

The Great East Japan Earthquake caused devastating damage on the coastal area of the northeastern region of Honshu of Japan, and much medical information flowed out from tsunami. Since the information of the perinatal care of the Iwate Prefecture, where the tsunami hits, was recorded by the data center server of "Ihatov". Therefore, "Ihatov" has been recognized as a very effective system.

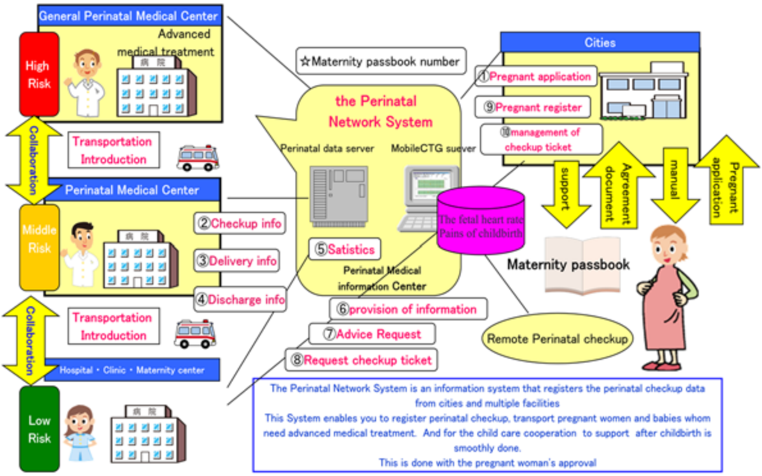

Fig. 3 “Ihatov” network

The Japanese government has decided to introduce a social security ID number in the near future; however, Iwate prefecture has already introduced ID number for newborn baby in advance. This number is one of the keys for sharing information between medical institutions and municipalities utilizing “Ihatov”. The pregnant woman can decide whether she will agree to share her information or not when she receives the maternity passbook with the number. If she agrees, the information can be shared with all hospitals and municipalities, and the data is carefully kept for the future. Medical institutions can find all patients’ data from various places easier utilizing “Ihatov”.

In Japan, hospitals are classified under three categories according to the risk of the patient; primary, secondary and specialized hospital. The specialized hospital is able to accept patients with higher risks. If the patient’s condition takes a sudden turn, the patient might be transferred to a specialized hospital at a higher stage. If the accepted hospital already has the patient’s data, using “Ihatov” they can prepare and manage the patient transfer faster and more efficiently, and are also able to manage transfer of the high risk pregnant woman to the hospitals selected from primary to specialized hospital in its region. The core hospitals joined the network and the clinics may also follow. This perinatal regional liaison has been bringing satisfactory results. Other prefectures will follow this model in the near future.

"Ihatov" regional alliances represent a significant effect in the following three points. "Ihatov" is a system to take advantage of a medical health information database. By registering using "Ihatov", the pregnant women and babies' emergency transfer to the hospital is implemented smoothly, and prenatal care is carried out under fully prepared circumstances. Furthermore, registration is carried out based on a personal agreement, and the individual's privacy is strictly managed.

Accelerate Overseas Operations and Domestic Operation

Accelerate Overseas Operations

In Japan, due to the decrease of obstetricians and gynecologists, some areas have to rely on a telemedicine system. In overseas, especially some developing countries, the situation is similar to Japan. There are not enough medical specialists for the increasing number of pregnant women. There are three risk categories; high, medium and low. Most hospital oversea, especially those located in rural areas treat medium and low risk patients due to the lack of medical specialists and medical surgery equipment.

Introducing a perinatal telemedicine system is meaningful to developing countries and rural areas. The perinatal telemedicine system is relatively simple and easy to operate. Hospitals are only to prepare PC and mobile CTG. The benefit of using mobile CTG and PC telemedicine system will efficiently improve perinatal care even with the decreasing number of healthcare specialist. For example: the possibility to diagnose pregnant woman in remote location from the hospital with only a few specialist.

Accelerate Domestic Operation

Declining birthrate and the increasing aged population of Japan is progressing more rapidly compared to Europe. The population of 65 and above years of age is 25% of the total current population. It has been estimated that the rate of aging will be 30% in 10 years, and a nearly 40% in 30 years. It means that the number of young people who takes care of the elderly will reduce. There are not enough young people to adequately take care of the elderly. To ensure better health for the elderly, there is necessity to manage their own health by using smartphone and check the health data for themselves.

The maternity passbook is the starting point of the Personal Health Care, PHR. Relatively young women began to use the maternity passbook at first, which is written in the paper; however, they have already gotten used to using mobile technology such as: tablet and the smartphone as necessary in their daily life. We emphasize Electronic Maternity Passbook. The Electronic Maternity Passbook is connected and it can share information to hospitals and municipalities. The concept of the Electronic Maternity Passbook enables the user to be able to confirm the information, which is automatically inputted by municipalities and her primary care hospitals. For example: to take the necessary measures immediately from the system. The Electronic Maternity Passbook has the advantage not only childcare generation and pregnant woman, but also it bring benefits to the local hospitals, municipalities where she lives, and shops or companies that she is interested in.

It is desirable to generate PHR data from the system like “Ihatov”, which is a data interface with municipalities’ and the hospital. The PHR mechanism should be developed for many companies or shops that provide detailed information to the people as needed. In the future, we need a more realistic data integration technology and data mining technology. Data mining technology differentiates into environmental statistical processing and personal health history management. These technologies are also related to each other. It is convenient for individuals to find out their information instantly, based on their own health data. Currently, various institutions are carrying out R&D for creating mechanism to deliver more useful information to individuals.

The contribution below is an illustration of the application of the above perinatal telemedicine system.

Introducing Perinatal Telemedicine into Laos

Introduction

The Lao People's Democratic Republic (following Laos) is a landlocked country, and its population is 6,510,000. Laos is bordered by China, Vietnam, Cambodia, Thailand and Myanmar. Its area is same as Honshu, Japan. Laos is located important positions geopolitically in Mekong area and Indochina. Laos is a developing country in the ASEAN area, so there is big economic difference between Laos and other ASEAN countries. However, Laos is doing steady economic development by growth in the field of mineral resources and hydraulic power generation. Population growth is necessary for economic development, and Lao government’s targets are achievement of Millennium Development Goals (MDGs) and breakaway from the developing country by 2020.

For perinatal care, target 4 of MDGs is reducing infant and toddler mortality, and target 5 is improvement of pregnant woman health. The under 5 year’s old child death decreased to 79 in 2011 from 131 people in 2003 per 1,000. Even though it achieved 80 people aimed for until 2015, it is still low level. Therefore, the Lao government modified their target to 70 people per 1,000 until 2015. In addition, Laos is second highest rate for the under 5 year's old child death next to Myanmar among Mekong area. The infant mortality is improved to 68 in 2011 from 104 in 2003 per 1,000people, but it is far from new target value of 45.

Background and Issues

On average, a woman from Laos gives birth to 3.108108 children, and approximately 100,000 children are born every year in the whole country. This number is however not completely accurate as there is no family registry system in Laos. There is health checklist for pregnant woman decided by the Lao government. Based on WHO guidelines, examination items and contents are decided on depending on the week of pregnancy. Even though WHO recommends four check-ups during a pregnancy, some mothers never have a medical examination. The average medical examination rate in whole country is less than 80%.

The medical facilities compose of the central hospital, prefectural hospital, county hospital and health center. There is no doctor present at the health center, which is the primary medical facility, and usually there are only one to three nurses. The second medical facility is county hospital where only 27 of 130 facilities can perform an operation. For referral system from health center to county hospital is judged appropriately by patient diagnosis.

The number of the cell-phone subscriber is approximately 6,700,000 in Laos, and the population diffusion rate is around 104%. Not all people have own cell phone, and one has several prepaid SIM cards because of overflow SIM card. In this result, cell phone diffusion rate is very high.

Most of the subscriber of the cell-phone is 2G, and they use mainly telephone (voice call) and SMS (text). New smart phone is getting available, but there are still few people using it by 3G networks. LTC started providing 4G (LTE) at Vientiane on January in 2013, and will provide 4G (LTE) for major cities. So communications infrastructure is developing rapidly.

In addition, comparing to the landline is 150,000 (14% of household diffusion rate) and broadband is 110,000 (10% of household diffusion rate); we can see how cell phone subscriber rate is high.

System Integration

Two proposals are presented: 1) Web type of Perinatal Medical Record System and 2) Mobile fetal heart rates monitor "Mobile CTG".

Doctors and hospitals can use them by Internet and through server. Core hospital can see the data which rural hospital input, and also rural hospital can see the core hospital data in same way. Mobile CTG equipment set up at rural hospital and measure. They send data to core hospital doctor or specialist doctor, so doctors can diagnosis from remote area. It enables to share medical information of pregnant woman with remote medical facilities in a real time. The primary hospital with no specialist can perform an appropriate and safe medical care by the instruction of the specialist in remote area hospitals by using this telemedicine system. It brings good result for primary hospitals to improve their skills and to care patient properly.

Using communication line (2G, 3G, 4G), Mobile CTG can measure fetal heart rate, fetal movement and contraction. It enables to share those data to the medical specialists in rural areas. Medical specialist can confirm the data of high-risk pregnant woman, and they can refer immediate and appropriate examination by using perinatal telemedicine system. The perinatal telemedicine system has been introduced in Laos in 2013. Two to three clinics that match the following characteristics were selected: (1) Rural area; (2) Only has midwives or nurses; (3) Does not have a specialized doctor.

The Timeliness of the Mobile CTG Monitor

During pregnancy, most likely, the condition of the patient will not take a sudden turn. Doctors can examine the results from a 20-40 minutes measurement, and see the foetus' heart rate to check the wellbeing of the foetus. This is the most seen case for telemedicine.

During delivery, there is a possibility that the condition of the patient changes all of a sudden. The monitor has an automatic diagnosis function, which prompts you to send the measurement results immediately. You can change the length of time of measurement deepening on the situation.

Two Mobile CTG Monitors were let to each two clinics to examine. The perinatal medical record system was ready for trial use, and the aim was to improve the system to suit the needs in Laos. For tele-consulting, TV meeting system by a Japanese company was used. The PCs were also supplied by the same company. The government-affiliated local network was used. During this trial at Mittaphab Hospital in Vientiane, a pregnant woman who measured the graph mentioned above in the morning (labor pains are strong, short interval). It was decided to keep her in the hospital. She gave a birth in the afternoon safely.

Discussion and Conclusion

One of the most important matters for perinatal care is data management. Data management has evolved beyond paper medical records, into the paperless digital world. Therefore, we have to establish the check-up for mother and baby with further improvement of medical technologies. The following recording format is required for perinatal electronic medical records:

- The data of perinatal information is recorded in time series.
- Easy to detect the slight changes in pregnant woman.
- Enables doctors to know good conditions for pregnant woman and if there any complications.
- Viewing the data provides critical information for the doctors to make confident decisions.
- Sharing perinatal information makes hospital to be patient ready before the ambulance arrives. Also, doctors and specialist enable checking for high risk patients remotely.

In Japan, clinics, primary hospitals, and core hospitals accept patients depend on patient risks and condition. This system has been advanced especially in the fields of obstetrician due to the decrease in obstetricians and gynaecologists. Regional alliances, open and semi-open systems, have proceedings with the primary, secondary and core hospitals. Overseas, especially in developing countries as is the case in Japan, there is a shortage of doctors. However, what is different between developing countries and Japan, is that in Japan medical education level, and mother and child medical examination system, are available. Solution to these problems: specialist in developed countries takes the second opinion in remotely. In addition, the usage of a maternity record book in developing countries is encouraged.

In order to introduce Japanese perinatal care model in developing countries, especially in Southeast Asia, and in particular in Laos, this takes time and needs some efforts. Once the systems are introduced and being used, the value and usefulness of them will surely be noticed. Currently, doctors in core hospitals have the technical ability to read mobile CTG monitor graphs. The mobile CTG system is a medical measuring instrument, which transmits medical data of fetal heart rate, fetal movement and contraction through internet connection. High-risk patients in primary hospitals or secondary hospitals can be helped through the specialist's early diagnosis. When the Japanese perinatal care model was introduced in Laos, doctors and midwives were also dispatched to educate local staff and to introduce the system efficiency.

The "Research project for introduction of ICT system for basic health and medical care (remote consultation for perinatal healthcare in rural areas) in Laos" was funded by the Ministry of Internal Affairs and Communications, Japan.

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The Regional Counseling Center (CCR): Technologies and Psychology for a New Organizational Model to Serve Cancer and Rare Diseases Patients and Their Relatives

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Introduction

The network of health organization today is extremely complex and its operation is often guaranteed by the ability of the various operators to manage the communication exchanges and relationships [1]. In this system the patient, in recent years, has taken an increasingly active role, placing himself in relation with the doctor no longer as needy and passive care and prescriptions, but as a person "who knows" and who enters in the care pathway asking for clear and competent information [2].

The Health System, through information and communication, tries to make the person who faces a care pathway as responsible for their choices. The patient is more often a person aware of the offer and services most appropriate. In addition, the changes that are shaping our society from a demographic, economic and social point of view (economic crisis, rising life expectancy, aging population, smaller families with fewer parental resources, reduction of the social network in urban centres ...) have favoured the emergence of more and more sophisticated and complex needs smallness of the social network in urban centres [3-4]. In relation to all these changes, the Social Health System requires an enrichment of care models, more in line with the needs and expectations emerging in patients who increasingly turn to technology as a tool to inquire about their health and improve their well-being [5].

The European Commission addresses a continuing interest in the development of new models of work in health care, aimed at health promotion and support of patients and their families during the course of prevention, diagnosis and treatment. The EU declares that eHealth has the potential to ensure sustainable health systems, equity of access, and health care more personalized and focused on users, improving the connection cost-effectiveness of health services [6].

Method

Within this frame of reference, the Regional Counseling Center (CCR) is born at first in 2009 as Regional Counseling Cancer Centre, with the scientific collaboration of the Regional Cancer Institute (ITT) and the Healthcare Management Laboratory (MeS_Lab) of Sant'Anna University (Fig. 1). Operatively it works like a "contact center" specialist on the needs of cancer patients and their relatives [7]. The same operative system was adopted in 2012 for improve rare diseases patients services, with the scientific collaboration of Health High Institute (ISS), Rare Diseases Tuscany Register (RTMR) and Monasterio Foundation [8, 9]. The mission is to provide information and counselling about health regional facilities and their professionals and resolution about organizational issues; besides it provides psychological support via telephone. Every citizen can access at facility through a toll-free number (800880101) and email: ascolto.oncologico@regione.toscana.it, ascolto.rare@regione.toscana.it. This is an important tool for the integration of services in the area of Tuscany and professionals, among them and citizens. The mode of Contact Center provides a system of management of multi-channel communication (telephone, fax-server individually, SMS, intranet platform, etc. ....) with either citizens and with the Local Health Authority (LHA). The requests are processed through a communication network in-bound/out-bound. The in-bound activities are aimed at receiving and handling incoming calls. The out-bound activities provide, however, the contact with healthcare referent, and the re-contact the user during the process of resolution and/or verification of the effectiveness of the intervention. All the information and data are inserted into software; these can be viewed by the operators of the center and by the healthcare referent. Each stage of the process enabled by the resolution of the issue, from the first contact with the user at the end of the practice, adhere to internal procedures of the Centre shared between operators and company representatives. This allows to manage continuously the process, to have a global monitoring of the identified needs, to examine the problems and how to solve the problem and finally to assess possible improvement actions paths social care.

At the toll-free number, (open 5 days/9h), respond psychologists/psychotherapists who, in the business of "Front-Line" (FL), play the role of host, taking charge and demand analysis, needs assessment (explicit and implicit), counselling, health information, orientation to the path of prevention diagnosis and treatment, through problem-solving activities or, where necessary, a link with the representatives of the local health. Patients

Fig. 1

can reach psychological support service both as a result of previous counselling or as a direct call. The psychologists / psychotherapists perform a more thorough evaluation of psychological disease and build a structured pathway grounded on the characteristics of the patient and his / her needs.

