

The logo for Med@Tel features a stylized globe icon on the left, composed of several curved lines in shades of orange and red. To the right of the globe, the word "Med" is written in a grey, sans-serif font. A red '@' symbol is positioned between "Med" and "Tel". The word "Tel" is also in a grey, sans-serif font. A grey line starts under "Med", goes down, then right, then up, then right, then down, then right, ending under "Tel".

# Med@Tel

**18-20 April 2007**



THE INTERNATIONAL EDUCATIONAL AND NETWORKING  
FORUM FOR **eHEALTH, TELEMEDICINE AND HEALTH ICT**

PROCEEDINGS



Editors: **Malina Jordanova & Frank Lievens**

# **Med-e-Tel 2007**

*Proceedings*

*of*

*The International Educational and Networking  
Forum for eHealth, Telemedicine and Health  
ICT*

Editors

Malina Jordanova, Frank Lievens

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**Editors: Malina Jordanova, Frank Lievens**

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## **eHealth, a key element of tomorrow's state of the art healthcare!**

Health is certainly the most important asset to everyone. Everywhere in the world, health professionals are devoted to promote, restore and maintain this priceless asset. Within our different healthcare systems we devote our energy to one common goal: ensuring the well-being of patients by safeguarding the highest level of healthcare possible.

The importance of health to our citizens is increasing and today the healthcare sector is a strong economic element and a real job-machine. This service-providing sector is growing strongly, however the services provided in this field should not be seen as standard commercial services! These services are a lot more! Free access should continue to be guaranteed to all our citizens, independent of their economic and social background, at the best possible quality level. I therefore strongly believe that the large amount of community funding that goes to the health sector and to research in this field, including health ICT, is generally well spent.

The health sector is and will be a very dynamic economic factor in the future. Recognizing the future potential of health technologies in general, I strongly support the efforts undertaken under the lead of the Minister of Economy and Foreign Trade, to promote Luxembourg as a prime location for health technology industry.

It is widely recognized that information plays a very critical role in provision of healthcare. Professionals need accurate and reliable information in terms of patient data, as well as accurate medical information concerning state of the art treatment and diagnose methods. By facilitating the sharing of this information, ICT can play a key role in healthcare provision. It is foreseeable that today's paper-based approach will have disappeared in tomorrow's state of the art healthcare. ICT solutions in health can also supply important tools to promote healthier ways of living and support prevention. ICT is a privileged tool to offer our citizen the best possible healthcare, to avoid harmful side effects and overmedication, to facilitate benchmarking and comparisons and to allow a modern and efficient management of our health services.

New technologies will open up new opportunities for healthcare professionals and patients. Better information will lead to better-informed, empowered patients and new ways of providing care. eHealth solutions facilitate treatment of patients in remote areas and more generally homecare.

This also means that significant challenges lie ahead: we will have to adopt new innovative eHealth solutions, manage the organizational, financing and regulatory issues involved and, last but not least, explain the benefits to professionals and their patients. The Luxembourg Government is aware of these challenges and actively working to address them. End of 2006, Luxembourg has therefore adopted its first eHealth roadmap.

Many innovative new ways of treatment and evaluation of quality will spread in the near future: electronic decision support systems, telemedicine, automated remote diagnose and monitoring systems, quality assessment tools ... many examples of those new innovative concepts and technologies are shown and discussed during this year's Med-e-Tel Conference. My congratulations and gratitude to all those involved in making this international forum for eHealth, telemedicine and Health ICT happen!

eHealth solutions have a tremendous potential we can't yet fully oversee. Many Governments, NGO's and industry are working today on shaping state of the art solutions, to be able to provide tomorrow's patients the best available healthcare. Our common challenge is to work together and share knowledge wherever it is possible. The Med-e-Tel Conference 2007 contributes to this process by presenting and discussing many of the very promising achievements in research and development.

Ladies and Gentlemen, let me conclude by stressing two important points we should stay aware off: first of all, whatever the merits of the technologies of the future are, we should never forget that the patient has to stay at the centre of all our efforts. Secondly, it is true that medical technologies can support healthcare. However the technological potentials and opportunities will only become reality in a collaborative approach, implying all stakeholders and making future solutions as user-friendly as possible.

Mars Di Bartolomeo  
Minister of Health  
G.D. of Luxembourg



LE GOUVERNEMENT  
DU GRAND-DUCHÉ DE LUXEMBOURG  
Ministère de la Santé

## Foreword

Over the past decades, evolution in medical research and technologies, cultural, social and demographic changes and globalization have confronted healthcare systems with new situations and subsequently require new solutions. The ultimate goal becomes that of delivering the best possible health service for anyone, at any time, from anywhere.

The dramatic increase of interest and application of ehealth/telemedicine during the past twenty years resulted in investments of billions. Nowadays, the integration of ehealth into the everyday life of medical staff and patients is a reality in developing as well as developed countries.

Med-e-Tel (The International Educational and Networking Forum for eHealth, Telemedicine and Health ICT, <http://www.medetel.lu/index.php>) focuses on the convergence of information and communication technology with medical applications, which lead to a higher quality of care, cost reductions, workflow efficiency, and widespread availability of healthcare services.

The aim of Med-e-Tel is to establish the scope of this modern communication health environment and to draw the lines of international action based on an overview and comparison of the current status of ehealth in numerous countries. It also stresses the major challenges involved in making several different industries coordinate their skills and efforts in order to achieve an optimal development within the healthcare environment using modern communication systems, before focusing on the role of networking for the successful implementation of ehealth.

In order to achieve its goals, Med-e-Tel brings suppliers of specific equipment and service providers together with buyers, healthcare professionals, institutional decision makers and policy makers from many countries around the globe and provides them with hands-on experience and knowledge about currently available products, technologies and applications. Med-e-Tel is a forum where state-of-the-art products, ideas, projects, and so on are presented and discussed. Year after year it becomes a breeding



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ground for new cooperations and partnerships between scientific groups, healthcare institutions, industry associations, SMEs and large corporations from all over the world.

The Med-e-Tel 2007 edition called together participants from over 50 countries. International organizations like WHO, ITU and EC were just some of the major players that took part in the event.

The preparation of these Proceedings is one example of our work together with many partners from all over the world. eHealth/Telemedicine is without doubt, an ICT application that will bring the benefits of health care and medical services to many countries. Many have already recognized it, and we see a rapidly increasing number of ehealth/telemedicine projects and partners. We are convinced that these Proceedings will provide you with useful information on various ehealth and telemedicine systems and solutions, on the benefits and problems that were encountered during or after implementation of ehealth and telemedicine systems or services, on lessons learnt, and thus will help those undertaking projects in the emerging ehealth/telemedicine needs of their own countries.

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Producers of the Med-e-Tel Exhibition and Conference

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## **Preface**

Papers provided in these Proceedings were compiled for and presented at the Med-e-Tel 2007 (The International Educational and Networking Forum for eHealth, Telemedicine and Health ICT). The event was held at Luxexpo, Luxembourg, Grand Duchy of Luxembourg 18-20 April 2007.