In some cases, it is sufficient only a few telephone conversations through the emotional containment experienced in the critical moments of disease pathway and a redefinition of the problem. In others, it may continue for a longer period of time and with the targets agreed with the user, and if the need arises, and there is a request from the user, the process continues with sending to psychologists localized at the various LHA. The easy access and availability phone allows the patient and family to receive instantly an active listening and a competent support, through which they can express and share concerns and emotional experiences related to the disease and the disruption that this generates in the life of the patient and of his/her "family".

Results

In seven years, the service managed 23,000 calls (inbound/outbound). A so high number of calls, above initial expectations, connotes the centre, initially experimental and innovative, as a stable reference point for the citizens of Tuscany.

At the center call mainly patients (47%) and families (39%), aged between 25 and 75 years. The remaining 14% (11% rare diseases service and 3% cancer service) is represented by the operators of the system of social health of Tuscany. The data confirms the significance of the service and the perception of this as a point of reference and information exchange with a view of the network.

The 75% of the users need guidance activities within their care pathway requiring information about facilities for diagnosis and treatment in the area of Tuscany. The remaining 25% requires a telephone psychological support, of which only 5% required to continue the psychotherapy in the psychology services at hospital.

Our data help us to analyse the main phases of the disease in which users express their needs.

- The prevention phase, in oncology field, reaches up to 15%, while users, patients with rare disease, reaches the 0.3% only.
- During the treatments called up to the 20% of cancer users similarly to the users in the area of rare diseases (25%).
- In the diagnostic assessment phase, orientation and support need involves the 6% of cancer users against the 14% of the users in the area of rare diseases.
- Problems in follow up are encountered by the 20% of cancer users and 18% of rare users.

The Centre is also a point of reference in the final stage of life and of bereavement (4,5% cancer users vs 1% rare users), often for relatives, which contact us to get information on palliative care and psychological support in order to share experiences of pain, anger and loneliness, related to this moment so intense.

The most of actions performed is defined, in 95% of the cases, as a psychological support to managing an "emotional crisis" due to specific events related to health care. The most of cancer users called after the communication of the diagnosis, during treatment and in follow up phase. Differently the most of users in the area of rare diseases called while they are in touch with the diagnostic iter and in relation to coping difficulties to the chronicity condition. Generally, support themes are: critical state of "emotional loss", anxiety related to the uncertainty of the future, fear of suffering and dying and anger.

Usually, in the first time, you can manage the sense of urgency, helping to verbalize fears and concerns the condition that the disease has determined, taking the time necessary to express and process emotions, but also to develop ability to reading events and more efficacious problem-solving skills.

A brief intervention was also functional for those users who called Centre for family difficulties to share and communicate about the disease. In this case, the intervention was aimed to stop psychological dynamics like silences, secrets, exclusion and deep loneliness induced by diseases, through promotion of dialogue, sharing, needs expression and, especially, a empowerment process of the patient or family.

Conclusions

The potential of a service like this are various. The phone allows to achieve users with various difficulties (personal or logistics) that don't have direct access to the sanitary services.The strong network created with the Regional Health System (health care referents) shortens the gap/distance between professional and user, ensuring their needs; that promotes the patient's centrality and autonomy during the illness pathway. This approach improve equity of access, continuity of care and the quality of Tuscany cancer and rare diseases networks, supporting and accompanying the person for the entire path of the disease. In this way is also possible to recover those users who, disoriented by the impact of the disease, have difficulty to move efficiently in the care pathways. In this context, the primary goal of the Center is to promote an autonomous and responsible attitude in relation to their care pathway, supporting him/her or making him/her able to make informed choices about his/her health, through the activation-reactivation of internal and external personal resources.

The data recording allows quantitative and qualitative analyses to improve actions for sanitary services. Therefore, it is possible to bring out critical and to promote future action to implement the effectiveness of pathway of care and the guidelines of cancer and rare diseases Tuscany networks. The experience of recent years, revealed the need to use further and more specifically the service by introducing, next to the phone mode, new communication technologies through the WEB 2.0. Using these technologies would make contact easier with users under the ages of 25 years, who focuses more on other forms of communication to stay in a therapeutic relationship. Probably this is the reason for that, now in our series, this age range appears to be not so heavily represented.

In conclusions, the Center is an important hub for the regional health system in terms of efficiency and effectiveness. An informed patient, competent and responsible, has a better result in the management of their disease status and satisfaction in care. A system able to listen and take charge of people's needs promptly, prevents the emerging of critical in social-welfare path (avoiding migrations from one location to another with additional health care costs) and promotes results in terms of compliance of the patient. In addition, the timely taking over by the telephone reduces the level of pain and discomfort for patients and their relatives in each stages of illness and promotes a process of adaptation.

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Small Steps for Big Outcomes - Building a Smart Technology Strategy for People with Mental Illness

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Introduction

Mental health care services in developing countries are severely limited despite the significant proportion of global disease burden arising from mental illness in these countries. Several authors note the need for more mental health specialists, decentralization and community-based care, school based mental health services, availability and affordability of psychotropic medication, better mental health policy at the governmental level, integration with primary health care and more funding by governments generally [1-6]. Researchers note that mobile health technology used in other areas of health care have many applications to mental health care [7-8] and could help address the issues noted above. A systematic look at the development of smart technologies in mental health care may help move us forward to implement this promising solution.

To that end, a systematic look at the development of smart technologies in mental health care is provided below followed by a description of a smart technology system wide plan that was used to enhance mental health services by a mental health research group located in southern Ontario, Canada. Next two components of the plan are detailed, the first example describes a large multi-faceted approach and the second a more simplistic approach both designed to support individuals in community living. Finally, implications for developing countries are discussed.

Literature Review

To identify the literature relating to mental health technologies in developing countries, the CINAHL, PubMed, and Scopus online databases were searched. To be included in this review, the articles had to be written in English and published between 2012 and 2017. Since this literature review is focused primarily on technologies within developing countries, only the studies conducted in these countries were included. The key search terms used during this review were “technologies” and “developing countries”. To limit the search to technology within health care, the term “health” was also used. These key words were inputted into the search bars of each of the databases the abstract for each article was read to determine relevancy. In total, this literature search produced 20 articles related to health technologies within developing countries. However, only three systematic reviews were included which were relevant to the purpose of this paper. These reviews and the studies they reference are discussed in the subsequent section of this paper. The 2014 briefing document from the Mental Health Commission of Canada (MHCC) “E-Mental Health in Canada: Transforming the Mental Health System Using Technology” was used to provide a Canadian perspective on mental health technology.

Health Technology in Developing Countries

The widespread use of mobile phones in developing countries presents an opportunity for these technologies to be used to improve healthcare services [7-8]. A study conducted by the World Bank Group (2012) [9] determined that 72% of citizens in low- and middle-income countries had a mobile phone subscription in 2010, a 68% increase from 2000. The growing popularity of mobile phone use extends to rural and remote areas where individuals have limited access to healthcare providers [8, 10]. Mobile healthcare (m-Health) technologies present a cost-effective solution to increasing healthcare access in these areas.

There are many ways mobile technologies could be used to improve healthcare systems in developing countries. m-Health technologies can collect health data, monitor vital signs in real-time, provide treatment support, track disease outbreaks, warn of impending disasters, and educate patients [11]. Wireless devices, such as mobile phones and monitors, can be used to store patient health information and provide health care services [12]. m-Health technologies are also being used as an educational tool in developing countries to train healthcare professionals [13]. A variety of devices and methods have been used to facilitate this training. Tablets have been used for online tutoring and skills training [14], mobile phones have been used to provide education through text-messaging, applications, electronic dosing tools, and modules 15-16], and educational technologies have been incorporated into school curricula [17]. A study by Alipour, et al. [18] provides some support for the effectiveness of these interventions; they found that mobile phones were more effective than the traditional teaching methods and produced greater interest among the students.

Despite these benefits, many m-Health initiatives are not sustainable. Davey and Davey [7] found that many low-income countries do not have policies in place to support m-health technologies, such as telemedicine. To maintain patient safety and confidentiality while using m-Health technologies, policies and laws must be created [19]. Other barriers to the implementation of m-Health interventions include language, lack of privacy, and high turnover of mobile phones [20]. Before m-Health technologies can be incorporated into healthcare systems, further research is required. Quantitative research needs to be conducted in order to convince policy makers and institutions that m-Health is effective [13]. More research assessing the outcomes of these technologies within developing countries is also necessary in order to determine the feasibility of m-Health within the public healthcare system [7].

Mental Health Technology in Developing Countries

An emerging field of research has the potential to be applied using m-Health technologies to the improvement of mental health care in developing countries (mental health mobile health or mH^2). In their systematic review, Farrington et al. [8] discuss how mH^2 technologies can be used in developing countries to reduce the burden of mental illness on healthcare systems which otherwise lack the budget and workforce to provide appropriate treatment. Just as with primary healthcare, mH^2 technologies can be used to increase access to mental healthcare for individuals living in remote and rural regions. mH^2 technologies would be especially helpful in the treatment of mental illnesses as remote monitoring and therapy can be conducted through phone calls and text messaging [8]. In many developing countries there is a socio-cultural stigma associated with mental illness. Using mobile technologies to access mental health care services may encourage individuals to seek treatment without the weight of this stigma [8].

mH^2 technologies have already been applied to create mental health interventions. Through their systematic review, Farrington et al. [8] encountered numerous mH^2 interventions including mental health promotion programs through text-messaging, smartphone sensors that provide support for interventions and medication adherence in real-time, and talk therapy phone calls. Other interventions include Matthews and Dohrety's [21] Mobile Mood Diary system, which supports clinical interventions by tracking patients' moods, energy level, and sleep patterns. Several studies have used cell phones to deliver CBT therapy; Ekberg et al. [22] focused on treating anxiety disorder while, Vogel et al. [23] experienced some success treating obsessive-compulsive disorder.

Farrington et al. [8] also discuss the unique challenges that could arise when employing mH^2 interventions in developing countries. In order to ensure that mental health applications are socio-culturally sensitive, Farrington et al. [8] suggests that mental health applications are developed by an interdisciplinary team that includes local stakeholders (i.e. policy makers and patients) from each geographical context. Money et al. [24] acknowledge that stakeholder engagement increases motivation and promotes technology adoption, a notable advantage in the healthcare field where stakeholders can be reluctant to deviate from traditional practices. Since the majority of mH^2 technologies have been developed in Western countries, determining the effectiveness of these technologies in developing countries is of paramount importance [8].

The literature regarding mH^2 health technologies in developing countries is remarkably limited. Farrington et al. [8] identify the current literature as fragmented, narrowly focused, and small scaled. Studies that test mobile mental health technologies usually focus on a limited range of mobile applications for the treatment of a single disorder instead of attempting to use a range of applications to treat multiple disorders [8]. The research is further limited by small participant pools and short timelines. For example, the study testing the Mobilyze intervention for depression developed by Burns et al. [25] included eight participants and ran for only eight weeks. Farrington et al. [8] also noted that many of these studies were part of a pilot phase and there was a notable lack of randomized controlled trials. These are significant weaknesses that illustrate that there is a serious need for further research, particularly for large-scale interventions that use a wide range of mobile functionalities.

Mental Health Technology in Canada

In Canada, the Mental Health Commission of Canada (MHCC) advocates for the use of technology in mental healthcare. In their 2014 briefing document on e-Mental health, the MHCC described a range of technologies that can be used for mental health treatment, health promotion, and prevention including computerized interventions, tele-health and telemedicine, wearable computing and monitoring, virtual reality, social media, robots, and gaming. The MHCC [26] highlights three Canadian populations that would benefit from m-Mental health technologies: individuals living in remote or rural areas, youth, and First Nations/Inuit/Metis individuals. They suggest that use of mH^2 technologies could increase access to services, foster engagement, and allow for the development of culturally sensitive interventions and support groups respectively [26]. While these technologies do exist, they are not yet incorporated into the healthcare system. According to a survey conducted by the Commonwealth Fund [27] only 11% of Canadian physicians reported that their patients were able to contact them by email. While Canada has several e-Mental health interventions that have been proven to be effective through research, it too has issues of trying to reach remote communities with mental health care services. Added to that is the need for increased availability of internet services for remote communities. Finally, healthcare professionals will need to embrace mental health technologies before they become common practice in Canada. In order to build a local system in a city in southern Ontario that would support the use of smart technology in providing mental health care services the Lawson Health Research Institute (Lawson) mental health research group began a 7-year plan in 2010. Its progress is described below.

A Canadian Example of Implementing Technologies for Mental Health

The Lawson is the research arm of the hospitals in London, Ontario, Canada. London is a mid-sized city of 383,822 surrounded by rural areas. The mental health research group of the Lawson established a seven-year plan (2010-2017) to establish and test a smart mental health system (Examples of Green Funding Projects "Big" and "Small" see Figure 1.)

Stage 0 was to establish the Lawson Integrated Data Base (LIDB). This integration tool is hosted behind the hospital firewalls. It can pull data from community partners and integrate this with hospital information already behind the firewall. The integration of information is explicitly with client permission. Integrated information can be directly sent to clients who can determine who can see what, whether they can just read information or also enter information, and for how long this permission stands. Information can also be sent to specific platforms to provide various technological support for clients and their care providers.

The funding to establish this was successfully received from the Canadian Foundation in Innovation. This purchased the required hardware such as additional servers required and well as the software development.

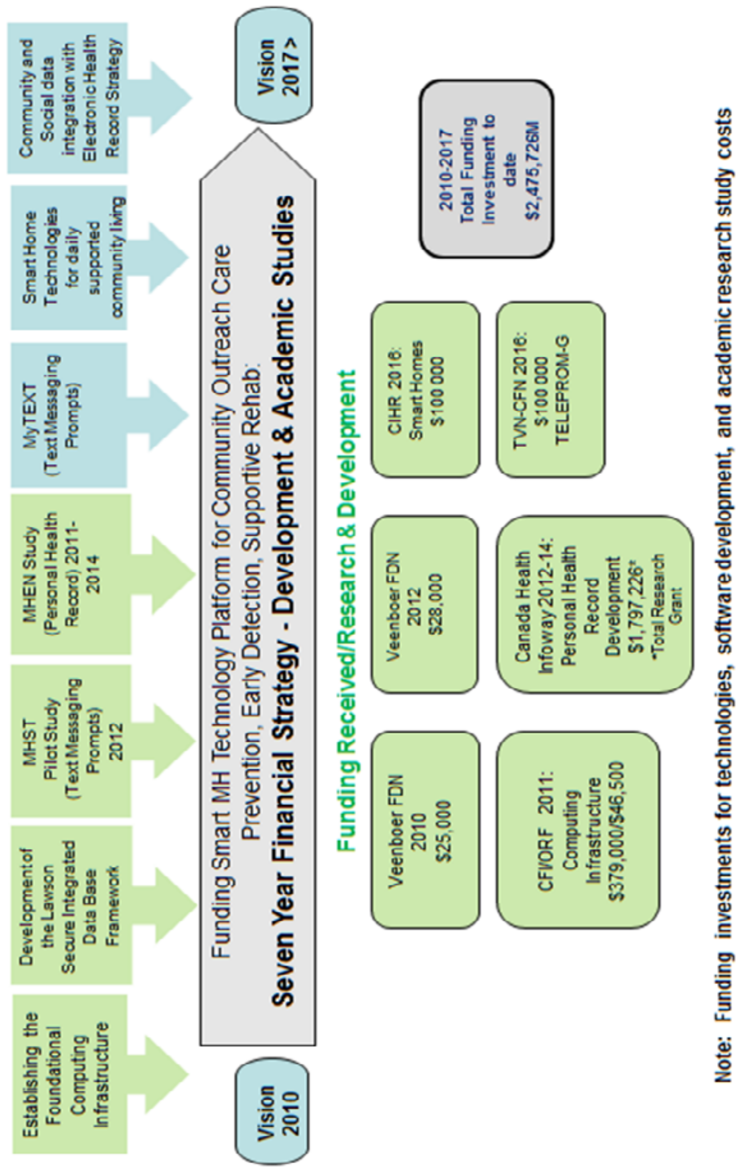

Fig. 1 Lawson Health Research Institute Mental Health Group: A 7-year plan

Canada Health Infoway/Personal Health Record Project - Mental Health Engagement Network

The Mental Health Engagement Network (MHEN) intervention was to support individuals with mental illness living in the community through a smart technology service delivery model. This intervention was built on the principles of health promotion and early intervention by an interdisciplinary team of health care providers, researchers, health information technology experts, and mental health clients. The MHEN provided clients with autonomy in their mental health care management through the Lawson SMART record (LSR). The LSR allows clients to access, maintain, and share their personal health information including medications, medical history, allergies, and their mental health care professionals' contact information. Clients can also access health maintenance applications, which allow them to monitor their moods, create health related journal entries, and receive reminders to help with daily living. Other applications allow clients to track physiological measure such as blood pressure, blood glucose, and weight. The client's LSR is accessible to their mental health care provider; this allows providers to remain informed on their client's health information and allows them to contact their client directly through the LSR's secure messaging system.

The MHEN project, funded by Canada Health Infoway, took place from September 2011 to March 2014 in London, Ontario, Canada and the surrounding areas. Four hundred client participants who had a major mood or psychotic disorder received a smartphone, a TELUS health space account, and a Lawson SMART record. Mental health care provider participants received a tablet and a TELUS health space account. The intervention provided supplementary care by increasing communication between clients and their mental health care providers. The project demonstrated that the use of mobile, web-based interventions can improve access to mental health care and may reduce the financial burden of mental illness on the healthcare system by decreasing the use of more costly services. For example, outpatient visits were reduced by a third with the technology, yet clients had fewer psychiatric admissions to hospital, fewer psychiatric visits to emergency and crisis services, and even fewer arrests. Previous publications discuss the methods and results of the MHEN study in greater details [28-32].

The Veenboer Project - Supporting Mentally Ill Patients in the Community by Using Handheld Devices

This pilot study [33] was designed to explore and evaluate the effects of community-based treatment supported by mobile (handheld) smart technology with a focus on rehabilitation, specifically supporting independent living and community integration. Individuals participating in the study were living in a treatment and rehabilitation supported housing situation and diagnosed with psychotic and mood disorders with associated cognitive deficits, contributing to challenges to achieving successful community integration. Cognitive impairments are prevalent in schizophrenia and have been associated with unemployment, poor social skills, difficulties in independent living, and more [34]. Technology has been used to assist with daily living in other populations, such as elderly persons with cognitive impairments [35]. Stip et al. [36], after reviewing the literature on cognition, remediation, smart homes and related technologies, concluded that rehabilitation of persons with schizophrenia and related cognitive deficits could be enhanced using smart home technology but published research on the use of SMART technology for patients with schizophrenia is limited.

For this project software solutions were developed and applied to existing smart technologies (android phones) in order to enhance the cognitive skills of these individuals by using prompts and reminders from the handheld technologies. In order to evaluate the effectiveness of this approach a mixed methodology longitudinal design was used consisting of baseline and endpoint interviews, assessments of cognition, global functioning, social and occupational functioning, severity of illness, and community integration success; and focus group at the endpoint with clients and care providers to discuss experiences with the smart technology. Purposive sampling was used to recruit clients and care providers.

The project utilized Lawson Integrated Database (LIDB) noted above in the 7-year plan. Care providers set up personalized prompts/reminders for each client in the software tool. Med prompts, reminders regarding attendance at groups, daily appointments, and blood work are examples. Inexpensive mobile phones along with standard basic service plans (unlimited text messages, 150 minutes of phone time during the week and unlimited phone time for nights and weekends and 100MB of Data) were purchased and provided to the participants. A conceptual overview of the software solution is provided below in Figure 2.

Evaluation results demonstrated that clients benefitted from having smart phones, particularly in the areas of community integration and connecting with others. Even though the sample was small (n=10) the community integration score demonstrated a statistically significant increase from baseline to endpoint. Smart phones provided clients with a sense of security to leave home alone. Qualitative results highlighted positive aspects of staying connected to others as the following quotes illustrate:

"I use the phone pretty much every day when I call my parents, or my cousins, and my aunt and uncle … so I use it to contact my support people, and that does include calling [treatment residence] when I'm out" (client)

"I like the texting because … it's good for building relationships" (client)

"In the past … we've had people complaining of anxiety, with paranoid feelings, that sort of thing, that are afraid to go out in the community, it's been a real comfort for people that they can basically call someone when they run into trouble" (care provider)

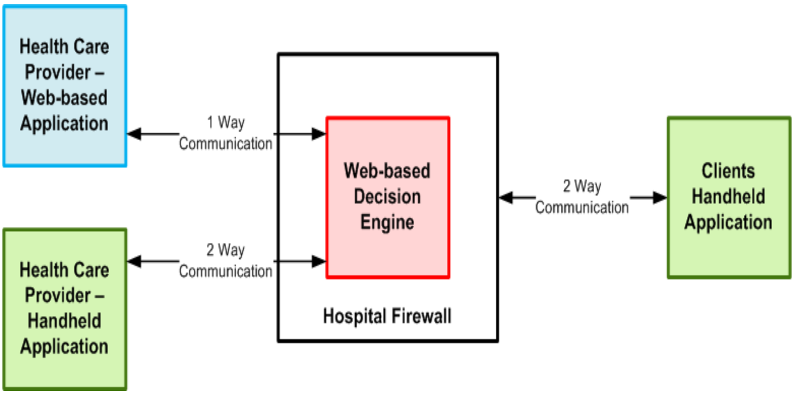

Fig. 2

Clients also reported using the phones to do banking, as an alarm clock and as a diversion by listening to music.

Unfortunately, once the research project was complete and even with the phones being left with the clients many clients were unable to afford service plans. Funding for sustainable service plans necessary to increase the benefits experienced by clients long-term is recommended.

Implications for Developing Countries

The wide use of mobile technologies in developing countries gives hope for the replication of the two projects noted above in mental health care. Canada and developing countries share a need to enhance services to individuals in remote areas and to enhance the everyday lives of persons with mental illnesses by supporting successful community living and thus decrease the burden of disease for these individuals and their families. Mobile technologies have a potential for strengthening the integration of community mental health care, which is affected by a mental health illiteracy of persons with mental illnesses, lack of trained, and inadequate distribution of mental health human resources in developing countries, especially in Sub-Saharan region [37-39]. For example, the use of mobile technology can enable mental health professionals from main mental health settings to remotely monitor, detect early symptoms of relapses, and avoid hospital readmissions associated with ignorance of these symptoms.

The Canadian examples provide evidence that technologies can be very successful to improve outcomes in mental health care but that this success was built on a plan. Farrington et al. [8] noted that "two phenomena have become increasingly visible over the past decade: the significant global burden of disease arising from mental illness and the rapid acceleration of mobile phone use in poorer countries." The significant investments in, and expansions of, mobile coverage infrastructure for many of the countries provides the basis for a countrywide service plan if other components are put in place. The need for funding and recruitment of an increased number of mental health professionals who are smart technology savvy could be less burdensome as technology would widen the spread of their impact in remote areas. Further, the rapid acceleration of mobile phone use may offer opportunities to alleviate barriers to mental health services related to accessibility and acceptability reported in mental health services of developing countries [39] by improving communication between health care staff and persons with mental illness.

On the other hand, the Canadian mental health examples also demonstrate that progress can be made with small as well as large projects. Utilizing software that would enhance communication with professionals, while also building skills for rehabilitation and community living such as, was illustrated in the two projects above would improve the overall delivery of care to many more persons in need of it.

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Use of Text Messaging and Email for Telemedicine Consultations by Remote Rural Doctors

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Introduction

The migration of health professionals to foreign countries has left the Philippines with an immense public health problem. This acute shortage of health professionals is exacerbated when you consider the unequal distribution of physicians, especially clinical specialists, in the country. Most clinical specialists, who remain, prefer to practice in urban areas. This leads to the maldistribution of health professionals in remote and underserved areas of the country [1].

The Philippine government attempted to mitigate the workforce problem by implementing the Doctors-to-the-Barrios (DTTB) Program of the Department of Health (DOH). The DTTB Program aims to deploy doctors, mostly general practitioners, to unserved/underserved, hard-to-reach, and critical fifth and sixth class municipalities without doctors for at least two years [2]. With its over 25 years of implementation, the program has deployed hundreds of medical doctors in various rural communities across the country. However, since majority of these physicians are general practitioners, some even fresh from medical training, there may be a need for specialists to guide them in their clinical decision making for complex cases.

The University of the Philippines Manila - National Telehealth Center (UPM-NTHC) explored strategies on how to enhance access to health information and services between remote doctors and clinical specialists. In 2005-2007, the Center initially used broadband solutions for a telemedicine service in ten rural areas of the country. By the middle of the project, an independent review pointed to a possible failure unless realignment of the strategy was done. Since broadband connectivity was unreliable in rural and remote areas, the UPM-NTHC shifted to short messaging service (SMS) and basic email as possible modes of communication.

SMS, or text messaging, is a communications protocol that allows users to send and receive short alphanumeric messages using mobile phones [4, 5].

Its use in the Philippines has been widespread and phenomenal which led to the country attaining the title of “text messaging capital of the world” [6]. Despite the 160-character limitation of SMS, it still enables general practitioners to refer problematic cases from rural communities to domain experts (DE) from the University of the Philippines - Philippine General Hospital (UP-PGH). Key to the telemedicine program is the delivery of specialized health information that may translate to better patient care.

The SMS/Email Telemedicine Program was formally launched on 15 October 2007 through a Memorandum of Agreement signed between the UPM-NTHC and the DOH during the Continuing Medical Education (CME) Conference of the DTTB Program. A total of 34 DTTBs from various remote villages of the Philippines initially participated in this program. The DTTBs were asked to sign an agreement that the information which they will receive are opinions of the DEs and that the final diagnosis and management for the patient shall remain their responsibility. To remove the financial barrier for these doctors, the UPM-NTHC gave each doctor a monthly Php100.00 (approximately US$2.00) credit load to enable them to refer their cases to the UPM-NTHC. The doctors were encouraged to refer at least one case per week regarding any domain. The UPM-NTHC gave them the option to send their clinical referrals via text message to any of the two network mobile numbers (Globe and Smart). In instances where they do not have any problematic cases to refer, they were asked to send a census of all the cases they saw during the previous week. Only non-emergency cases were accepted and processed because the UPM-NTHC can only assure that all cases were completely processed within a 48-hour turnaround time.

In succeeding years, the program was extended to other DTTBs and municipal health officers (MHO) practicing in rural areas. Over the past 10 years, a total of 774 doctors, practicing in rural and underserved municipalities, signed up to participate in the telemedicine program. However, as of April 2017, only 103 DTTBs and MHOs were still actively referring and requesting for consultations with clinical specialists for telemedicine cases.

Methodology

UPM-NTHC Central Operations

Central operations staff, comprising of Telehealth Physicians, Telehealth Nurses and DEs from various clinical specialties, manage the SMS/Email Telemedicine Program. The Telehealth Nurses who triaged the cases to the appropriate DEs received the text messages. In cases where they had difficulty in classifying the referral, they elevate it to the Telehealth Physician. The text messages were sent to the DEs through the modality that they chose. Some preferred to receive text messages through their cellular phones, while others opted to receive an email containing all the referrals for the day. All the DEs were alerted via SMS for any incoming referrals addressed to them. Once the referrals were answered by the DEs, the Telehealth Nurse forwarded the replies to the inquiring DTTB.

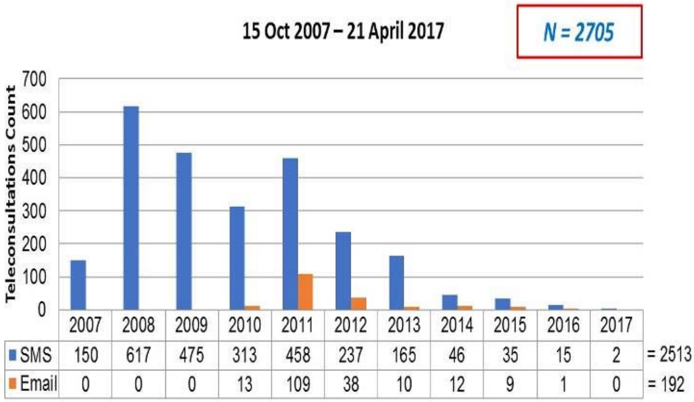
Technology Aspect

Initially, the Center used two SMS-capable cellular phones to receive the text messages. The Telehealth Nurses manually encoded the referrals from the phones to a spreadsheet database. All SMS transactions (receiving from the DTTB, sending to the DE, and vice versa) were done using the two mobile phones. After two months of this process, the SIM cards were then connected to a GSM modem so that incoming text messages were readily available in a computer interface. The Center utilized playSMS [7], a flexible Web-based mobile portal system, to manage all the incoming and outgoing SMS transactions. The shift in the technology to automate the various transactions improved the workflow and minimized the possible errors in encoding. Email was also introduced in 2008 and this helped increase the number of telemedicine referrals because this provided another available platform for remote physicians to reach out to clinical specialists for medical advice.

Over the years, the technologies evolved, which led to the increased availability of open source technologies with potential applications for telemedicine. One of these technologies is called FrontlineSMS [8], which is a communications tool designed to help manage how SMS messages are sent and received as well as how contacts are managed and stored. It also allows information to be exported to spreadsheets for reporting. Another application that the Center utilized, albeit briefly, was the Internet Pathology Suite (iPath) [9]. The Center used a telepathology platform for a brief period in managing tuberculosis cases. Both technologies were completely abandoned after the Center developed the National Telehealth System (NTS) as part of a 2011 project commissioned and sponsored by the Philippine Department of Health.

Results

The UPM-NTHC received 2,705 telehealth consultations from 15 October 2007 to 21 April 2017. There were 2,513 teleconsultations (92.9%) sent through SMS, while 192 (7.1%) were sent through email (Figure 1). Among clinical specialties, Internal Medicine had the most referrals (794) followed by Pediatrics (534). Other referrals were from Obstetrics and Gynecology (356), Dermatology (218), Radiology (214), General Queries (192), Surgery (146), Medico-Legal (77), Otorhinolaryngology (65), Ophthalmology (61),



Fi. 1. Number of Teleconsultations (SMS vs Email)

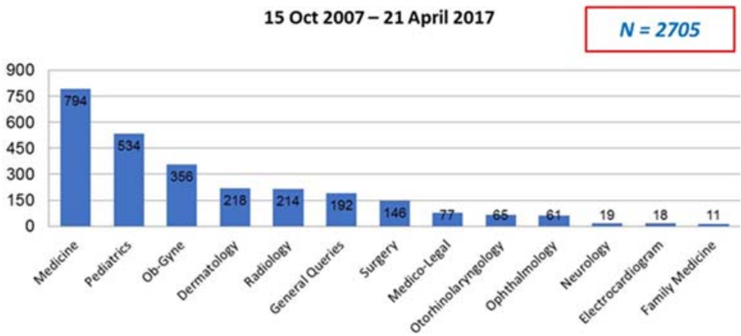


Fig. 2. Distribution of Teleconsultations by Clinical Specialty

Neurology (19), Electrocardiogram interpretation (18), and Family Medicine (11). Figure 2 shows the distribution of referrals by clinical specialty.

The Center was able to respond to 2,646 out of the 2,705 referrals, yielding a response rate of 97.8%. Of the 59 unanswered referrals, 49% were Medico-legal (15) and Internal Medicine (14) cases.

However, the data shows that there has been a steep decline in consults and referrals over the years. The year 2008 was the peak year for telemedicine cases with 658 consults being received and processed through SMS. However in 2012, the number of telemedicine cases began to decline from 567 cases

(458 via SMS, 109 via email) received in 2011 to only 275 cases (237 via SMS, 38 via email) received and processed in 2012, followed by 175 cases (165 via SMS, 10 via email) in 2013, 58 cases (46 via SMS, 12 via email) in 2014, 44 cases (35 via SMS, 9 via email) in 2015, 16 cases (15 via SMS, 1 via email) in 2016, and only 2 cases received through SMS from January 2017 to April 2017.

Discussion

The geographic configuration of the Philippines, being an archipelago of over 7,100 islands, has made it nearly impossible to physically station a medical practitioner in all its municipalities. Moreover, the handful of doctors deployed in rural villages, who are mostly general practitioners, may lack certain clinical expertise to resolve complex cases in the community. These health providers may require the assistance of trained clinical specialists who, on the other hand, are usually located and practice in urban areas.