At the very beginning, it is necessary to clarify that:

- The sessions are listed in the order of their actual presentation, while the papers in the sessions are arranged in alphabetical order.
- Only papers that were submitted on time and were prepared according to the rules are included in the Proceedings. The full-size format was no more than 4 pages for regular papers and 6+ pages for invited papers
- The Proceedings do not represent a textbook on ehealth/telemedicine.
- Despite the fact that papers from so many countries are included in the Proceedings, the collection does not represent an overview of ehealth /telemedicine achievements worldwide.

The Proceedings is a collective experience of colleagues from different continents and different cultures. It is an eclectic collection of essays.

The aim of the publication of these Proceedings is to permit those who are planning to introduce ehealth / telemedicine applications in their regions or countries to rely on experiences of others in order to avoid mistakes and to reduce potential problems.

We hope that anyone involved in ehealth / telemedicine will find these Proceedings extremely interesting. We also hope you will enjoy your reading.

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## **OPENING SESSION**

# CONVERGING BIOTECHNOLOGIES TO IMPLEMENT E-HEALTH KNOWLEDGE SHARING

G. Tritto

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**Abstract:** Converging BioTechnologies - NanoTechnologies, BioTechnologies, Information Technologies and Neuro-Cognitive Sciences - NBICS for improving Human Performance and Healthy Condition opens new opportunities and challenges in the developments of new BioEconomies.

Convergence of NBICS Technologies is based on physical unity at the bio- nanoscale and on bio- technology integration from that scale. New revolutionary approaches in Health Sciences are expected from the joint soldering between the NanoSciences and the Molecular and Biophysical Biology through key computational transforming and developing tools. BioKnowledge Centers and BioDataBases Libraries can support developments in systems approaches, mathematics and computation for NBICS to understand the BioLife, the impact on human society and the evolution of the scientific research as closely coupled in complex, hierarchical and transversal systems.

Improvement of human performance through integration of new generations of Bio Technologies generates a new virtual scenario for the Health-Knowledge sharing and implementation in bio-medical compunetics, predictive, preventive and regenerative medicine, and disabilities. A global, virtual e-Health Knowledge sharing network can play a major role in information and communication, monitoring and evaluating the governance of the entire research process and subsequent technological developments and the extent to which healthy, not-healthy and disabled persons and their values will be supported and protected.

**Keywords:** 1. Biotechnology 2. NanoTechnology. 3. E-Health 4. Bio-Knowledge

## **Introduction**

NBIC (Nanotechnology – Biotechnology – Information Technology – Cognitive Science) Strategy, proposed from NFS report in 2002, gives the opportunity to present a large platform on which crescent and strategic technologies can be implemented in Health and Health-Care with a global approach, linking new economies and bioeconomies for sustainable development to the accelerating changes of the technological innovations.

Advanced and innovative concepts of Health, linked to the Human Performances, Qualities of Life, Cognitive Enhancement, Pharmacogenomics, Regenerative Medicine and Cell Therapies, are focalized on the huge compartments of the healthy, working populations, on the healthy populations living in state of vulnerability as old people, children, mother and child, and on disabled people, not only to apply predictive and preventive medicine strategies, but also to improve their intrinsic capacity building in the social-economical and environmental cohesion for regional growths.

Convergence of NBICS technologies is a scalar process, from macro dimension to very subtle, inframicroscopic and submolecular dimensions. . New revolutionary approaches in Health Sciences are expected from the joint soldering between the NanoSciences and the Molecular and Biophysical Biology through key computational transforming and developing tools.

The fundamental role of ICT tools derives from the basic, elementary link through the scales: information and transfer of information, with the storage of information content and the generation of a dynamic, temporary, knowledge and of the acquired, hardware embedded, knowledge.

### **Fundamentals of Knowledge in NBICS: BioInformation and BioKnowledge**

BioKnowledge Centers and BioDataBases Libraries can support developments in systems approaches, mathematics and computation for NBICS to understand the BioLife, the impact on human society and the evolution of the scientific research as closely coupled in complex, hierarchical and transversal systems.

### **Converging Technologies and BioTechnologies transforming Medicine**

Bioconvergence is a new term in which advances in genetic engineering, advanced computational processes, nanobiology and synthetic biology are leading to reshape the economies of the world and perhaps even the very definition of life itselfs.

Updates in molecular genetics, biomolecular and physiological modeling software, advanced genome cloning and synthesis technologies, and developments in synthetic tissue and organs, bioinformatics and related computing, IT resources, and an ever more diverse range of interrelated technologies are forging the progenitors of an ultimate example of convergence as a process, as a business and economic model, and as a socioeconomic paradigm of a transglobal, unparalleled, and absolutely irreversible transformative nature: at the end the biological engineering and bio-economy future of the entire planet.

### **Synthetic Biology and Trans-humanism: Bio-security and Bio-safety**

Synthetic biologists study the control and design of biological components and new organisms to solve a host of important health, energy, and environmental problems that cannot be solved using naturally occurring biological entities. The inherently multidisciplinary field draws on innovative research in chemistry, molecular biology, bioengineering, physics, and computer science. It is consequent that technological advances need new rules, concerning Security and Safety.

Synthetic biology programs will face up to security issues: to address the potential problems before the reality is not an intellectual exercise, but it is a matter of Ethics of Science and Technology. Training for responsible Governance in applied research for innovation and sustainable development and bioindustry for bioeconomy is a major role of the UN international agencies, especially into the areas of Education and Science.

From Understanding to Action in BioSafety and BioSecurity involves the choices of the international communities at the Education and Knowledge Transfer, Science and Technology, Industry and Government, Product-Technology platforms to fund Community-Based Options for Improving Safety and Security in Synthetic Biology

On the other side Synthetic Biology will face up to the values and the perceptions of what means to be "healthy", "disabled" and "suffering people" and to the socio-economical strategies on Health and Health-Care of the populations in the global world asset and at the level of the regional bioeconomies.

### **ICT, BioKnowledge Sharing and e-Health**

Improvement of human performance through integration of new generations of Bio Technologies is creating a new virtual scenario for the Health-Knowledge Sharing and implementation in bio-medical compunetics, predictive, preventive and regenerative medicine, and disabilities. A global, virtual e-Health Knowledge Sharing Network can

play a major role in information and communication for BioLife and Health Sciences, in monitoring and evaluating the governance of the entire research processes and subsequent technological developments and the extent to which healthy, not-healthy and disabled persons and their values will be supported and protected, using ICT services and providers for Health worldwide.

BINTEL Project: ICT for Knowledge Transfer in BioTech for Health

UN Millenium Development Goals and UN–UNESCO Decade of Education for Sustainable Development put at the goals of their objectives “Man and his Biosphere”.

BioLife and Human Life are strongly intermingled and interdependent for BioDevelopment and BioEnhancement for the so-called Bio-Economy.

ICT-Networking will permit to develop the intelligent (ICT-I) platforms for human needs and for dynamic interfaces with the natural environment for the next generations on the emerging knowledge societies of the global village.

Biotechnologies offer new perspectives and represent a new challenge for Humanity to understand BioLife and to shape on continuous dynamics the capacity building process of Man and his Biosphere:

1. To educate people to the biological values and resources (BioLife) to bring BioSciences and Knowledge for Health closer to the people.
2. To develop Knowledge Centers on Bio-Sciences and BioTechnologies for Sustainable Development, to generate permanent education network for new generation of teachers.
3. To stimulate the generation of Creative Cultural BioEnterprises, linked human creativity resources and innovation biotechnologies, collected in bio-clusters for bioincubators’ networking.

The convergence of BioTechnologies and LifeSciences with other technologies, such as nano(bio)technologies and information technologies will educate professional and non-professional operators to find solutions that bridge Life Sciences and BioTechnologies for a knowledge-based bio-health awareness and strategy, constituting a veritable sustainable strategy for human development and environment regeneration.

Thinking Bio is thinking globally; bringing bio-knowledge through biotechnology closer to the people is to fund the new balance between Man and his BioSphere in a Knowledge-based Bio-Economy.

# TELEMEDICINE IN INDIA – THE APOLLO STORY

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## Introduction

With 7000 beds, 44 hospitals and 4000 consultants in 50 specialities it is no surprise that Asia's largest healthcare provider, the Apollo Hospital Group also runs the oldest and largest multi speciality telemedicine network in South Asia. The growth and development of Apollo Telemedicine Networking Foundation is a story by itself. These success stories served as a catalyst for others in India to join the bandwagon. and make telemedicine a reality. The challenges faced and the methods implemented in introducing a paradigm shift in a developing country will be discussed.

Today ATNF has 102 peripheral centres including seven overseas. Their location ranges from the Andaman and Nicobar Islands, Mizoram in north-eastern India to Lagos in Nigeria. Teleconsultations have covered most disciplines ranging from sexual medicine to neurosurgery. Patients have been evaluated from distances varying from 200 to 2800 km. Videoconferencing has been used for participating in regional, national and international medical conferences. Tele lectures from different parts of India are made available to postgraduates regularly. A pilot project involving telemedicine through a mobile hospital on wheels has been completed. These tasks were not easy. There were trials and tribulations. Changing the mindset of the people was even more difficult than getting funding and technology. India with its multicultural heritage and diversity is indeed a paradox. We have regions where drinking water is not available and at the same time we make, launch and recover our own satellites.

### *Telemedicine – The Apollo Experience*

About 19,000 teleconsultations have taken place with Apollo Hospitals Chennai in the last 7 years, the flagship hospital of the group. 80% of the teleconsults are tele reviews. As most of the centers are located in suburban and rural areas, the use of tele monitoring equipment like ophthalmoscopes, endoscopes etc are not used. Facilities are available for tele auscultation and for viewing an Echocardiogram live in a few centers. ECG's, plain X-rays,

CT scans, ultrasound pictures, and other reports are either scanned and emailed or directly viewed from an illuminated x ray lobby at the remote end. Though HL7 compliant user-friendly state of the art software is available at the tertiary centers, this is still not routinely used at the remote center. It is extremely difficult to standardize the protocol at the remote end and to ensure that the software is always used. Most often a high school graduate operates the remote center. Interaction is not always in English. About six different languages are commonly used. Frequency of teleconsultations in a discipline, depends primarily on the enthusiasm of the consultant. Thus, teleconsultations may be lower in a specialty, even though the incidence and prevalence of diseases is higher.

The largest user of the telemedicine facility is *Dermatology*. Excellent photographs are transmitted from digital cameras, obviating the routine use of Dermoscopes. Patient satisfaction is found to be very high. Psychiatry follows a close second, accounting for about 20 percent of the total telemedical consultations. Time taken for a teleconsult in Psychiatry, varies from 15 to 40 minutes. Most teleconsultations are recorded after obtaining permission from the patient. The cost for a consultation varies from 10 to 12 Euros. This includes cost of transmission and the consultant's fees. Travel costs alone would have been 30 to 45 Euros. *Neurology and neurosurgery* tele-consultations include detailed clinical "examination" of pseudo seizures, involuntary movements, Parkinsonism, myopathy etc. [1, 2, 3] Several seriously ill head injured patients were managed by the local general surgeon, including evacuation of an acute sub dural hematoma, and excision of compound depressed fractures of the skull, with the confidence, that online neurosurgical video teleconsultation is available [4]. 2285 patients in remote areas with neurological afflictions (medical and surgical) have been evaluated through telemedicine. In all neurological and neurosurgical cases, the teleconsultant is able to give a definite opinion and guide the local physician. Some cases require management in a tertiary care hospital. Details of the treatment are discussed in detail with the patient and the family, so that they are well informed and fully prepared (e.g. Meningoceles, Metastasis) other cases like tuberculoma brain, cysticercosis brain were managed by the family physician under the supervision of the specialist. These tele discussions are of considerable help. Tele consultation was particularly useful in the follow up of already treated patients. *Sexual medicine* is a specialty, not available even in many tertiary hospitals. More than 225 teleconsultations have been given in this discipline alone with gratifying results.

### *The Aragonda Story*

Commissioning the world's first VSAT enabled, modern secondary care hospital in the village of Aragonda, on March 24<sup>th</sup> 2000, Bill Clinton, the then president of the USA, said “ *I think it is a very wonderful contribution to the healthcare of the people who live in rural villages and I hope that people all over the world will follow your lead, because if they do then the benefits of the Hi-tech medicine can go to everyone and not just people who live in big cities*”.

This pioneering attempt to make available secondary and tertiary medical expertise through satellite was started as a pilot project in a village called Aragonda (population 5000). 16 km from Chittoor, a district in the State of Andhra Pradesh in South India. (Fig 1) This 50 bedded hospital was equipped with a CT scan, an ultrasound, ECHO, automated laboratory equipment, an incubator, TMT, PFT and Endoscopy. Initially a paediatrician and a general surgeon were available in addition to four general duty doctors. Emergency and Trauma Services is available with one Ambulance. Today, the hospital has 9 consultants, 5 Residents, 37 Nurses, 12 Technicians, 63 other staff. Every month 200 in-patients are treated. 2953 surgeries have been carried out so far.

Simple web cameras and ISDN telephone lines were initially used. Video conferencing systems and a VSAT (Fig. 2) supplied by the Indian Space Research Organisation was subsequently used for a proof of concept validation, that telemedicine to villages in India is feasible. In the last 7 years, almost 2000 teleconsultations have been given to the poorest of the poor to those in and around this village (Table 1 and 2), 250 Echocardiograms transmitted from the village of



Fig. 1 Location of Aragonda village



Fig. 2 Aragonda Village VSAT enable

Aragonda were seen live in Chennai.