With the availability of SMS technology reaching even the far-flung regions in the Philippines, the geographic barrier to the dissemination of specialized health information has been reduced. Health information exchange between a central facility and a remote village doctor is now possible and even crucial to the management of patients in the rural setting. The familiarity of rural doctors with the use of mobile phones makes it a better communication tool compared to Internet-based solutions. The accessibility of SMS at the point of care, as well as its economical rates add to its advantages of being used in the rural setting.

In this telemedicine program, rural doctors made use of SMS to refer the challenging cases that they encountered in the community. Despite the 160-character limitation of the SMS technology, the ability of most mobile phones to compose multiple short messages into one message made it possible for the referring doctor to provide more clinical information for review by the DE. However, for earlier models of mobile phones without such capability, the character limitation may pose some difficulties in sending and retrieving lengthy messages. The limitations in allowable characters of a text message was further shun through the use of a text vocabulary or text speak [10]. This made use of truncated or abbreviated words to keep the messages brief and concise. It is worth mentioning that despite the use of such language, the DEs were still able to understand the intended message of the DTTBs.

Based on the domain analysis of the telehealth referrals, the DTTBs referred mostly Internal Medicine and Pediatrics cases probably since majority of the outpatient consults in the provinces are in the domains of general adult and child medicine. In most cases, the health information given by experts helped the rural physician in managing the case.

The UPM-NTHC was able to answer 97.8% of all the referrals received. The unavailability of some DEs during a few periods of time made it difficult to answer the cases within the allotted time frame. Furthermore, since the University does not have a full-time Medico-legal Expert, a number of medico-legal referrals remained unanswered. In certain instances, the referrals were forwarded to agencies outside the University.

Telemedicine consults and referrals received via email also helped referring physicians who were more comfortable using more traditional means of communication compared to the 160-character limitation of SMS. We found that the number of telemedicine cases referred through email also declined in the same manner as the SMS-referred telemedicine cases.

It is also important to understand why there has been a steady decline in telemedicine referrals and consultations since 2012. We surmise that this may be attributable to the exponential increase and availability of smartphones with Internet access and the improvement of Internet connectivity and communications infrastructure in the country. We believe that because of these factors, the referring general practitioners are now able to look up the information they need on the Internet using their smartphones, which may significantly reduce the need for consultations with clinical specialists. The availability of smartphones has also allowed these remote physicians to download and utilize mobile apps such as PubMed4Handhelds [11] in order to access information that they need at the point of care. Further studies are needed in order to validate our claims and findings.

Conclusions

SMS is a viable telemedicine application in the Philippine setting due to its accessibility, availability, affordability and mobility. Email may also be used in areas with more stable broadband connectivity. Rural doctors, who are the front liners in the remote communities of the country, need to be supported through health information. The extensive use of mobile phones and SMS technology nationwide provide a life link for general practitioners to refer their challenging cases to a specialist. In conjunction with email use, both platforms provide an easy way for remote physicians to refer or consult with clinical specialists about their clinical dilemmas.

There is a need to assess the satisfaction of both the remote doctors and DEs with regards to the implementation of the SMS/Email Telemedicine Program so that modifications can be done to improve the service for both stakeholders. Aware of the great potentials of SMS as an application for health, there is a need to develop standards and guidelines for this emerging field.

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Facilitating Healthy Lifestyle and Rehabilitation

Home Telerehabilitation Service for Persons Following Lower Limb Amputation

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Introduction

In the majority of European countries, the proportion of people with disabilities (i.e. limitations in activity and participation) is estimated to 10% [1]. Disability level and incidence of amputations have been increasing globally [2]. Many patients do not receive adequate rehabilitation through traditional programmes due to limited rehabilitation period, lack of rehabilitation capacities and professionals and inadequately designed programmes, e.g. their rehabilitation program does not start early enough. On the other side, financial capacities of national healthcare systems to maintain their present level and scope of the agreed healthcare rights have been diminishing. New health care services, based on new more efficient and financially less demanding models than the existing, have to be developed. The strategic documents of the European Commission have outlined the solution, i.e. improving the health care system by introducing new organisational models of treatment, which will fundamentally change the way health care services are provided at all levels of health care. As much health care as possible should be provided within the home environment. The European Commission recognises potentials of new services based on modern information and communication technologies (ICT) using telemedicine (telehealth) services to support patients in their home environment. A solution to this problem might be telerehabilitation – a support service for a patient at home enabled through ICT.

Telerehabilitation is delivery of rehabilitation services via ICT [3]. Clinically, this term encompasses a range of rehabilitation and habilitation services that include assessment, monitoring, intervention, supervision, education, consultation, and counselling [4]. Telerehabilitation is a sub-domain of a broader area of telehealth. Telerehabilitation service, as presented in this paper, is a service aiming at enabling a patient physical rehabilitation out of rehabilitation institution, e.g. at home. Different technological solutions have been used to interact with patients: from Internet-based applications, videoconferencing, virtual reality systems etc. The telerehabilitation solutions were real-time with the patient and the therapist present (synchronous) or store-and-forward (asynchronous).

Transferring health care services into a home environment of patients - potential service users, is aiming at raising a quality of life of the service recipients, lowering the increasing costs for healthcare services and thus reducing a pressure on governmental funds for social and healthcare welfare. Principles and methodology of designing a telerehabilitation services are well presented in a tool-kit produced in Australia based on an iPad as a consumer electronic product [5]. Some recommendations and guidelines are already available [6, 7].

The European Commission supports activities in the area of telehealth, where telerehabilitation is a sub-domain of the telehealth. Several projects have been supported within different research and development agendas, e.g. Framework Program 7 (FP7) and Horizon 2020. Therapeutic solutions were addressed in project like REWIRE, Rehab@HOME, HC@Home - EU-CaRE, ICARE4EU, CLEAR, VIMED® TELEREHAB, STROKEBACK, etc. Platforms for managing information and data were developed in projects Make It ReAAL!, PD_manager, Rehab@Home and others.

Research in the area of telerehabilitation supports the use of telerehabilitation for delivery of rehabilitation and habilitation services. In the area of research of telerehabilitation services aiming at supporting amputees, Rintala et al [8] reported successful use of telerehabilitation for wound assessment in patients, following lower limb amputation. High patient satisfaction scores and successful implementation of telerehabilitation for amputee-related applications were also reported [9 - 11].

Development of Telerehabilitation Service for Amputees

Rehabilitation of persons following lower limb amputation should start immediately after the amputation. It has to be continued until the full reintegration of the patient into his/her community. In practice, after discharge form a surgical ward, majority of amputees go home for recuperation and continue with rehabilitation approximately 2 months later. To fill the gap between the discharge from acute hospital and the admission to a rehabilitation institute patients should receive a telerehabilitation service at home (Fig. 1). This should be available to the patients also after traditional rehabilitation at a rehab institution, if an additional home rehabilitation would be required.

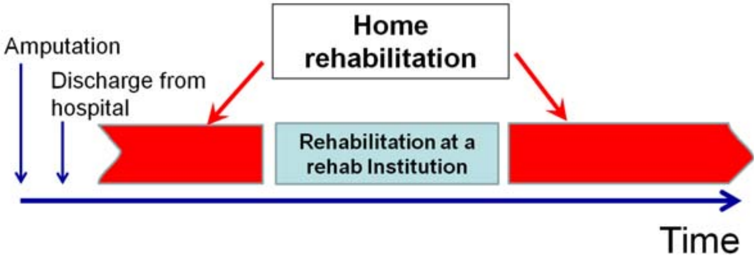

Fig. 1: Timeline of telerehabilitation at home

A model of an interactive Cloud based multimedia telerehabilitation service was designed and set-up (Fig. 2) [12, 13]. It was based on multimedia contents (movies), presenting exercises, to be practiced by the supported patient at his/her home.

The University Rehab Institute Ljubljana, Slovenia prepared the video movies. Two servers were set-up: video contents server and an application / database server. A web-based portal was designed, enabling the patients to watch the exercises and the therapists to maintain patient records, multimedia contents management, therapy prescriptions. A teleconferencing system (Skype) was embedded into the solution.

The patients and the therapists were provided a tablet PC (Samsung Galaxy Tab 10.1 with a prepaid data transport) to access the videos over the Internet. The user interface for the tablet PC was carefully designed (Fig. 3). Simplicity of the service use for the patients was the paramount requirement. The users accessed video exercises with only four touches of the screen. Navigation was used only for movie selection and play. A response to a therapist's Skype call was enabled on the tablet by one finger touch only.

Telerehabilitation Service Evaluation

Eleven patients following unilateral trans-tibial amputation were included into the service evaluation representing an intervention group. Each patient was physically and functionally assessed through standardised physiotherapy (PT) and occupational therapy (OT) tests before and after using the service. He/she received a tablet PC to access their exercises on the Internet. For each of them an individualized program (training) was prepared consisting of a group of movies/exercises. The exercises were grouped and delivered consequently with a progress in the rehabilitation.

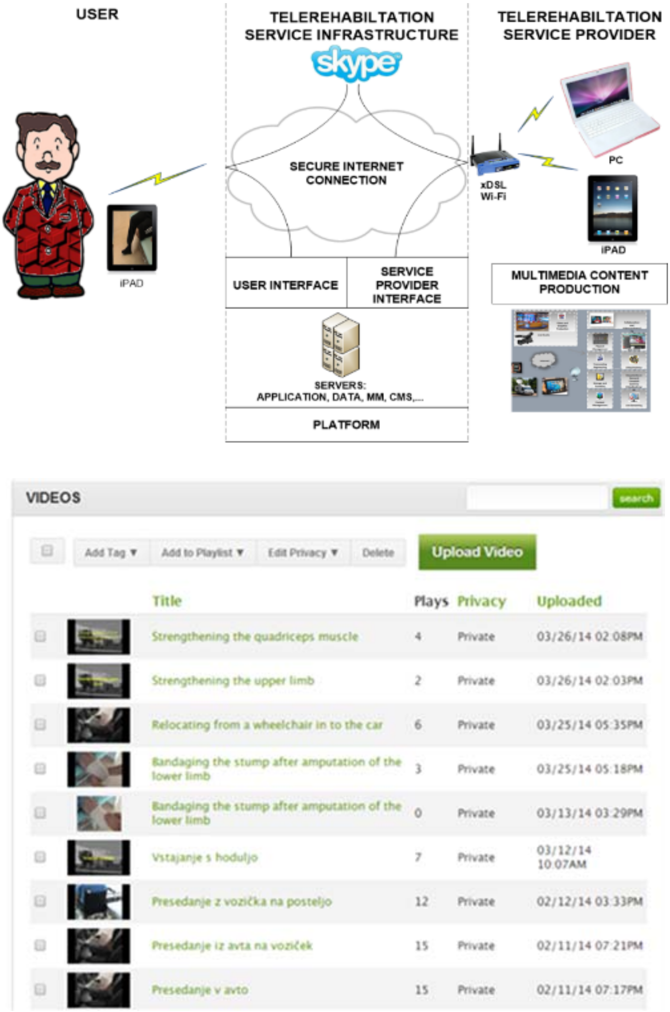

Fig. 2: Telerehabilitation service model (top) and a snapshot from a multimedia server presenting access to the exercises (bottom).

A distant therapist (PT, OT), who visited each patient on a weekly basis using Skype videoconference system remotely, supported the patients. The objective of the remote visits was to check exercise performance. Based on the results of the training, the therapist determined the next group of exercises (movies) to be practised by the patient until the next visit. The Ljubljana Rehab Institute's Ethics Committee approved the study.

In total 27 videos were prepared (13 from PT, 14 from OT). They were grouped to achieve their specific aims: bandaging, muscle strength or transfer sills (from a wheelchair to a bath and reverse, from a wheelchair to a car). Patients watched them as presented in Table 1. Use of the telerehabilitation service by the patients is presented in Table 2. The therapists visited the patients by Skype once per week and made 2–7 videoconferences per patient.

Table 1: Use of multimedia contents at home telerehabilitation by type of exercises

Multimedia content – exercises / movies	Number of exercises	Used by no. of patients	Number of views
Bandaging	3	9	69
Trunk + hip muscle strength	3	6-8	90
Range of movements – hip flexors	1	10	34
Quadriceps strength	3	4-8	40
Upper limb strength	3	4-7	36
Transfers (wheelchair, bath, car etc.)	10	1-7	114
Stand up, sit down	4	1-4	13
Total number:	**27**	**11**	**396**

Table 2: Descriptive statistics of the home telerehabilitation service use.

Telerehabilitation statistics	AVG	SD	Min	Max
Use of telerehabilitation (days)	23.0		8	50
Number of exercises (videos)/therapy	12,1	4,8	5	18
Number of exercises watched	37,4	33,6	13	135
Number of exercises (videos) watched	19,9	13,5	7	55
Number of prescribed telerehabilitation. therapies/patient	1,8	1,2	1	4

Discussion

In the paper a telerehabilitation service is presented that was developed and evaluated at the University Rehabilitation Institute in Ljubljana, Slovenia, for patients following lower limb amputation. The telerehabilitation service enables a continuous rehabilitation within a patient's home environment after discharge of the patient from a surgical ward. The patients involved in the evaluation used the service before they started a traditional rehabilitation at the Rehab Institute. In this paper only the technological solution used in the research study is presented. Clinical outcomes of the telerehabilitation service evaluation were encouraging and will be published elsewhere.

The study confirmed that the implemented service model and the technology solution suited the purpose. Consumer electronic products - tablet PCs were used by the patients and the therapists. As indicated by Taylor and co-workers [14] use of consumer technology for telehealth requires customisation of applications and services. For the presented service, this was done at the web application side as well as on the tablet. The patients found their interface simple to use and intuitive. Only four finger touches to the tablet screen were needed to start watching an exercise. In addition, the therapist's user interface was simple. One hour training for therapists was sufficient for them to effectively manage patient records, therapies and Skype visits.

The service was well accepted by the patients and the therapists. All the patients and the therapists found the solution interesting and useful. Their level of satisfaction was assessed by a questionnaire.

The evaluation raised the ambitions that the telerehabilitation service model might enable transition from the existing rehabilitation to more advanced practices also for other groups of patients, e.g. after stroke, lower back pain etc.

Conclusions

The results of telerehabilitation service evaluation indicate that the telerehabilitation service used in the study was adequate for provision of rehabilitation to patients with lower limb amputation at home. The service has potentials to supplement the existing rehabilitation at a tertiary level institutions thus supporting and empowering the patients in their home environment. Its regular implementation in clinical practice would fill the gap in standard rehabilitation of patients after lower limb amputation.

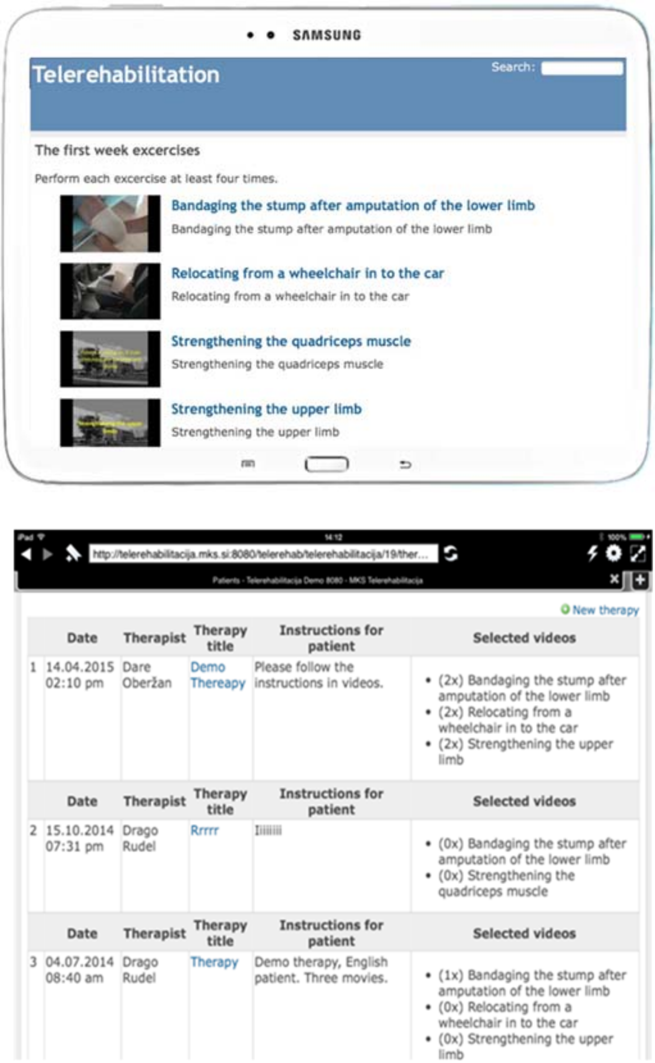

Fig. 3: View to the user's screen on a tablet PC with a set of exercises (top) and therapist's view of prescribed therapies/exercises on the TR portal (bottom).