Every Tuesday morning a tele grand round takes place in which all the super specialists from the Department of Paediatrics interact with the doctors in the village through VSAT. Children with complex conditions get the benefit of expert advises. The residents at the tertiary hospital in Chennai have an opportunity to study diseases occurring in faraway places. During the last 54 months more than 200 grand rounds have taken place from Chennai. These CME programmes have helped augment the standard of medical practice in Aragonda

A specially designed software (Mediscope) was initially used and the clinical history and physical findings transferred from Aragonda. Images of x rays and ultrasound were scanned, compressed and sent thro ISDN lines (64 x6 384kpbs). CT images being DICOM compatible were directly electronically transferred to the telemedicine computer for onward transmission to Chennai. Most of the teleconsultations were initially off line – store and forward. The tele consultant’s opinion was sent back to the primary physician. There were no fixed hours for tele consultation – a medical officer being available at the telemedicine unit at Chennai from 9am to 5 pm. Arrangements are now being made to provide emergency tele consultation as well. When the tele consultant wanted to

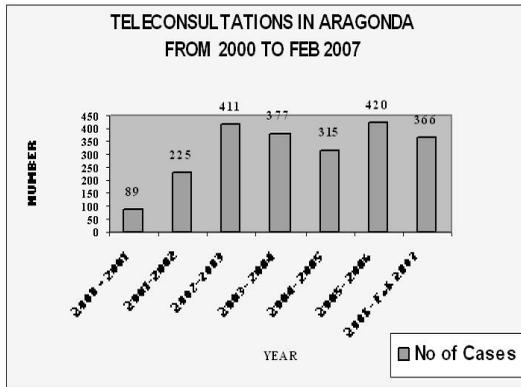


Table 1 Teleconsultations in Aragonda

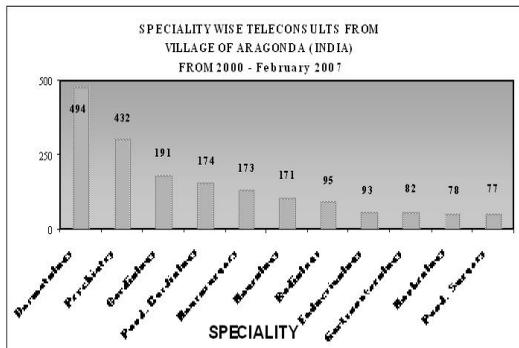
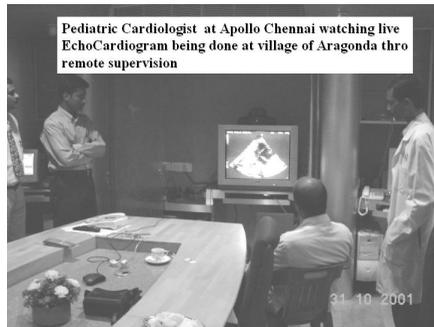


Table 2 Teleconsultations in Aragonda

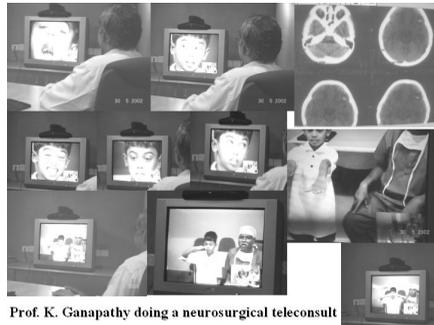
directly interact with the primary physician and the patient, a “net meeting” was initially arranged. Later on with availability of better infrastructure a formal videoconference was held using state of the art video conferencing equipment. All such on line interactions were recorded and stored. Some cases required management in a tertiary care hospital. Details of the treatment were discussed in detail with the patient and the family so that they were well informed and fully prepared. Interestingly the acceptance of tele consultation by the rural patient, the sub urban doctor and the suburban community was much better than expected. None of them were really averse to a tele consultation. The tele consultants have also accepted this new method of interacting with a patient. Detailed evaluation of the socio economic benefits needs to be done.

What started as a proof of concept validation in 2000 has turned out to be a super success story. It is not only the 2300 villagers in the region who had teleconsultations who have benefited, not only their families, not only the doctors in the village hospital who are essentially having daily CME sessions, not only the city consultants who now know what rural medical practice, but society as a whole. During the last 7years we have proved that Geography has become History. Aragonda served as a catalyst to energise the Indian Space Research Organisation to VSAT’s for telemedicine. Today 165 peripheral hospitals are connected to 35 super speciality hospitals through VSAT’s. As the world’s first VSAT enabled village to have telemedicine ARAGONDA has indeed been an eye opener. What India needs today is 100,000



*Fig. 3 Live Echocardiogram being viewed*

today distance is meaningless and that



*Fig. 4 Demonstration of a teleconsultation by a cardiologist at Apollo Hospitals Chennai*

Aragondas...*Improbable- Yes. Impossible- No!*

### **Hospital- on-Wheels**

As part of the DISHA (DIStance Healthcare Advancement) Project, 4070 patients were seen, from 1<sup>st</sup> July 2005, to 30<sup>th</sup> November 2006, at a village in Theni district, 90 km from Madurai a city in Tamil Nadu in South India. The air conditioned Hospital-on-Wheels (Fig. 5), has an x-ray machine, an ultrasound scanner, an echocardiogram, an ECG, a mini biochemistry laboratory, microbiology collection facility, an examination couch and a toilet. 142 laboratory tests were done including hematology, clinical pathology, biochemistry, histopathology and microbiology. 248 X- Rays, 138 ECG's and 58 ultrasounds scans of abdomen were done. An NGO carried out preliminary studies, created awareness and worked out the logistics with the villagers. Using an ISRO enabled VSAT, real-time teleconsultations, through the video conferencing equipment on the van, were obtained. 63 patients were referred for tertiary care management. Satisfaction levels among the villagers, who, through this hospital-on-wheels, had access to specialist healthcare, were high. As a pilot project the hospital-on-wheels, was a win-win situation for the tertiary care hospital, which could increase its reach, for the rural population and for the healthcare delivery system as a whole. However long term sustainability would imply major subsidies and availability of health insurance. Many problems were encountered in establishing connectivity from the mobile van.



*Fig. 5 Telemedicine for Hospital- on-wheels*

### **Growth of ATNF**

During the last 7 years 92 centres have been set up in different parts of India besides 7 centres in Colombo, Dhaka, Lahore, Maldives, Lagos, Yemen, Sudan and Kazakhstan. Centres in India extend from the Andaman and Nicobar islands to Mizoram in North Eastern India. The tertiary care Apollo hospitals at Hyderabad, Delhi, Ahmedabad, Madurai and Kolkatta also act as referral centres. Telecamps enable a specialist to see several patients one after another.

### ***Other uses of Video Conferencing***

The Telemedicine department of Apollo hospitals Chennai was the only unit from Asia, which took part in The 1<sup>st</sup> Arab International Conference on Telemedicine in January 2001. Subsequently a paper was presented from Chennai, at an International conference on telemedicine at Upsaala Sweden in June 2001. This was an Intercontinental Live multipoint Symposium between Europe, Africa, Asia, Australia and Americas on the topic “Telemedicine as a tool for a more equitable distribution of health care delivery around the world” Video conferencing is an inexpensive way of projecting the state of the art facilities available in India to a global audience. In August 2001 the Dept of Neurosurgery had a two-hour teleconference with Fujitha Health University, Nagoya Japan. This international grand round went off without a hitch. A similar meeting followed UDMNJ New Jersey in December 2001. **Since then 108 regional, national and international videoconferences in different medical specialities have taken place.** . These conferences augment the skills of those taking part. One’s perspectives are changed and we start thinking globally. In addition, a surgical and a paediatric tele CME takes place every week. The faculty is in Chennai and the residents in other hospitals dispersed all over India.

### ***Role of ATNF in growth and development of Telemedicine in India***

As a pioneer in telemedicine, ATNF has played a significant role in the growth and development of Telemedicine in India. It has been on the Standards Committee on Telemedicine ([www.mit.gov.in/telemedicine/home](http://www.mit.gov.in/telemedicine/home)), the National Task Force on Telemedicine, the Working Group on Telemedicine of the Planning Commission and the Working Group of the SAARC committee on Telemedicine, ATNF has been selected by the Govt of India for the mega project to provide teleconsultation and tele education to the 53 countries of the African Union. The crusade for popularising telemedicine has included the presentation of more than 120 papers in regional, national and international meetings. About 40 papers have also been published. Telemedicine is also an excellent CME medium educating the non-specialist. The knowledge that a specialist is only a mouse click away, does wonders for a rural physician’s morale. Tele-medicine is changing the way healthcare will be delivered to the common man, No more, would those in rural India have to travel to nearby metros or state capitals to avail of specialty treatment. Though scores of pilot projects have been launched, progress has been excruciatingly slow, due to paucity of capital

infrastructure or perhaps more important the lack of commitment, involvement and refusal to change the traditional mindset.

It is our dream and hope that within the next few years there will be telemedicine units in most parts of suburban and rural India. Eventually no Indian will be deprived of a specialist consultation wherever he/she is. Consultation will soon be only a mouse click away!! This is not impossible. For this to happen, a critical mass must be reached. What is required is not implementing better technology and getting funds but changing the mindset of the people involved, awareness should permeate throughout society. Real growth will take place only when society realizes that distance is meaningless today, and that telemedicine can bridge the gap between the “haves” and the “have-nots,” at least in so far as access to healthcare is concerned.

### **Acknowledgments**

We are thankful to the founder chairman Dr. Prathap Reddy, Mrs. Preetha Reddy Managing Director and Mrs. Sangita Reddy Executive Director of the Apollo group for providing the encouragement and the necessary infrastructure, which enabled the starting of telemedicine.

### **References**

- [1] Ganapathy K - Telemedicine and neurosciences in developing countries: Surgical Neurology. 58: 388 – 394, 2002.
- [2] Ganapathy K: Telemedicine and neurosciences A review. Journal of Clinical Neurosciences Nov, 851-862, 2005.
- [3] Ganapathy K.- Telemedicine in neurology. Neurology India 53,238, 2005.
- [4] Ganapathy K. Telemedicine in the Management of Head Trauma: An Overview Indian Journal of Neurotraumatology, 1, 1-7, July 2004.

**EHEALTH: ESSENTIAL SUPPORT TO  
SURGERY AND TRAUMATOLOGY**

## TELEDIAGNOSTICS OF FRACTURE HEALING PROGRESS

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**Abstract:** Fracture healing is a specialized process leading to restoration of bone integrity and function. Early detection of fracture healing impairment is mostly demanded to introduce the optimal treatment leading to recovery as early as possible, instead of delayed or non union. Subjective physical examination may not lead to conclusive results. An assessment using more objective methods of analyzing the degree of healing of a fracture is required for the identification of bone union and treatment discontinuation. The quantitative measurement is required for fracture healing evaluation. Having definite measurements orthopaedic trauma surgeon would be able to monitor healing processes, and set predicted time for bone union, the end of immobilization or fixation removal.

The aim of this study was to improve assessment of fracture healing progress or impairment examined by initial phase of Web based analyzing tools. The realistic and quantitative evaluation of fracture healing may create a new specialized EHR based orthopaedic trauma data approach. The busy orthopaedic surgeon requires suitable methods with user friendly interface to implement them into daily clinical practice. A Web based orthopedic computer aided diagnostic system requires several components which influence its effectiveness including: image processing methodology responsible for the analysis, database structure archives and distributed patients data. A graphical user interface needs to be applied in order to enter the data and present it to the user. Classification and controlled evaluation of healing features using dynamic Web pages design is necessary for a remote access telediagnosics. The current study is part of a project resulting in a computer-assisted analysis of a fracture healing radiograph yielding

**assessment of fracture gap appearance and callus maturity. Various features of fracture healing are considered for analysis and clinical decision support. At various stages of healing process different image processing problems have to be addressed. In the current study first we develop MFC (Microsoft Foundation Class) application for testing the image processing routines and comparing the results of quantitative image analysis with the visual interpretation of extracted regions of interest. In next step the Web based graphical user interface has been designed and implemented. The Web application may also serve as a teaching tool.**

### **Introduction**

Fracture healing is a specialized process leading to restoration of bone integrity and function. Early detection of fracture healing impairment is mostly demanded to introduce as early as possible the optimal treatment leading to recovery instead of delayed or non union. Separate subjective physical examination may not lead to conclusive results, so an assessment using a more objective methods of analyzing the degree of healing of a fracture are required for the identification of bone union and treatment discontinuation [1-7]. The quantitative measurement is required for fracture healing evaluation. Having definite measurements an orthopaedic trauma surgeon would be able to monitor healing processes, and set a predicted date for bone union, the end of immobilization or fixation removal.

### **Aim of the Study**

The aim of this study was to improve assessment of fracture healing progress or impairment examined by initial phase of Web based analyzing tools.

### **Material and Methodology**

Data prospectively and retrospectively collected based on health records of fracture patients hospitalized in Chair and Department of Orthopedics and Traumatology of the Locomotor System were used for the study. Health Record collection includes digital or digitalized images. Database is used to test and learn features and parameters describing fracture healing phenomenon. At the beginning few selected features were chosen for further analysis namely:

- Relative index – Ratio of average optical density [OD] of callus to OD of cortical bone and changes of its value in time,
- Callus index and changes of its value in time,

- Optical density distribution in callus and fracture gap, including: topogram 2D, mean inclination of edges of bone fragments [1, 4, 5, 6].

Selected parameters lead to satisfactory correlation of fracture healing progress and others like: relative optical density of the callus, fracture gap width and distribution of OD values within newly formed bone. X-ray derived data of optical density and other patient's personal data (age, sex, medical history records) useful for fracture healing prediction. Analytic algorithms i.e. artificial neuronal network, would have apply for creating prediction model using retrograde error propagation as a method of learning. Available clinical material is required to neuronal network teach and test.

## **Results**

Internet accessibility of the system for orthopedic trauma departments warehouses huge number of records and allow using new analytic methods. System is divided into functional modules: Central Database Server, Computation Server, Advanced Analytic Application, Simple Analytic Application, Orthopedic Web Application. Central data base stores variables collected in orthopedic telemedical system, including EHR data, RIS, LIS, and PACS systems. Cases, X-ray images and other data collected in the system. Central data base becomes repository for knowledge base created by data mining. Advanced image analysis is performed on computation server for fracture healing prediction computation.

Advanced Analytic Application is a tool that allows advanced analysis of X-ray image and evaluation of prognostic algorithms. AAA can be used by experts as a tool enhancing teleconsultation. Simple Analytic Application is an application for end users (physicians, orthopaedic trauma surgeons). This application allows initial analysis and defining parameters for advanced analysis. Multiformal design may enlarge prospective entry material due to low resolution images additionally to DICOM standard.