Acknowledgment

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Providing Telephone-based Physiotherapy and Its Outcome on Quality of Life in Patients with Knee Osteoarthritis

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Introduction

Knee Osteoarthritis (OA) is a prevalent musculoskeletal condition affecting older people and causes pain, physical disability, and reduced quality of life (QoL) with considerable economic burden on the health care system [1].

In Nigeria, the prevalence of OA has been documented by several studies [2, 3] and the knee joint is the most frequently affected [2]. The management of knee OA focuses on optimizing the patient's QoL [4]. The term QoL refers to the general well-being of individuals and societies [5].

Physiotherapy treatment for knee OA involves therapeutic exercises that are used in almost all treatment sessions in the management of knee OA [6]. Exercises are effective and well-tolerated treatment for knee OA [7]. The usual pattern of managing patients with knee OA requires the patients to keep attending the clinic for one-on-one sessions with the physiotherapists. However, patients who live far away from the clinics may find it difficult to attend clinic regularly due to distance and cost of transportation [8, 9]. In order to address these problems, which could make treatment ineffective, tele-physiotherapy, that entails the use of telecommunications technology as a medium for providing information for therapeutic exercises to patients at homes that are at a distance from the physiotherapy clinics [10], is considered.

Tele-physiotherapy is the development of tele-monitoring systems to facilitate independent rehabilitations of patients within their own homes [11]. Telemonitoring is a convenient way for patients to avoid travelling and to perform some of the more basic work of healthcare for themselves [12]. The objective of tele-physiotherapy is to allow patients and medical experts to carry on their sessions through telecommunication networks as if they are in the same place [13]. The applications of tele-physiotherapy effectiveness have been documented in some medical conditions such as in the rehabilitation of stroke and patients with total knee replacement [14]. Thus, the practicability and usability of tele-physiotherapy in developing nations like Nigeria, needs to be ascertained using the available, affordable and relevant telecommunication. Tele-physiotherapy was not explored among patients with knee OA in Nigeria before this study was carried out.

Methods

We investigated the outcome of a six-week telephone-based physiotherapy on quality of life among individuals with knee osteoarthritis and compared it with those who received physiotherapy in the clinic.

Participants

Patients diagnosed with knee OA were drawn from out-patient Physiotherapy clinics in three hospitals in Southwestern Nigeria: University College Hospital, Ibadan, Neuropsychiatric Hospital, Aro, Abeokuta and State Hospital, Ijaye, Abeokuta, Nigeria.

Inclusion criteria: patients that have been diagnosed with OA of the knee joint, patients that are literate in English or Yoruba language and patients that have means of communication via mobile telephone.

Exclusion criteria: presence of co-morbid medical conditions such as; mental illness, diabetes, uncontrolled high blood pressure, cancer etc. that can influence overall well-being

Outcome Measure

World Health Organization Quality of Life-Bref (WHOQoL-Bref) and its Yoruba translated version: The 26-item WHOQoL-Bref is used in clinical trials to investigate changes in quality of life over the course of interventions [15]. The WHOQoL-Bref was developed in the context of four domains of QoL: physical, psychological, social and environment and domain scores are scaled in a positive direction, that is, higher scores denote higher quality of life [16]. It is self-administered by respondents but an experienced interviewer may assist the administration by reading items aloud where self-completion is not possible, usually for reasons of literacy or disability.

The results of a study conducted by Skevington et al. [17] of WHOQoL group indicate that overall, the WHOQoL-Bref is a sound, cross-culturally valid assessment of QoL, as reflected by its four domains: physical, psychological, social and environment. The internal consistency shown by Cronbach's alpha for physical domain is 0.82, psychological domain is 0.81, social domain is 0.68 and environment domain is 0.80. Summary Pearson correlations (one tailed test) between domains for the total sample were strong, positive and highly significant ($p < 0.0001$), ranging from 0.46 (physical vs. social) to 0.67 (physical vs. psychological). The Yoruba version is a valid translation of the English WHOQoL-Bref. Stroke participants' domain scores on the Yoruba translated version of WHOQoL- Bref correlated significantly with those on its English version (r = 0.695-0.859; p = 0.000) [18].

Fifty individuals with knee OA were included in this randomized control trial. They were assigned randomly and equally, using a computer-generated table of random numbers, into two treatment groups: Clinic Group (CG) and Tele-physiotherapy Group (TG).

Tele-physiotherapy Group

Quality of life of this group of patients was assessed at baseline using WHOQoL-Bref. Standardized home-exercise programmes for patients with knee OA [19] were explained and performed for these patients. A copy of the standardized home programme exercise for patients with knee OA was given to each patient in this group to serve as a guide, while performing the exercise at home, three times in a week for six weeks. Mobile telephone monitoring using uniform statements contained in structured telephone monitoring guide on the three occasions of standardized home exercise programmes in a week was done to monitor and coach them about the home programme procedure. Patients were also provided with exercise log-book for proper documentation of the exercise procedure. This group of patients only reported to the clinics at second, fourth and sixth week for re-assessment of their QoL .

Clinic-based Group

Quality of life of this group of patients was also assessed at base-line using WHOQoL-Bref. However, the physiotherapists, not the patients, administered the same standardized exercise programme for patients with knee OA [19] to this group, three times in a week for 6 weeks in the clinic and they were neither monitored nor coached on mobile telephone. These patients' QoL was also re-assessed at second, fourth and sixth week of clinic intervention.

Data were analyzed using ANOVA and Independent t-test. Both English and Yoruba versions of the WHOQoL-Bref were used to obtain data on participants' QoL in order not to exclude participants who were not literate in English language from participating.

Results

Fifty patients (26 males and 24 females) with osteoarthritis of the knee in age range of 37-72 years with a mean age of 55.50±7.55 years participated in the study. Twenty-five patients (12 males and 13 females) were in the clinic group (CG) with a mean age of 54.96±7.81years and an equal number (14 males and 11 females) in the tele-physiotherapy group (TG) with a mean age of 56.04±7.40 years. Participants in both groups were comparable in age (CG - 54.96±7.81 years and TG - 56.04±7.40 years).

There were significant within group improvements in the TG and CG's physical health domain of WHOQoL between weeks 0-4, 0-6, 2-4 and 2-6 (tables 1 and 2). The TG's psychological domain of WHOQoL showed significant differences between 0-4 and 0-6 weeks (table 1), while the CG's psychological domain of WHOQoL showed significant differences between weeks 0-2, 0-4 and 0-6 (table 2). There were no significant differences in TG and CG's social relationships domain and environment domain of WHOQoL across baseline, 2nd, 4th and 6th week of intervention (tables 1 and 2). Between-group comparison of CG and TG revealed that there were no significant differences between CG and TG's physical health, psychological and social relationships domains of WHOQoL across baseline, 2nd, 4th and 6th week of intervention However, there was significant difference in the environment domain (table 3).

Table 1: Comparison of Participants' WHOQoL Domains at Baseline, Second, Fourth and Sixth Week of Intervention of the Tele-physiotherapy Group

Domain	Baseline	2^{nd} week	4^{th} week	6^{th} week	F	P
Physical Health	53.72 ± 11.40	53.32 ± 9.70	64.08 ± 9.28	69.28 ± 10.94	11.208	0.00*
Psychological	64.48 ± 10.03	67.04 ± 9.10	69.72 ± 7.97	71.96 ± 7.55	3.464	0.02*
Social Relationship	64.80 ± 8.92	64.52 ± 9.41	66.80 ± 8.29	67.04 ± 8.44	0.560	0.64
Environment	64.52 ± 7.76	65.08 ± 7.16	67.76 ± 8.11	68.48 ± 8.09	1.570	0.20

Table 2: Comparison of Participants' WHOQoL Domains at Baseline, Second, Fourth and Sixth Week of Intervention of the Clinic Group

Domain	Baseline	2^{nd} week	4^{th} week	6^{th} week	F	P
Physical Health	51.48 ± 15.61	55.68 ± 14.00	64.08 ± 13.05	71.16 ± 12.00	10.214	0.00*
Psychological	61.04 ± 10.45	66.60 ± 10.74	69.84 ± 9.45	71.40 ± 8.23	5.399	0.00*
Social Relationship	65.76 ± 12.37	67.04 ± 11.62	67.00 ± 11.22	69.04 ± 10.58	0.350	0.79
Environment	59.08 ± 8.01	59.76 ± 8.58	62.24 ± 8.48	63.76 ± 7.80	1.750	0.16

Table 3. Between Group Comparison of Participants' Environment Domain of WHOQoL at Baseline, Second, Fourth and Sixth Week of Intervention

TIME POINT	GROUP	N	ED MEAN ± SD	t	P-VALUE
Baseline	CG	25	59.08 ± 8.01	-2.439	0.02*
	TG	25	64.52 ± 7.76		
Second Week	CG	25	59.76 ± 8.58	-2.379	0.02*
	TG	25	65.08 ± 7.16		
Fourth Week	CG	25	62.24 ± 8.48	-2.353	0.02*
	TG	25	67.76 ± 8.11		
Sixth Week	CG	25	63.76 ± 7.80	-2.099	0.04*
	TG	25	68.48 ± 8.09		

*Significant level is at 0.05

Discussion

This study has provided empirical information on the effect of a 6-week tele-physiotherapy programme on quality of life of patients with osteoarthritis of the knee. It appears there are no documented studies on the effect of tele-physiotherapy among individuals with knee osteoarthritis in Nigeria. Therefore, the findings from this research would be compared with related works from other parts of the world and studies in different patients' population.

Likewise, Keerthi et al. [20] assessed the efficacy of tele-rehabilitation via videoconferencing when compared to telephonic consultation for home based treatment of patients with knee OA using exercise. The results of their study showed percentage difference in pain, stiffness, and physical function in both groups, i.e. patients in tele-rehabilitation via videoconferencing and patients in telephonic consultation group. The percentage difference in the former is a better home based exercise program in osteoarthritis of knee, though. In addition, Russel [21] documented that the achieved outcomes following six weeks of either traditional outpatient rehabilitation services or internet-based outpatient rehabilitation (tele-rehab group) in 65 patients who underwent total knee replacement (TKR) are similar. The patients were randomized to receive six weeks of either traditional outpatient rehabilitation services or tele-rehab group. Patients in the tele-rehab group received rehabilitation exercises (open and closed kinetic loop active exercises) through real-time (live video and audio) interaction with a physical therapist via an internet-based system and therapy sessions were limited to 45 minutes.

The above reports are similar to our research findings, which showed no significant difference (P>0.05) in physical, psychological and social relationship domains of quality of life between patients with knee osteoarthritis (OA) in tele-physiotherapy group and clinic based group at baseline, second, fourth and sixth week of intervention. Furthermore, the efficacy of tele-physiotherapy as shown in our findings where significant differences were noted in quality of life of patients in tele-physiotherapy group between weeks 0-4, 0-6, 2-4 and 2-6 in physical health domain and weeks 0-4, 0-6 and 2-6 in psychological domain of WHOQoL is similar to the outcome of a study conducted by Margolis [22]. He reported that patients receiving telemonitoring, along with high blood pressure management support from a pharmacist, were more likely to lower their blood pressure than those not receiving extra support.

Our study shows that the outcome of quality of life in patients with osteoarthritis of the knee under tele-physiotherapy treatment is comparable to those in clinic-based group following six weeks of intervention. Besides, there were significant improvements in physical and psychological domains of quality of life in patients with osteoarthritis of the knee following 6-week of tele-physiotherapy intervention.

The effectiveness and usability of tele-physiotherapy in the management of patients with knee osteoarthritis have been demonstrated in this study. This mode of therapeutic intervention in patients with knee OA would undoubtedly reduce clinic visits, clinic waiting time and cost incurred on transportation to the clinic, especially for patients living at distant places from physiotherapy clinics.

Conclusion

From this study, there seems to be clear benefits of delivering physiotherapy at a distance with a telemedicine technique that allows patients to access physiotherapy at home. Six-week tele-physiotherapy improved QoL in patients with knee OA, comparable to clinic-based treatment. Thus, telephone-based physiotherapy should be incorporated into the rehabilitation programme of patients with knee OA.

Note

An extensive version of this study was published in the International Journal of Telemedicine and Applications, i.e. Odole, A.C., Ojo, O.D. (2014): Is Tele-physiotherapy an Option for Improved Quality of Life in Patients with Osteoarthritis of the Knee? International Journal of Telemedicine and Applications Article ID 903816 http://dx.doi.org/10.1155/2014/903816

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Telemedicine: A Success Story of Assessment and Rehabilitation of Psychiatric Patients in the Rajan Pur District of Southern Punjab, Pakistan

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Background

In Pakistan mental health rehabilitation facilities are limited to big urban centers. Two to three psychiatrists per million patients are available and confined to large cities despite the fact that the majority of our population resides in rural areas. Unfortunately, the existing hospital-based psychiatric services are poorly utilized [1]. Because of social stigma attached to psychiatric patients and popular misconception about mental illnesses, society and even family members sometimes abandon their loved ones [2]. Most individuals with mental disorders do not acquire health services for their conditions. Even in developed countries with well-organized health care systems, 44 - 70% of patients with mental disorders do not receive treatment. In developing countries, the figures are even more startling, with the treatment gap being close to 90%, despite the fact that four of the six leading causes of death are due to psychiatric disorders (depression, alcohol-use disorders, schizophrenia and bipolar disorder, etc.). There is an enormous gap between the need for treatment and available resources [3]. Psychiatric problems in Pakistan are increasing due to growing injustice, poverty, violence, insecurity, terrorism, political uncertainty, unemployment, gender discrimination, unhealthy lifestyle, ill health, stressful working conditions, genetic factors, unrestricted urbanization, and loss of protective family networks. The decline of 42% of the population below poverty line is a dangerous and alarming condition [4]. Poverty, illness, illiteracy, and expense of treatment are major factors contributing towards a rapid increase in mental illness in Pakistan since the last 15 years [5]. Even in this modern age, many patients become dependent on faith healers for the cure to their mental problems. These faith healers have strong marketing networks to prey on the vulnerable [6]. The brutality and inhuman treatment of psychiatric patients commonly prevails with them. Patients are chained, raped, beaten, burnt and scarred on their body sometimes leading to death. To make matters worse, family members are not allowed to interfere during treatment [7].

Rajanpur is the headquarter of Rajanpur District (Fig 1.), located in the extreme southwest part of Punjab, Pakistan (29:06N, 70:19E). It has a population of 1.1 million of which 14.27% are urban [8]. 38% of people live below the poverty line and 69% people earn a dollar a day. Literacy rate is below 34% [9]. Rajanpur has a district headquarter hospital and three *tehsil* headquarter hospitals with a total staff of 56 doctors of which only 12 are specialists in their respective fields [10]. There is no Psychiatrist available in this district or in its catchment area. Due to poverty, illiteracy, and absence of medical facilities, the majority of patients consult faith healers, Saints, Hakims (herbal doctor), black magic, and witch doctors.

Telemedicine in Rajanpur

Fig. 1

In an area like Rajanpur, where availability of doctor is a big problem, the telemedicine system is a great convenience for the poor. The system became operational in 2009, connecting Mayo Hospital Lahore hub with 7 District Headquarter (DHQ) Hospitals including Rajanpur. More than 12000 patients were provided free of cost medical consultation and treatment, of which 615 were psychiatric patients. The high number of tele-consultations are due to the vast catchment area of the district, availability of free medical advice and treatment from highly qualified doctors, and the comprehensive propagation of the telemedicine system by the health and government authorities as well as ordinary masses.

Telepsychiatry Services to Rajanpur

Telepsychiatry can provide cheap but quality mental health services to deprived areas [11].