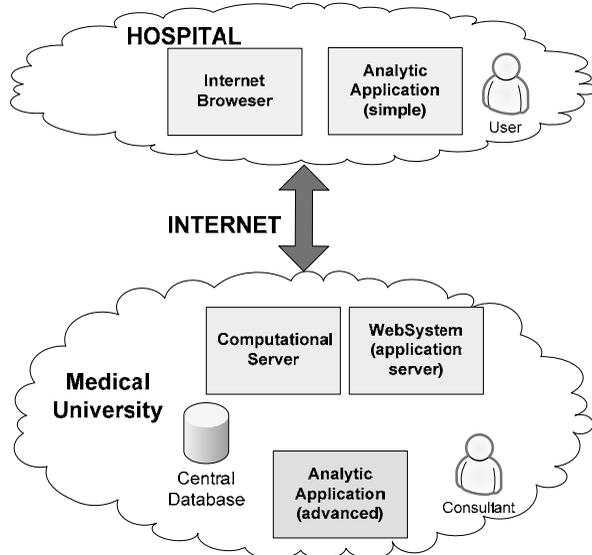
Orthopedic Web Application is a password protected application allowing entering and accessing data stored by the system. Authorized user may browse all results, analyses and predictions. This application becomes a platform for information exchange among users. Currently, individual elements of the system are implemented and tested. Presented system should improve diagnostics and treatment of fractures due to widespread availability and modern scientific methods.

## Discussion

Subjective physical examination of bone union may not lead to correct conclusions, so an assessment using a more objective method of analyzing the degree of healing of a fracture is required for the identification of the completion of fracture healing and treatment discontinuation. In general, histology is considered an excellent evaluation method.

However, as a direct but invasive method it may not be applicable in most clinical cases. The quantitative measurement is required for fracture healing evaluation. Having definite measurements an orthopaedic trauma surgeon

would be able to predict refractures, monitor healing processes, and set an exact date for the end of immobilization or fixation removal. Realistic and quantitative evaluation of fracture healing may create a new valuable scientific tool for orthopaedic trauma research. The analysis of various factors, including biological, pharmacological, physical, mechanical, genetic and others, influence on fracture healing remains a great challenge in orthopaedics. Many non-invasive quantitative techniques for measuring fracture healing have been reported over the past decades. Their acceptance is not high and regular use is rare. A reliable method should allow the determination time of adequate union by its strength, quality and quantity, but the busy orthopaedic surgeons require suitable methods with user friendly interface to implement them into daily clinical practice. Combination of many known methods in one system may lead to new conclusions deriving from already studied cases and build knowledge base



*Fig. 1 Schematic presentation of Telediagnostic Expert Orthopedic Decision Support System*

for further studies. Orthopedic computer aided diagnosis system (OCADS) requires several components which influence its effectiveness namely an image processing methodology responsible for the analysis, database structure archives and distribution the patient image data. A graphical user interface needs to be applied in order to enter the data and present it to the user. By designing dynamic Web pages a remote access to the entire is granted. Developed telediagnostic expert orthopedic decision support system is aimed to enhance fracture healing evaluation, optimize and rationalize process of diagnostics and treatment. Analysis of quantitative parameters describing healing progress, utilized in daily practice would allow predicting and monitoring normal or impaired fracture healing sequence, detect impairment as early as possible, and support clinical decision and improve final outcomes.

### **Conclusions**

The busy orthopaedic surgeon requires suitable methods with user friendly interface to implement them into daily clinical practice. A Web based orthopedic computer aided telediagnostic system is required for supporting image processing methodology and its analysis, database structure archives, graphical user interface and distributed patients data. The current study is part of a project resulting in a computer-assisted analysis of a fracture healing radiograph yielding an assessment of fracture gap appearance and callus maturity. Various features of fracture healing are considered for analysis and clinical decision support. The user interface may also serve as a teaching tool. The realistic and quantitative evaluation of fracture healing may create a new era for orthopaedic trauma research.

### **Acknowledgment**

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### **References**

- [1] Glinkowski W, Żyłkowski J, Wojciechowski A, Górecki A. The Development of methods for quantitative clinical assessment of the fracture healing Proceedings of the XI International Conference Medical Informatics & Technology Ed.: Piętka E, Łęski J, Franiel S. MIT 2006, 46–61
- [2] Glinkowski W, Górecki A. Clinical experiences with ultrasonometric measurement of fracture healing Technology and Health Care 2006, 13, 1–13
- [3] Glinkowski W, Kornacki M, Ambroziak M, Górecki A. Relative Optical Density Image Analysis (RODIA©) of digitized radiograms for tibial fracture healing monitoring International Congress Series 2004, 1268, 1292
- [4] Glinkowski W, Ciszek B, Gil M. Teleconsultations in orthopedic trauma and neurotrauma utilizing mobile digital assistant International Congress Series 2005, 1281, 1329

- [5] Kornacki M, Glinkowski W. Relative Optical Density Image Analysis (RODIA). Clinical application – preliminary report of FHM and IEE subsystems usage *Med Sci Monit* 1998, 4 (Suppl.2), 136–139
- [6] Rowiński, J., Glinkowski, W., Glebowski, P. Estimation of optical density of bone tissue radiograms with laser densitometry *Proceedings of SPIE - The International Society for Optical Engineering*, 2000, 4515, 193-198
- [7] Wade R., Richardson J. Outcome in fracture healing: a review *Injury, Int. J. Care Injured* 32 (2001) 109–114

## AN OUT-PATIENT SURVEY OF PLASTIC SURGERY PATIENTS

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**Abstract: Introduction:** This study aimed to determine patient's views and satisfaction in the burns and plastic surgery outpatient clinic.

**Material & methods:** A two-part questionnaire was randomly distributed to patients in the clinic over a three-month period.

**Results:** 120 questionnaires were distributed. The main information source prior to consultation was the general practitioner. 10% of patients expected perfection without complication following surgery; all of these were seeking aesthetic procedures. 24% thought MRSA infection was unacceptable and would complain. When asked 43% of patients preferred to see a consultant. Following consultation 31% thought they had seen a consultant when in reality only 13% had. The accuracy rate of patients in correctly recognising the senior house officer was significantly less than that of specialist registrar and consultant ( $p < 0.001$ ). Following a  $> 1$  hour delay, 43% of patients would change their initial choice from consultant to any junior doctor. Overall 76% of patients were very satisfied with their consultation, with no significant differences between individual team members ( $p > 0.05$ ).

**Conclusions:** Patients do not accurately recall members in the plastic surgery team, after consultation. A delay in waiting times has an influence on patient choice for consultation, but overall satisfaction is not adversely affected.

**Key words:** Out-patient consultation, Patient perception, Satisfaction.

### Introduction

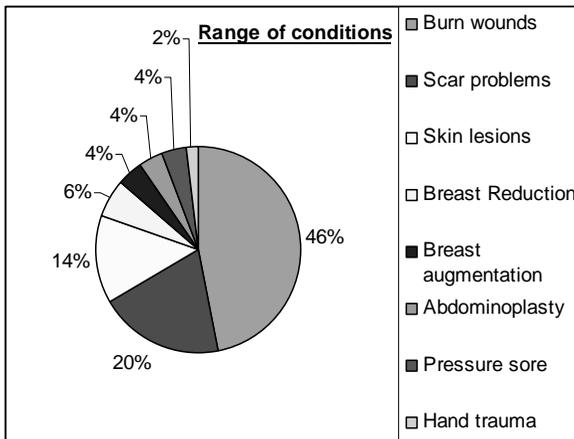
Previous studies show that satisfied patients are *more likely to keep appointment and comply with treatment* [1]. The aim of this study was to determine patient's experience in the burns and plastic surgery out-patient clinic and factors affecting them.