Comprehensive telepsychiatry clinical services were initiated with the collaboration of the Department of Psychiatry, Mayo Hospital Lahore. Though the initial response was low, gradually the number increased (Table 1). Between 2008-2013 six hundred and fifteen patients from Rajanpur and its catchment areas, including adjacent districts of Rahimyar khan and D.G. Khan (Punjab), Dera Bughti (Baluchistan), and Jackobabad (Sindh) provinces, were treated (see Table 1).

Table 1: Tele-Psychiatry consultations at different remote stations

Station	Consultation Year				
	2009	2010	2011	2012	2013
Gujrat	-	3	1	7	-
Rajanpur	76	116	173	109	141
D.G. Khan	9	12	3	7	-
Jhang	5	7	1	3	1
Khushab	-	-	12	5	2
Sahiwal	-	2	-	-	-
Attock	-	-	3	15	7

In clinical sessions, feedback on social and cultural practices, demographics, and other contributing factors to the mental disorders were also collected. These factors contributing to the disorders include poor economic condition of the people, social and cultural conditions, extreme religious believes, inequality, fear of life security, injustice and alarming rate of drug dependency (Table 2).

Table 2: Factors responsible for psychological disorders in Rajanpur

Problem / issue	Factors which were helpful in acceleration and creation of problem								
	Security	Genetic	Right violation	Acquired	Fear	Discrimination			Others/ unknown call
						Gender	Injus-tice	Eco-nomic	
Schizop-herinia	0	3	0	15	9	3	0	2	19
Drug Depend	154	0	8	31	7	3	8	31	27
BPE	2	0	13	3	7	3	1	4	16
Convers-ion & Hysteria	2	0	5	3	7	8	1	1	2
Psy. Dep	7	2	17	4	11	7	3	9	18
Epilepsy	0	14	0	9	0	0	0	0	11
Annoyn-ess/ anxiety	3	7	11	7	7	11	2	13	17
Nerv. Break down	0	0	2	4	4	2	1	1	3

Disorders Recorded Through the Telemedicine System

During the 4 years of telepsychiatry services provided, 615 psychological cases were recorded from Rajanpur district and its catchment areas from patients belonging to rural and urban backgrounds (Table 3).

Every socioeconomic group was affected by the following disorders including but not limited to schizophrenia, depression, brief psychiatric episode, epilepsy, drug dependency, anxiety, epilepsy, and hysteria. Demographic and background data was collected between the patient's guardian and the consulting doctor via questionnaire.

Consultancy Plan for the Psychiatry Patients

Since its establishment, the telemedicine system at Mayo Hospital launched an extensive telepsychiatry program with the department of Psychiatry Mayo Hospital Lahore at the request of the Medical superintendent at DHQ Hospital in Rajanpur and the city district government.

The first psychiatric case was registered on March 3, 2009. Two days out of a week were fixed for the telepsychiatry clinic for which three consulting psychiatrists were present. The patients were registered at sites in closest proximity to their residence and the doctor present at that site recorded their history, before presenting it to the psychiatrist at the hub. The psychiatrist consultant at the Telemedicine hub had full liberty to interact with the patients and their attendants, who were present at the remote end. Each case study was discussed between the doctor at remote and psychiatrist at hub before the treatment plan consisting of Pharmacotherapy, Family education, and Counseling was arranged.

Table 3: Distribution of mental disorders in different social groups

Problem	Frequency			Social Group			Belong to	
	Gender							
	No	M	F	Poor	M. class	Rich	Urban	Rural
Schizophre-nia	51	22	29	14	17	20	13	38
Drug Depend	269	263	6	126	82	61	112	157
BPE	49	17	32	11	23	15	18	31
Conv. & Hysteria	29	13	16	7	13	9	10	19
Psy. Dep	78	43	35	24	31	23	32	46
Epilepsy	34	11	23	9	12	15	11	23
Annoyness / Anxiety	71	42	29	17	34	20		
Nerv. Break down	17	11	6	3	9	5	45	26

Success of Assessment & Rehabilitation

The success of telepsychiatry clinics at Rajanpur depended on the availability of trained staff at the hub and remote stations, the efficiency of background data collection by staff, and the formulation of a comprehensive plan and its follow up with the patient.

The consulting psychiatrist classified the disorders as Mild, Acute, Severe, and rare occurrence. Since the treatment of Psychological disorders can be lengthy, it is necessary to maintain and update records through patient follow-up to monitor the progression of the disorder and the effects of the treatment overtime. The success indicators for the program such as feedback response of patient, their families, and their community were positive for different disorders. Overall, the rate of recovery for patients was 45 to 50%, which was a significant achievement (Table 4).

Table 4: Improvement level of Psychological disordered patients during 2009-2013

Improvement %	Freq	Gender		Disorders							
		M	F	Schizophrenia	Drug Depend	BPE	Conv. & Hysteria	Psy. Dep	Epilepsy	Annoyness	Nerv. Breakdown
0-10 %	9	7	2	4	12	1	0	3	7	5	0
11-20 %	37	24	13	3	45	3	3	7	3	3	2
21-30 %	73	51	22	9	42	4	2	24	8	22	1
31-40 %	260	181	79	5	67	9	7	14	13	16	4
41-50 %	123	96	27	12	27	13	11	9	1	9	6
51-60 %	72	62	10	11	27	11	4	11	1	5	1
61-70 %	11	5	6	5	38	6	2	3	1	9	1
71-80 %	5	2	3	2	11	2	0	7	0	2	2
Total	615			51	269	49	29	78	34	71	17

Conclusion

The resulting data presented above revealed an urgent need to explore such methods of treatment as telemedicine. In the West, a struggle to meet the needs of psychiatric services along with the developing advancements in the telecommunication industry has presented a magnificent mode to make medical care more accessible to the growing target population. Most telepsychiatry projects and programs have been reported from developed nations such as America, Australia, Canada, and certain European countries. In the developing nations, telepsychiatry has emerged initially as an offshoot of telemedicine and is still at a preliminary stage. Through the advancement and betterment of this system, programs can educate and improve understanding of psychological disorders.

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eHealth Medical Training Initiatives

Learning Opportunities: Teledentistry Contributions to Continuing Education in Brazil

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Introduction

Brazil has continental size. It is the fifth country in the world in size. Currently, its population is estimated at 206,08 million inhabitants [1], who live in 26 States divided into 5 different regions. There are 5,563 municipalities, all of them with considerable regional differences, regarding access to education and health services. Political analysts emphasize economic growth, political stability and poverty reduction as the main Brazilian positive characteristics.

Health is the universal right and the implementation of the National Dental Health Policy has been developed in Brazil since 2004. Some challenges faced by the Brazilian States have also highlighted the need for Continuing Education development, in order to improve all the required skills to operate in the Brazilian Unified Health System - SUS. In this field, the Nucleus of Brazilian Telehealth Program in Rio de Janeiro (UERJ) has been providing some activities in distance education such as live virtual seminars, which are recorded so that they can be broadcast and reused, and many courses all over Brazil [2].

In 2004, the directive GM 198 issued on February 13, 2004 established the Brazilian Policy for Continuing Education in Health. This document was responsible for the proposal of offering qualifying health care through the creation of new professional training techniques, recognizing work as a privileged space for pedagogical practices of formation and development for health workers and professionals. This proposal, however, demands the breaking of some paradigms, e.g. computer user literacy for health professionals; digital inclusion programs for the Basic Units of Health located all over the country; awareness to understand that learning at work is also a way of work, in other words, learning is not a waste of time, it means production and consequently, work. This paradigm shift is rather difficult to accomplish, especially if we consider all the repressed demand that causes the increasing of the mouth disorder rates in Brazil, although there have been some recent improvement in this area and we have witnessed a reduction in the mouth disease rate all over the country.

According to Rendeiro [3], Teledentistry enables us to use and stimulate activities concerning many technological areas, both in public health and in clinical. The use of information and communication technologies is an important resource for health, vocational training, continuing education, and research and knowledge management.

In the dentistry field, it is possible to assume that, the concept of Teledentistry - as a knowledge area integrated to Telehealth - has been growing considerably along the years, especially when it comes to interactive tele-education, tele-assistance and in the production of multi-centered researches [4]. In education, all the new information and communication technologies add a new dimension to the concept of telehealth. The idea that nowadays, society is globally interconnected and that our knowledge and our view of the world are usually incomplete and always being reprocessed, because we believe that somehow, we can continuously access all kind of information in a permanent basis [5], influence it.

According to [6], among the challenges for the extension and improvement of teledentistry, we highlight the concept of digital inclusion, due to the fact that health professionals are still not very familiar with the use of technology for information and communication. This lack of technological skills are liable to hinder their access to state-of-the-art tools and consequently, reduce the impact of teledentistry in the health outcome figures and rates. There are many discussions about the use of Telemedicine and Telehealth and how they may improve the efficiency of a health system, and all the benefits that they may generate. Yet, it is worth mentioning that we can only exploit their full potential when there is human resource commitment within the use of technology and an effective integration among all the participants aiming at adding all the efforts in order to multiply the results [7]. Therefore, the objectives of this study are to evaluate, uncover and map the pattern of access to two different courses in order to verify their nationwide reach.

Programa Brasileiro Telessaúde Brasil Redes – Brazilian Telehealth Program and UERJ Telehealth Center

In order to fulfill the commitment made in the Brazilian Federal Constitution of 1988, Art. 200, II which states the "order to training human resources", Brazil has adopted many strategies to overcome the difficult challenges to the development of the Unified Health System - SUS and consequently overcome and short the remaining and vast distance between supply, production and health demands concerning the organization of a network of health services. This network must allow users to access all the high-calls, humane care they need to fulfill their necessities through an efficient management model and the health professional training in order to develop all the necessary skills to help them work within all the levels of the system with quality and resolutivity [8, 9].

The Brazilian Telehealth Program, known as REDES [10], is a nationwide program that offers distance education, including online education courses addressing health professionals, who work with Primary Healthcare, and online seminars aiming at offering full-scale training for teleconsults and telediagnoses, improving population assistance services. This program was created in Brazil 10 years ago as the result of a successful experience of a national pilot project, which created State Centers of Telehealth in nine universities in Brazil, including the Centre of Telehealth at UERJ, Rio de Janeiro State University. The program is regulated and supported by the Brazilian Health Ministry [11]. It is also connected to other programs such as UNA-SUS, The Open University of the Brazilian Unified Health System.

The Centre for Telehealth was created at the Rio de Janeiro State University [12 – 14] in 2003. The program mission is to promote the use of information and communication technologies with the purpose of offering open and inclusive distance education to population and health professionals through teleassistance, teleconsults and telediagnoses. In that context, the programs use multimedia including not only virtual learning environments, but also teleconference software, web systems and applications developed by the teams. Among all the multidisciplinary and interdisciplinary actions taken, there are some groups, which stands out from the others, such as medicine, dentistry, nursery and physical therapy.

The Teledentistry group from UERJ, besides all the domestic activities in Brazil, has also assumed the coordination of the Working Group of the International Society for Telemedicine and Health. Among the results obtained, Figures 1 and 2 represent, respectively, the Brazilian users and the international partners of the Centre for Telehealth at UERJ. Moreover, since 2013, the Centre for Telehealth at UERJ is responsible for the only Graduate Program in Telemedicine and TeleHealth in Brazil, which has *international north-south* cooperation in science and technology - Professional Master's in Telemedicine and Telehealth.

Figure 1. Brazilian Map of the distribution of registered users on the platform of the Centre for Telehealth at UERJ, until February 2017.

Figure 2. Map of international coverage of the Centre for Telehealth at UERJ

We live the time of e-Health. The increasing use of Information and Communication Technologies (ICTs) have created new opportunities and challenges, propelling the development of artifacts, techniques and knowledge that provide more opportunities to use them in various aspects of life. Relational and behavioral technologies, neologisms, and also some concerns with the ethical and intellectual properties were included in the discussions, they are all complex issues related to these new dilemmas of our everyday lives.

The same happens to Dentistry and nowadays we face a virtual evolution in Teledentistry in Brazil, here understood as the use of ICTs to connect professionals, institutions and communities with large centres, encouraging discussions, exchange of experiences, expanding the effectiveness and quality of the care sector. The deployment and improvement of many actions in the context of the education, assistance, production and dissemination of knowledge allow the interaction among teachers and researchers of higher education institutions, health professionals, undergraduate and graduate students, public managers, national and international organizations.

All this national pioneering and global leadership set out with the Coordination of the Teledentistry Working Group (WG Teledentistry), taken in April 2012, during the Meeting of the international Society for Telemedicine and e-Health (ISfTeH), held in Luxembourg, has contributed to the deployment of various national strategies aiming at the dissemination and consolidation of Teledentistry. Teledentistry is a huge challenge, a process in construction, which requires the improvement and consolidation of networking, already being developed, as well as the maintenance of all cooperation promoted and the availability to keep learning and sharing the resources developed in a coordinated way so that time and cost can be optimized and assessment and planning can be continuous.

The supply of learning opportunities and services using ICTs allowed us to overcome many barriers, including the distance and isolation of some professionals working in the Brazilian Program known as Estatégia Saúde da Família (ESF), in English: Family Health Strategy (FHS), not only concerning continuous and permanent education, but also problem-solving situations, in which health professionals either have questions or are in a doubt, or even need to discuss a case during a decision-making process. It has also led us through a path of innovation, which has helped us understand the educational process incorporated in the service.

Considering the case of the program Atenção a Saúde Bucal, Oral Health Care, the context is not different whatsoever. The inclusion of Oral Health

Teams in FHS in 2000 and the implementation of the Brazilian Oral Health Policy in 2004 [15], have expanded the Family Health Teams with the incorporation of the Oral Health Teams. It has also expanded the supply of workstations, providing full scope of performance for the health professionals who kept on having their training based on the surgical-restorative model, not developing the required skills to work with Primary Care.

In Brazil, the consolidation and deployment of Teledentistry came from isolated initiatives in Centers that have integrated the Pilot Project. Each one of these centers bear particular characteristics in certain areas, including the Centre created at UERJ, which has presented greater development in Tele-education and the center in Rio Grande do Sul State (UFRGS), which has developed greater expertise in tele-consultancy and the building of second opinion formation in health.

An important initiative to integrate, share and empower Teledentistry actions and experiences national and internationally was the creation of the National Network of Teledentistry-RNTO (http://programa.telessaudebrasil.org.br/vhl/teleodontologia-em-foco/rede-nacional-de-teleodontologiae-nucleos). This Network is Coordinated by ABENO - Brazilian Association for Dental Education and The Teledentistry Center of the Dental School of the University of São Paulo - USP, in partnership with the Centers of Teledentistry of the Rio de Janeiro State University - UERJ and the one from Rio Grande do Sul State (UFRGS), and Secretary of State of Health of Mato Grosso do Sul (SES Mato Grosso do Sul) [16].

In the area of Tele-education, an important strategy implemented by the RNTO was the development and implementation of the Course Upgrading in Teledentistry: Teacher Training and Higher Education Institutions Support for the creation of Learning Networks and Collaborative Working in Health. The construction of the course was supported by ABENO and shared by the Centers of Teledentistry from USP, UERJ, UFRGS, SES Mato Grosso do Sul, through virtual meetings and workshops and on-site meetings carried out at USP, São Paulo University in Brazil. It aims at supporting and guiding professors from the Dentistry Coursers interested in implement Teledentistry Centers in their higher education institutions and integrate them to RNTO (more info at http://www.abeno.org.br/abeno-news/abeno-news44.html). For the discussion of experiences and sharing of knowledge and lessons learned, a second initiative created by RNTO was the development of a Special Interest Group - GIS, in Teledentistry as part of RUTE - Telemedicine University Network, Rede Universitária de Telemedicina, which consisted in a virtual space for the interaction between IES and Research (http://rute.rnp.br/web/sig-teleodontologia).

The international experience is characterized by the participation of General Coordination and Coordination of Teledentistry Core Telehealth Networks Brazil/ UERJ as members of the International Society for Telemedicine and e-health - ISFTeH, and the implementation of the Working Group - WG Teledentistry - assumed in April 2012. During the scientific event in Luxembourg, Med-e-Tel 2013 (www.medetel.eu), we have formalized the creation of the Teledentistry Working Group, including undergraduate and graduate students into all the activities promoted to disseminate Telehealth among all the new participants and contribute to its development, producing innovation, knowledge, techniques, results and impacts.