### Material and Methods

A two-part questionnaire was randomly distributed amongst patients in the burns and plastic surgery outpatient department over 3 months (Appendix I). Part 1 was completed before consultation and the second part just afterwards. The results were analysed using Fisher’s exact test with significance being achieved if  $p < 0.05$ .

### Results

120 questionnaires were distributed, of which 102 (85%) were returned fully completed. These included new referral 48/102 (47%) and follow-up 54/102 (53%) patients.



The mean age was 30 years (range 10 – 60 years) and the male to female ratio was 1:1.1. The range of conditions seen is shown in Figure 1.

*Information source (see Table 1)*

Figure 1: Pie chart illustrates spectrum of conditions seen in plastic clinic

Table 1: The various information sources used by patients prior to clinic.

Source of information	Patient number (n=102)
General Practitioner (GP)	56(55%)
Friends/relatives	4(4%)
Television	2(2%)
Newspaper	2(2%)
Internet	0
None	38(37%)

### Expectations of treatment outcomes

17% of plastic patients, expected perfection following surgery and this was much less in the burns group (4%), although significant differences

could not be detected due to small patient numbers. All these patients sought consultation for aesthetic surgery procedures, which included breast augmentation and reduction, abdominoplasty and rhinoplasty.

**Views on MRSA**

Twenty-four percent of the patients stated MRSA infection in hospital was unacceptable and would complain if it occurred during their stay. While 4% of the burns patients were aware of possible MRSA transmission between patients, none of the plastic patients were aware of this cross infection risk.

**Patient perception of plastic surgery team at consultation**

Overall 42/102 (41%) of patients correctly recalled the plastic surgery team member they saw. 43% choose to see a consultant in the clinic (Table 2).

Table 2: This table shows the patient’s preference of person for consultation, if given a choice.

Member of plastic surgery team	Patient number (n=102)
Consultant	44(43%)
SpR	38(37%)
SHO	4(4%)
Nurse	12(12%)
OT	4(4%)
Unknown	0

Following consultation, 32 (31%) patients *thought* they had seen the consultant when only 4 (13%) had done so *in reality*. There was similar variability in how patients incorrectly perceived other staff (Table 3). The overall accuracy rate of patients’ to recognise the grade of consulting doctor was 67% with a consultant and 60% with a SpR\*, but dropped significantly to 19% with the SHO\* (p < 0.001).

Table 3: Patients perceptions and its accuracy: The rows illustrate patient views of whom they thought had seen during consultation and the columns show the person who actually saw them, in reality.

In reality Patient	Consultant (n=6)	SpR (n=6)	SHO (n=3)	Nurse / OT (n=2)	Patient perception	Patient accuracy per team member
		0	4			

Consultant	4	16	12	0	32/102 2 (31%)	4/32 (13%)
SpR	2	30	8	0	40/102 2 (39%)	<sup>3</sup> / <sub>4</sub> (75%)
SHO	0	4	6	0	10/102 2 (10%)	3/5 (60%)
Nurse / OT	0	0	6	2	8/102 (8%)	<sup>1</sup> / <sub>4</sub> (25%)
Not known	0	10	2	0	12/102 2 (12%)	0
Overall accuracy	4/6 (67%)	30/60 (50%)*	6/34 (18%)*	2/2 (100%)		

**Waiting times and delay**

Seventy-six (74.5%) patients were seen within 1 hour of waiting in the outpatient clinic and only 26 (25.5%) patients had to wait > 1 hour. As the delay increased to > 1 hour, the patient’s original person preference for consultation altered (Table 4).

Table 4: Comparing patient preference at start of clinic and following a delay of >1 hour.

	Initial preferenc	Changed preference after > 1hr delay	95% confidence interval
consultant	44/102 (43%)	Consultant 24/44 (55%) Junior doctor 18/44 (41%) Nurse 2/44 (4%)	39%-70% 26%-57% 1%-15%
SpR	38/102 (37%)	Consultant 18/38 (47%) Junior doctor 12/38 (32%) Nurse 4/38 (11%)	31%-64% 18%-49% 3%-25%
SHO	4/102 (4%)	Junior doctor 2/4 (50%) Nurse 2/4 (50%)	7%-93% 7%-93%

**Patient satisfaction**

None of the patients were dissatisfied with their consultation. The majority (78/102, 76%) were judged to be very satisfactory and 24/102

(24%) moderately satisfactory. There was no correlation between individual team member and patient satisfaction ( $p=0.25$ ).

**Preference for the next consultation**

Forty- four patients (43%) preferred to see the same person in their next clinic appointment. Those that choose to see some other team member next time (28) is shown in Table 5.

Table 5 Patient preference of a different plastic surgery team member for the next consultation

Preference for next consultation, if not same person (n=28)	No. of patients	Burns	Plastics
Consultant	20	6	14
Same grade, different person	10	6	4
SpR	2	2	0
SHO	0	0	0
Nurse	2	2	0
OT	4	4	0

For discussion, conclusion, acknowledgments and references please refer to the electronic CD

# **COLOUR FIDELITY OF DIGITAL SKIN IMAGES: SUBJECTIVE ESTIMATION BY DERMATOLOGISTS**

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***Abstract:*** Teledermatology requires submission the digital skin images of rather high quality, otherwise a remote consultant might not be able to make a correct diagnosis. It is important to elaborate the criteria of colour accuracy, which are based not only on optical measurements, but reflect also perception of colour distortions by dermatologists. We made an attempt to estimate if colour distortions in different parts of spectrum are of similar importance for dermatologists reviewing the same skin images with known color distortions (randomly introduced by a computer program). The dermatologists have demonstrated maximum sensitivity to distortions of red colours, while distortions of green colours were shown to be less important; blue colours appeared to be of practically no importance. The results may provide not only input for creation of digital cameras/video cameras with colour reproduction characteristics more suitable specifically for teledermatology, but may also contribute to better understanding the process of making diagnostic decisions by dermatologists.

## **Introduction**

Digital skin images submitted to a remote consultant in the process of teledermatology consultations should be of high quality, otherwise a dermatologist might not be able to make a correct diagnosis. Unfortunately, by the moment only subjective estimations are used in teledermatology to evaluate if certain images are of good quality or not. It is especially important to elaborate the criteria of colour accuracy. Such criteria are to be based not only on optical measurements; they should also reflect perception of colour distortions by dermatologists themselves.

## **Methods**

We made an attempt to estimate if colour distortions in different parts of spectrum are of similar importance for dermatologists reviewing the same skin images. A set of sample set images was created; it included most typical images (eczema, dermatitis, atopic dermatitis, mycoses, skin cancer). A computer program was created, able to consequently demonstrate 30 sample images, implementing random colour distortions of red, green, and blue for each of the images. The ranges of distortion were not known to a dermatologist reviewing the images, but were recorded by the computer program. The dermatologist had to estimate the colour fidelity of a specific image (as a score from 1 to 5, i.e. from “very bad” to “perfect”). Then the distortions and their estimations were statistically compared.