Objectives and Methodology

This study intended to evaluate, uncover and map the pattern of access to two different courses, in order to verify their nationwide reach. Among various courses offered and produced by UERJ Teledentistry Center, we have selected the two most accessible courses: "Pediatric Dentistry" (ODO, in Portuguese *Odontopediatria*) and "Atraumatic Restorative Treatment" (TRA, in Portuguese *Tratamento Restaurador Atraumático*) and the information about the number of enrollees and place of residence from 2011 to 2016. In addition, to analyze the problem-solving ability of Primary Health Care through Dentistry teleconsulting.

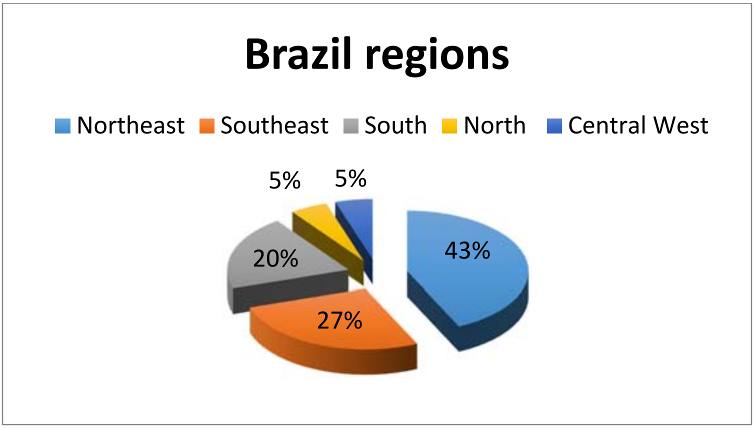
The study was conducted using the date base of the courses from 2011 to 2016, Telehealth / UERJ platform. All figures were organized in an Excel spreadsheet and analyzed in relation to the frequency percentage.

Results

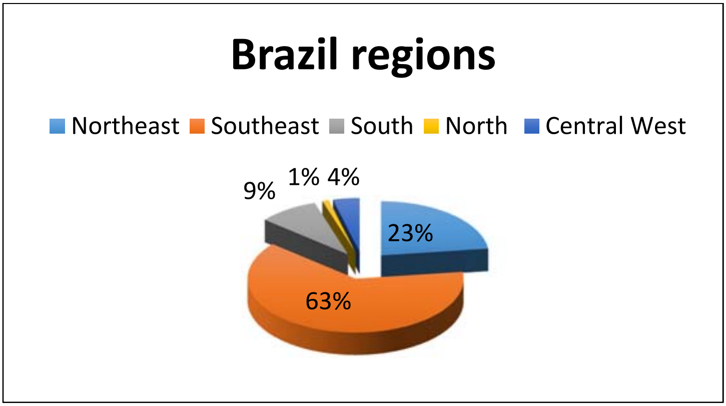
For the course named as TRA, out of the total number of participants (3508), 63% are from the Southeastern region of Brazil, 23% are from the Northeastern region and 9% are from the Southern region. The Central-West and South regions have shown fewer participants (1% and 4% respectively).

For the ODO course, considering the total number of participants (2836), 43% are from the Northeast, 27% from the Southeast and 20% from the South region of Brazil. North and Central-West have shown a smaller share (5% each).

Graph 1: Pediatric Dentistry Course accesses from 2011 to 2016 by Brazil regions



Graph 2: ART (Atraumatic Restorative Dentistry) Course accesses from 2011 to 2016 by Brazil regions

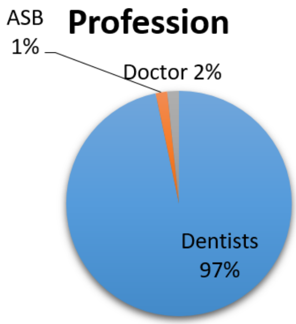


To analyze the ability of solving problems of Primary Health Care through Dentistry Teleconsulting, through data analysis, we have concluded that dentists (Graph 3) made 97% of all requests.

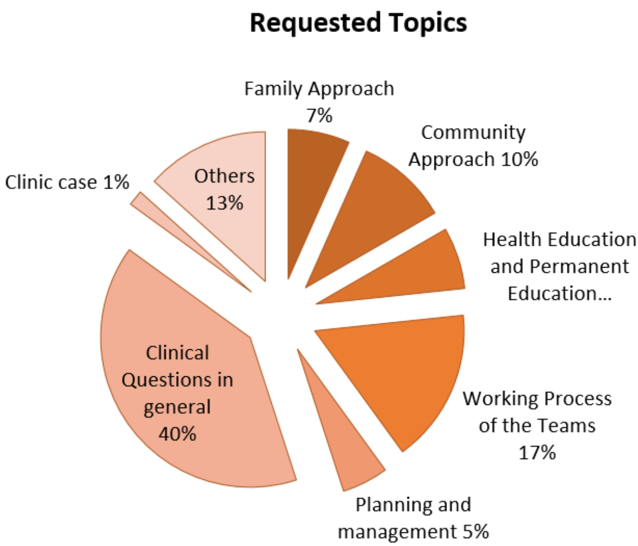
Regarding the requested topics (Graph 4), we have observed that 40% of teleconsultation address issues related to clinical questions in general, 17% are about the working process of the teams, 10% concern community approach, and 7% are both for family and for health education approach.

As for problem-solving capacity consulted, 98% of professionals reported that teleconsulting intervened in process, reducing the number of references to another level of care.

Graph 3: Professional Profile of the applicant



Graph 4: Requested Topics



Conclusions

According to these outcomes, it is possible to conclude that the courses offered and analyzed by Brazil Telehealth Networks/UERJ, located in Rio de Janeiro, Southeastern Region have national scope, offering learning opportunities for all dental professional from all regions of Brazil. They help with learning opportunities, overcoming barriers, including distance and the isolation of health professionals in health units in Brazil.

As for problem consulting, 98% of professionals reported that teleconsulting intervened in conduct, reducing the number of referrals to another level of care. All reported there was no need for specialist consultation to resolve the case. Based on data analysis, we conclude that the teleconsultation has contributed to the problem-solving capacity in Primary Health Care, reducing the number of referrals to other levels of care.

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Remote Interactive Training for Doctors Based On Video Conference Solutions

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Medical education, as no other area, requires an access to best practices and knowledge of leading practitioners: diagnosticians and surgeons, as even best in class course books. 3D films and modern simulators cannot replace clinical discussions with experienced doctors and communication with peers, while mastering new methods of diagnostics and surgeries. One would like to gain knowledge from best professionals, leaders in their areas. However, in real life it is not always possible, as renowned medical professionals do not work in the same clinic, let alone a city or country. In this regard, the advent of modern videoconference, tools are very helpful. They provide remote interactive communication based on high quality audio and video signal, simultaneous broadcasting of two video streams and in the near future – transmittance of a 3D image.

Our experience of remote interactive trainings for doctors in video conference format started with using inexpensive Intel and V-Con videoconference systems, PictureTel office systems and ISDN digital telephony. Notably, to provide transmission at speed of 24-30 frames per second (for broadcasting surgeries for instance) we had to use 6 to 8 digital phone channels. That increased the costs of telemedical lectures. However, the costs were still 10 times lower as compared to overall costs of a lecturer's trip to any remote region. Even larger cost saving effect was demonstrated during first remote video conferences that helped us promptly solve issues of diagnostics and treatment.

If we compare costs of a teleconference organized to diagnose and choose treatment for newborns with heart defects, they are 100 times lower than an actual trip of a patient and his family to Moscow Cardio-Vascular Center. It is also important to note that the telemedical project "Moscow to the Russian Regions", launched in late 1990s, and aimed at organizing remote trainings for doctors and telemedical consulting, revealed a high level of interest among the regions. The only constraints for our activities were the limited digital capacities and low budgets of clinics during the economic crisis.

With the development of digital telecommunications and a possibility to use HD video format, we moved to a new level of teletraining for doctors. Our aims were:

- To hold remote lecture courses as part of continuous postgraduate training for doctors;
- To involve the best Russian and foreign clinics for holding interactive master classes with on-line broadcasting of surgeries and diagnostic procedures;
- To offer remote telementoring for young doctors (primarily surgeons) by experienced medical professionals.

The idea of remote telelectures is to use multiple point video conference format based on high quality audio and video signal for full-pledged interactive communication between the lecturer and a remote audience of doctors. During the lecture, it is possible to organize clinical and medical case discussions or demonstrate any presentations, videos, medical research data, ECG, X-Ray images, etc. It is also possible to examine a patient by using diagnostic equipment. Maintaining contact between an audience and a lecturer might be problematic, however this challenge is set off by a possibility to attend lectures of renowned professionals from various cities and countries.

The idea of interactive master classes in videoconference format is to provide full-pledged interactive communication between the audience located remotely and an operating surgeon. Observing a surgery is possible by means of video cameras installed in the operating theatre and a camera on the surgeon's helmet. This approach allows to learn from the experience of a great professional as students can watch the surgery "through the eyes of a surgeon" (It is well known that often a surgeon has to keep his head low over the operating field and even his assistants can't see all the surgical procedures). It is important to note that video cameras in the operating theatre are controlled remotely (zooming, pointing a camera to an object, switching from one camera to the other). This is done from a remote classroom (except for a camera on the surgeon's helmet) and this allows observing work of an entire surgical team or some of its members. During many surgeries (endoscopic, X-ray and others) and diagnostic procedures it is important to provide a remote audience with two or more simultaneous video streams. An example is a case that enables at the same time to watch hands of an endovascular surgeon and an X-ray image of placing a stent or positioning an ultrasound sensor.

On top of that, there is a possibility of interactive communication. During on-line broadcasting, it is important to get a 3-D image of a surgery. That will provide for a good understanding of everything the surgeon does. However, this effect is impossible to achieve by means of a standard camera, therefore, we have developed a stereoscopic set consisting of a surgical helmet equipped with two miniature digital HD cameras with the same optical characteristics, means of control, etc. Several patents protect this development. Within two years, it was tested in such areas as neurosurgery, oncology, maxilla-facial surgery, laser surgery and others. It has proved to be very helpful during interactive master classes for practicing surgeons.

The idea of telementoring is rather simple. It is aimed at organizing interactive communication between a young doctor working at an operating theatre or a diagnostic room and his experienced mentor located remotely. In challenging circumstances, this format helps the young doctor immediately to apply his mentor’s advice and demonstrate acquired skills.

In conclusion: Modern videoconference technologies are effective for remote medical trainings (Table 1). However, we see a need in modernizing existing technologies with the account of specific goals of medical trainings, first and foremost, trainings of top-level doctors. Firstly, it is organizing simultaneous broadcasting of two videostreams, one of which provides stereoscopic images. Secondly, image quality has to improve up to 4K. Thirdly, these solutions have to be integrated with virtual reality technologies and that is very relevant for telementoring. Now we are exploring these areas together with Russian and foreign developers, R&D and educational facilities.

Since September 2015, a two-day course is conducted at the Department of Medical Informatics Medical University People's Friendship University (PFUR), for students of the medical faculty on the topic: "Telemedicine Fundamentals." The aim of the short cycle is to give students theoretical knowledge and, most importantly, practical skills.

Within 2 days, the students listen lectures by leading experts in the field of telemedicine technologies, from which they learn the principles of the organization of work telemedicine center (Table 2).

Then the students are directly acquainted with the specifics of the telemedicine center. Taking an active part in holding videoconferences between the leading medical specialists and students, the latter realize how effective the distance education is for improvement of the professional skill of doctors.

It is very important the students to be convinced of the possibility to broadcast lectures on a very large and remotely disparate audience. Via the examples of teleconsultations, students understand the importance and significance of remote consultations and become familiar with their scenario, i.e. preparation of clinical material, including the results of medical tests and the research itself, consultation, preparation and execution of the conclusions.

Table 1: The interactive training school during last two decades

1999 Teleconsultation Moscow - Yakutia

1999 Moscow, Lecture on pediatric neurosurgery

2004 Lecture for Russian doctors given in the University of Regensburg (Germany)

2004 Lecture for doctors from 12 Russian regions given in Moscow

2014 Demonstration of an endovascular procedure

2014 Demonstration of an open heart surgery

2015 Utilization of a stereoscopic set

2015 Stereoscopic set in neurosurgical operating theatre

2016 Broadcasting of an endoscopic procedure

2016 Broadcasting of an eye surgery

There comes a long awaited and so pleasant for all students standings. We do not advocate boring tests in the form of answering questions or tests that often do not correspond at all to the clinical work. Students must demonstrate in practice what they have learned. Without this offset, they do not pass successfully. However, the preparation for offset and the offset itself are so exciting experience that learning from the very beginning becomes the "meaning" and, therefore, everything becomes interesting.

In the standings, students must prove that they can actually work in a telemedical center and, if necessary, conduct remote consultation (as a consultant or as a doctor, requesting advice) and do everything professionally in order to graduate of PFUR.

So, how the set-off takes place?

In preparation, students are divided into several subgroups. Each subgroup has a doctor, who needs to advise the patient (a very complicated case, and should consult a specialist leading clinical center), consultant (center employee, the highly skilled) and a patient. The clinical case, which will be the subject of consultation, is selected or created.

The doctor and his colleagues are preparing a short message about the patient's clinical condition, choosing to display all the results of the clinical tests and prepare them for operational demonstrations.

Consultation takes place via video conferencing. The doctor reports and presents the patient. The patient may ask questions, too. The consultant, based on the data obtained from both the doctor and the patient, provides a conclusion or advices about the diagnosis and makes recommendations.

What's so complicated, you ask. Teleconsultation involves training and clear rules of conduct. That is what must be demonstrated to the students. They have to be convince that following the rules will ensure a successful teleconsultation.

Table 2. Students training

SALAMAT WIKI: An Experience of Collaborative Authoring for Health Content Creation

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Introduction

Technology alters habits and thus leads to a change in life style. Today, Information and Communication Technologies (ICT) and, subsequently, Internet play a crucial role in this regard. Now, for instance, many people seek the answers for their questions through search engines and websites, and one of the most important types of questions they may have is those concerning their diseases and health conditions [1]. Already one in 20 searches on Google is about a health-related issue.

Looking Up Health-Related Questions on the Web

When one has a bad headache, for example, he or the people around him immediately resort to search engines to look for explanation of this condition, its causes and types, and even ways to get over it. However, the problem is that the Internet is filled with a lot of information that is relevant or irrelevant, correct or incorrect, and reliable or unreliable. The question of reliability and validity can be the most important issue in this regard. Also, the availability of useful information regarding health differs from one language and culture to another. Hence, particularly in the issues concerning health, there is a demand for accurate and high quality information, in terms of both framework and content, in different languages [1].

Quality and Validity of Data & Information on the Web

High volumes of data available on the Web, on the one hand, and the fact that anyone having access to the Internet can increase these data, on the other hand, have led to a rather chaotic cyber atmosphere. Not only do these facts question the reliability and validity of these data, but they also call for the need to manage such vital information more properly [2]. For instance, when the search for the information about cancer in Farsi on Google was probed, only one of the ten results on the first page was from a reliable source, i.e.

The Cancer Research Center of Medical University of Mashhad, and the rest were of less quality and reliability.

Web 2.0 and Wikis

Web 2.0 is a set of economic, social, and technology trends that collectively form the basis for the next generation of the Internet - a more mature and distinctive medium, characterized by user participation, openness, and network effects [3].

The emergence of Web 2.0 and development of the cooperative culture in constructing the information on the Web have provided Internet users with many potential facilities, which lead to democratization, on the one hand, and increase of availability and quality of knowledge, on the other hand. Development of Wikis, particularly its unique instance 'Wikipedia', is a clear evidence of this fact. Following Web 2.0, concepts, like Health 2.0 and Medicine 2.0, are being designed and developed today.

A wiki is a Web application the content of which is collaboratively added, updated and organized by its users. A wiki's content is editable through a Web page interface. The site's users create the content, define the relationships, and establish the links between the site's Web pages [4].

Collaborative Authoring

Collaborative authoring concerns the activities involved in the production of a document by more than one author, the components of which involve pre-draft discussions and arguments as well as post-draft analyses and debates [5]. Based on this definition, the collaborative authoring process includes the writing activity as well as group dynamics. Another definition is "...any piece of writing, published or unpublished, ascribed or anonymous, to which more than one person has contributed, whether or not they grasped a pen, tapped a keyboard, or shuffled a mouse." [6] A wiki is a tool for collaborative writing.

Primary Framework of Such Health Wiki for Farsi Language Web

Investigating the Farsi-speaking community's tendency to look up their health-related questions on the Web and also the responses they receive, this project planned to set up a concentrated health wiki for patients. In other words, the main purpose of this effort is to design a Web-based responsible source for the people, tending to search for health-related information on the Web.

Considering the importance of validity and reliability of the health-related information, the primary purpose of this project was not to create a complete wiki but to set up its structure under the country's Medical Council or universities of medical sciences. In this project, all the doctors who are done with their general practice and final year medical students could be defined as the people who can enter the system and add or edit information on it.

Salamat Wiki in Its Pilot Implementation

The basic idea of this project and its primary framework were presented at Med-e-Tel 2012 in Luxembourg [7]. It took about three years to implement the initial phase of project in small scale (final year medical students of a university). Finally, Salamat wiki started as the first main project of eHealth Center of Tabriz Pars Clinic, which was supported by Community Medicine Group of Tabriz University of Medical Sciences and Information Technology Research Center of Tarbiat Modares University. For the first time, Salamat wiki was presented to the medical students in Nikoukari Ophthalmology University Hospital on January 7, 2015 (Fig. 1).

Fig. 1. The first presentation meeting of Salamat Wiki

This project was named Salamat Wiki. *Salamat* in Persian means "health" and/or “healthy”.

In order to select a suitable software application for Salamat Wiki, we did several studies. Most of the wikis in the world use open source software like Mediawiki. However, given the fact that our content creators are not IT specialists and they may have less computer skills or may not have enough time to focus on Mediawiki platform, we decided to design proprietary software for our wiki. In this software, a modular template was developed and a simple and user-friendly data entry form was created and launched on the domain http://salamatwiki.ir.

With the approval of the Faculty of Medicine, Tabriz University of Medical Sciences, and also, with the cooperation of Community Medicine Group, the introduction of Salamat Wiki to the final year medical students was made possible in April 2015.

Accordingly, a meeting was held every month for about 15 medical students, who were invited to contribute in this project as content creators.

For those who volunteered to collaborate, we created accounts so that they could access the platform.

By the end of the first year of pilot implementation, 11 meetings were held. These meetings revolved around two topics:

- Principles of training the community - Identifying needs, providing content tailored to the needs and level of understanding of the community and
- Learning how to insert content into wiki pages.

Structure of Salamat Wiki

In the first stage, Salamat wiki focused on a brief description of diseases. Structure of the page concerning a particular disease consisted of the following items: title in Persian, title in English, a descriptive picture, category, definition, symptoms, prevention, treatment, complications, information that is more useful and resources (Fig. 2).

Fig. 2. Home page and a sample disease page

Moreover, there were also some other pages or sections created along with any disease description page:

- *More complete description of disease,* which offers more complete or specialized information about a disease.
- *Discussion page* in which content creators and supervisors can talk about processes of creating and inserting relevant content regarding any disease. This page is visible only for users and

members of system and patients or other information seekers could not see the physicians' conversations.

- *Patient experience:* It is possible for visitors of wiki to add their own experience of any disease they suffer from. These experiences will be visible to anyone, contingent upon a system member's approval.
- *Page creator and contributors:* on the left side of the page opposite the title of each disease, the name of the creator of that page, who started the title for the first time, is written. In addition, if other users edit the content or add more data to the page, their names will show up as contributors under the name of creator. In fact, anonymous content is not accepted and users are responsible for authenticity and reliability of their entered texts.

In this website, any activities of each registered user are recorded in his/her file and a dynamic resume is created for each user; that is, their profiles show how many pages they have created or how many pages they have contributed to in the content creating process. This can encourage contributors to create more educational content for the public and community.

Mechanism of content creating is as follows: First, the user logs in and creates a page titled, for instance, Diabetes, and then inserts information such as definition and symptoms. Once this information is submitted, a second student can enter this page and add some other information to the symptoms and/or edits other information; such as a text regarding the treatment of diabetes. Other doctors and medical students can continue this process.

The process of content creating in this website is under supervision of specialist physicians and each category of diseases has at least one supervisor. Actually, these specialists are chief editors of their own fields. "Table 1" shows access levels in Salamat Wiki. In this way, contents are gradually being more complete, and website visitors could be sure that reliable individuals wrote the health-related contents.

In addition to the possibility of making a discussion between the supervisors and the writers in this system, there is also a supporting virtual group in a Telegram messenger, which is the most popular social media platform in Iran, where the members of Salamat Wiki can have more discussions with each other. There are many examples of the discussions that have led to more improved texts in this group.

In the period of pilot implementation of Salamat Wiki, about 150 physicians and medical students registered and 90 topics of diseases were created in less than a year. In addition, 13 specialist physicians cooperated with Salamat Wiki as supervisors and chief editors of several categories of diseases in this period.

Table 1

Access level	Title	Duties
1st level	Project management team	Overall supervision, creates or validates users' account
2nd level	Supervisors	Scientific monitoring of contents
3rd level	Wiki administrators	Monitoring compliance with rules of wiki
4th level	Content creators	Creating and editing wiki pages
5th level	Patients and the public	Submission of their experiences about diseases

Results

A year after the pilot implementation of Salamat wiki, the project promotion stopped to review and improve the tools and procedures; however, the created pages are still accessible and show up in the search engine results pages. Given the relative success of this project, a second collaboration agreement was signed with Alborz University of Medical Sciences to develop a similar process. Salamat wiki also won the 2nd Place Award for the medical education process at Shahid Motahhari Regional Educational Student Festival.

The following could be considered as the signs of the partial success of Salamat Wiki:

- One of the measures of success is the website's ranking on search engines, particularly on Google. It would be ideal if we could reach the first page of Google search results in most of the related key words. Now, Salamat Wiki is on the 4th page of google search reports on average. It is worth mentioning that we reached the first page in some key words.
- There are about 150 physician or medical students registered on Salamat Wiki, among whom 27 people were involved in content writing. There is also an additional number of users, who have not started writing yet, but are actively supporting the group and are contributing to the discussions. Given the fact that only 0.5% of Wikipedia users are active editors, these results are impressive.
- The pilot phase of this project was carried out with the cooperation of only one university. If more universities agree to collaborate

and the technical structure of the system improves, the results will also improve.

Special Features of Salamat Wiki

- Focus on describing diseases;
- Physicians and medical students as content creators;
- Specialist physicians as supervisors of each category;
- Modular structure of disease description page;
- Inclusion of the name of the author and collaborators on each page;
- Creation of a dynamic resume for each user;
- Ensuring the visitors of the reliability of the contents through linking the contents to the writers' profiles;
- Focus on presentation in scientific and educational organizations;
- Patient-oriented content creation.

Challenges of Salamat Wiki:

- Lack of motivation for content creators;
- Lack of a specific and full-time organization for content management;
- Simple and unattractive page designs;
- Lack of basic user registration form;
- Focus only on the North West region of the country in presenting activities;
- Focus on academic aspects and neglecting business opportunities;
- Focus only on diseases and inaccessibility of other health related useful information;
- Non-exhaustive software;
- Unclear promotion plan.

Conclusion

In addition to creating useful contents for patients and other information seekers, collaborative authoring on wiki simultaneously provides an opportunity for the cooperation and interaction between specialists and young physicians and helps the education process be more efficient in a community oriented way. In other words, wiki could empower patients and medical students and increase interactions between patients and physicians (Fig. 3).

Fig. 3. Education process and interactions between doctors and patients

On the other hand, the main challenge of a wiki is to motivate users to create contents. The founder of Mediwikis, one of successful health wikis, emphasizes that "One of the big challenges, when creating a wiki, is encouraging the contributors; after all, why would someone give up their time for free, to write a piece of information for someone that they will likely never meet?" Stuart Maitland continues: "We contribute information to "pay it forwards" to the next generation of patients and medical professionals. We feel ownership and academic self-esteem for contributing to the project and producing something that other students would find helpful".

Although such motivations can be useful for some of the content creators, the creation of content at an acceptable rate requires much stronger motivations. One of such motivating factors can be providing academic intensives for content creators. While universities allocate certain points for journal and conference publications in the academic promotion procedures, they do not value content creation in lay language on the Internet. Meanwhile, it is this simple information that can help educate the society, since the content in academic journals are not accessible to patients. Thus, incorporating the content creation in the academic evaluation systems would motivate the creators to produce a content with the goal of getting promotion in the academia rather than gaining direct financial benefits.

Hence, the use of such structures is recommended for other counties and languages, if the potential challenges of their implementation are well thought out.

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Conclusions

Lessons Learned and Future Trends in eHealth Application

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The text summarizes the lessons learned from over 10 years activities in telehealth. It was one of the results of the activities of ITU-BDT Study Group 2 Question 2/2: “Information and telecommunications/ICTs for e-health”. The text is part of Question 2/2 final report from 2017.

The mission of Question 2/2 (2014-2017) was to improve health by providing ITU Members with strategic information and guidance on effective practices, policies and standards in eHealth. It acted as a catalyst by creating, sharing and applying knowledge in ICTs to solve basic health issues. During the last Study period, the Question has focused on the necessary steps to assist the raising of the awareness of decision-makers, regulators, telecommunication operators, donors and customers about the role of information and telecommunication technologies in improving healthcare delivery in developing countries. It encourages the collaboration and commitment between the telecommunication sector and the health sector in developing countries, in order to maximize the utilization of limited resources on both sides for implementing e-Health services.

The following lessons were formulated for the healthcare policy and decision makers from developing countries:

Lessons Learned

General Lessons

Lesson 1: Terminology – the need for adoption of standardized terminology is evident

Even in the ITU contributions, different terms for one and the same service are used. The application of standard terminology will support coherent and consistent communication and documentation across all parties involved in eHealth services.

Figure 1: Necessary adaption of national laws to the modern way of working

Lesson 2: Networking and exchange of information at all possible levels – local, national, global, is a basement for successful eHealth adoption

Do not reinvent the wheel! There is a lot of expertise and information, successful stories and failures available and there are people to learn from. Exchange of knowledge is important for effective implementation of eHealth.

Lesson 3: Development of sustainable eHealth policy

Adaption of national laws to the modern way of working is a long lasting task. The reasons why such adaption is needed is illustrated in Figure 1.

Local and national decision and policy makers have to pay more attention to long lasting policy solutions and avoid solving issues just for the moment. Special attention has to be paid on:

- Inadequate funding and lack of ICT skills at all levels of healthcare system. A basic start is to adapt the medical students' curricula to the new realities, including more courses about ICT, eHealth and telehealth. Special interest may be the open source solutions as a cost effective software applications;
- Finding satisfactory local billing and reimbursement solutions as without such stimuli the wide and sustainable eHealth services cannot exist;

- Licensure and Scope of Practice (Standard of Care) must also be widely discussed and taken care of;
- One of the main roles of the authorities is to define the policy frame of eHealth implementation and development ahead in time.

Lesson 4: Strong governmental involvement through national eHealth master plan and/or application of ITU-WHO National eHealth Strategy Toolkit is another prerequisite for success

In addition, never forget that healthcare is a local issue, i.e. the delivery will always take place in a local or regional setting, and i.e. the local authorities have the crucial role for eHealth promotion. Smaller (local) administrative units can respond quicker and with greater flexibility to the healthcare demands of their citizens. This will ensure that the implemented eHealth services, are responding directly to citizens' needs. Regional authorities may also, with ease as compared to national administration, facilitate the early involvement of healthcare stakeholders as well as all interested parties, in the planning and development stages of eHealth implementation.

Organizational Lessons

Lesson 5: Selecting the right approach, involving local policy makers and coordination are vital for success of eHealth adoption

Lesson 5.1: Selecting the correct approach in eHealth implementation is essential.

There are two different approaches. The first one is a 'top-down' approach that focuses on developing policy, procedures, regulations and guidelines to aid decision-makers. The second is a 'bottom-up' approach, which begins with those who are mostly affected by the issues and attempt to develop consensus, recommendations and policy. Choosing the one and totally neglecting the other, is not the best strategy.

Let us not forget: Implementing eHealth is not exclusively a government's work! The top down approach has its benefits, but the same refers to the bottom up approach. Finding the balance is the beneficial strategy. The well-adjusted policy is a responsibility of local authorities. The practice revealed that policy makers at developing countries at any level, incl. regional and local levels, could act to enable, promote and support eHealth deployment but always have to balance this support.

The need for policy balancing act is illustrated at Figure 2 [1]. The balanced top-down policy support contributes to making healthcare more sustainable by wide application of eHealth that in turn will:

- Provide alternative ways of delivering healthcare;

- Ensure better and more equitable access;
- Use existing resources more efficiently and effectively.

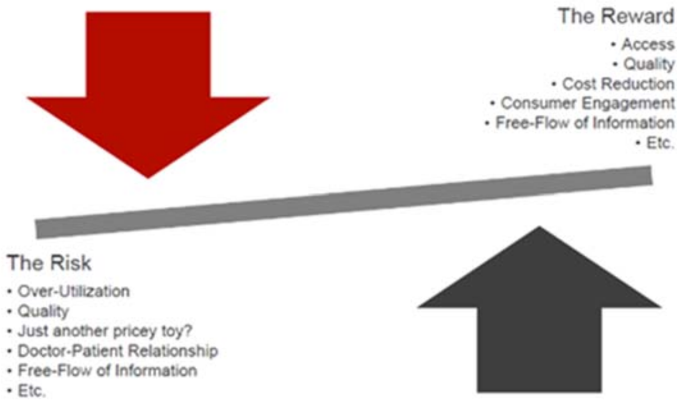

Fig. 2 The policy balance after [1]

Lesson 5.2: The selection of the technology– hard and software; the available network bandwidth; choosing mobile and and/or wireless techniques – these are significant challenges and the right decisions may pre-define the success or the failure of the eHealth implementation.

Lesson 5.3: Paying special attention to the early impact – services that have an immediate impact on users are vital.

Lesson 5.4: Management and support are essential to move from the pilot stage to wide implementation of eHealth services. Both may come from local or national authorities.

Lesson 5.5: Public-private partnerships may also be extremely successful.

Privacy, Security, Standards

Lesson 6: Development of eHealth policy and application of standards is necessary

Access to a secure communication infrastructure, standards and privacy and security of data and services are important but standards and legal documents take a long time to be developed. Yet, the usage of standards is mandatory, as this will ensure interoperability in a later stage of eHealth implementation. The role of the government in developing policies and application of standards is inevitable.

Concerning standards – technical or for the high quality of the services – no need to re-invent the wheel. Learning from the others will save time, efforts, money and help meet the future.

Future Trends

With all of the new smart application available today, it is not easy to make the correct decisions. To achieve viable, high quality, cost-effective healthcare, decision makers, at all levels, have to know not only the current situation but to have idea of the future tendencies, too.

What are the trend in eHealth development in the future? The [2] formulate them as:

- Big Data and Artificial Intelligence – the combination of both will give us the possibility to map and predict disease, risk factors, side effects, diagnoses and costs and follow citizens' health throughout their life.
- Distributed Healthcare, i.e. care is no longer available in only a specific physical locations. Patients may choose where they wish to receive help. In near future, they will be able to hold their appointments via video link, to be monitored at home or, when appropriate, to use online therapy. Using videoconferencing to provide at-home care for the elderly and mobility challenged is at the door.
- Smart Devices – they are already part of our everyday lives. Their introduction and acceptance has paved the way for numerous new products that will combine this kind of technology with smart materials and assistive devices. Internet of Things based devices that will significantly contribute to delivering health services.
- Interoperability – the future is in small interoperable devices.
- Electronic health records – their wide application is the nearest future. However, to make them usable across cities, states, and nations, it is necessary to invest ICT allowing those systems to communicate across the networks.

In conclusion, let us cite [2]. What we need is "*Courage and Determination: While not really a trend per se, decision-makers, users and patients will need courage and determination to successfully move eHealth in the right direction. On the other hand, given that we're staring down the barrel of an ageing population and escalating healthcare costs, do we really have any other choice than to boldly seize the solutions eHealth offers?*"

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