### **The results**

Three US dermatologists and five Russian dermatologists have participated in the study, viewing the same range of digital skin images. It was shown that though Russian dermatologists (less experienced in teledermatology) gave slightly higher scores for similarly distorted images compared to their American colleagues, both Russian and American dermatologists established very similar margin for acceptable colour distortions.

Both American and Russian dermatologists have demonstrated maximum sensitivity to distortions of red colours, while distortions of green colours were shown to be less important. Blue colours appeared to be of practically no importance. The regression analysis was performed; it provided the following equation of regression:

$$\text{Score} = 3.98 - 0.016R - 0.011G$$

where R – distortion of red component, G – distortion of green component.

### **Discussion**

The obtained results might be partially explained by the fact that the dermatological images used for the experiment represented mostly skin inflammation resulting in erythema. It is obvious that red colours are essentially important for characterization of erythema, that is why dermatologists could be most sensitive to the distortions of red colour. The results may provide not only input for creation of digital cameras/video cameras with specific colour reproduction characteristics, but may also contribute to better understanding the process of making diagnostic decisions by dermatologists, which may eventually lead to development of automated systems for skin images evaluation.

## **INEXPENSIVE TELEMEDICINE APPLICATIONS AND TRAUMA SYSTEM DEVELOPMENT IN LATIN AMERICA: ECUADOR'S EXPERIENCE**

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**Abstract:** Enhance trauma system development via innovative electronic health data management systems using local available resources. Trauma is a global epidemic especially in low and middle income countries. There is a paucity of data to support or validate the various advocated interventions to improve trauma care in the Latin American region. Without a continuous and uniform trauma data collection system, the Latin American countries will continue to lag behind in the development of evidence-based regionalized trauma systems. A regional trauma surveillance system was established in Southeast Ecuador, involving 1 hospital in the Amazon jungle, 3 hospitals in the rural provinces, 1 urban definitive care facility, and the Provincial Ministry of Health. The progression of patient data across the spectrum of care was carried out electronically using the most reliable technology available in the region. Simple, bidirectional, point to point dial-up connectivity was used for data transmission. An electronic reference network was established. Data transmission was feasible across the electronic network. In one year, prospective trauma data has been collected on 2,256 patients. This is in contrast to the combined 3 year rudimentary data from local statistics on 1,446 trauma cases reported to the ministry of health from all the hospitals in the southeastern region. The collected data was used to implement multiple evidence based trauma management programs. Inexpensive telemedicine applications can improve injury surveillance systems and promote trauma system development in the region of the Americas. The implementation of a provincial data management network can be useful in the assessment of the burden of injury at the regional level.

## **Introduction:**

Trauma is a global epidemic [1][2]. In low- and middle-income countries, where 90% of fatalities are occurring, trauma is a major public health crisis. In the region of the Americas, trauma accounts for 11 % of the global dead [1-3]. Despite multiple WHO and other governmental and nongovernmental initiatives to improve trauma care in the region, progress has been slow for several reasons. For instance, there remains a paucity of data to support or validate the various advocated interventions [4][5]. In the past, most if not all efforts of the Latin American trauma societies and committees focused on individualized experiences from various Latin American hospitals or health centers [6][7][8] . No true regional or national presentation in terms of trauma improvement and outcome was feasible, partly because of the absence of a regionalized trauma system and/or inaccurate national trauma statistics. The major impediment to health system development in developing nations is inadequate or nonexistent data. Without an appropriate, continuous and uniform trauma data collection system, the South and Central American countries will continue to lag behind their North American counterparts in the development of evidence-based regionalized trauma systems [9][10][11]. Such systems, however, are either nonexistent or not affordable in the developing nations. In developed nations, sophisticated electronic health data management systems have been instrumental in providing continuous and accurate health statistics at the regional and national level. The objective of our study is to enhance trauma system development in the developing nations via innovative electronic health data management systems using local available resources.

In the South American country of Ecuador, trauma is one of the leading causes of mortality. In a recent field evaluation carried out by the International Trauma System Development Program (ITSDP) of the Virginia Commonwealth University (VCU) in the southeastern provinces of Ecuador, trauma care and management were found to be rudimentary. There was not adequate injury statistics to develop appropriate injury prevention and intervention programs. The local statistics were not able to capture pertinent injury data, such as location, type, and mechanism, and essential prehospital trauma information. The regional (provincial) statistics suffered from the inability to receive, assemble, and analyze the injury data in a continuous and reliable fashion [12]. Based on the site evaluation described, an international collaborative effort between ITSDP, the provincial ministers of health, and the Cinterendes Foundation was initiated. Since 2003, preliminary projects to establish the infrastructure for a regional trauma system in the southeastern region of Ecuador were undertaken,

including the development of various prehospital and hospital basic trauma care education and hands-on practical courses, injury prevention programs, and trauma system development.

### Methods

Since local statistics were unable to truly document and evaluate the ongoing trauma system development efforts, a regional trauma surveillance system was established in the southeastern provinces of Ecuador. The surveillance system was limited to five hospitals selected to represent a sample of the progression of the patient from the health centers (HC) in the Amazon jungles - (province of Morona Santiago- 23,797 km<sup>2</sup>;115,412 inhabitants) to the rural hospitals (RH) in the provinces of Morona Santiago and Pastaza (29,325 km<sup>2</sup>; 61,779 inhabitants) and then to the major definitive referral center (DRC) in the urban region (Province of Azuay - (7,995km<sup>2</sup>; 599,546 inhabitants). One hospital was selected from the HC, three from RH, and one from the DRC. An Emergency Department Trauma form was created, along with the development of an electronic trauma registry. The trauma registry was installed in each participating hospital. A central electronic repository database was established at the Provincial Ministry of Health.

The Trauma registry was created in Microsoft Access 2000. VB.net was chosen as the programming medium. The progression of patient data across the spectrum of care was carried out electronically using the most reliable technology available in the region. Simple, bidirectional, point to point dial-up connectivity was used for data transmission. The database communicates and transfers data to the Ministry of Health by using Windows networking to initiate a dial-up PPP connection

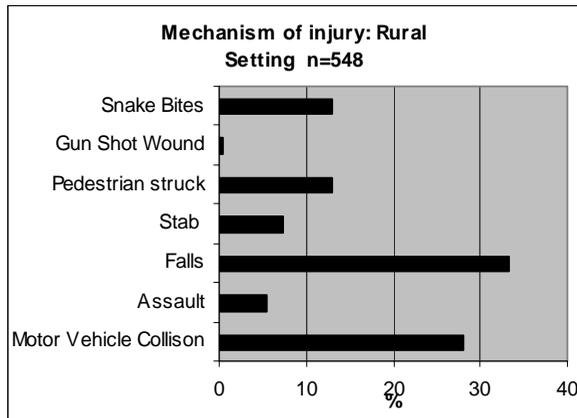


Fig. 1 Mechanism of Injury in Southeastern Ecuador

between the two points. An electronic reference network was established. The PPP connecti on allowed

the use of a modem to create a secure private point to point connection to transfer data on a weekly basis between the participating hospitals and the Ministry of Health.

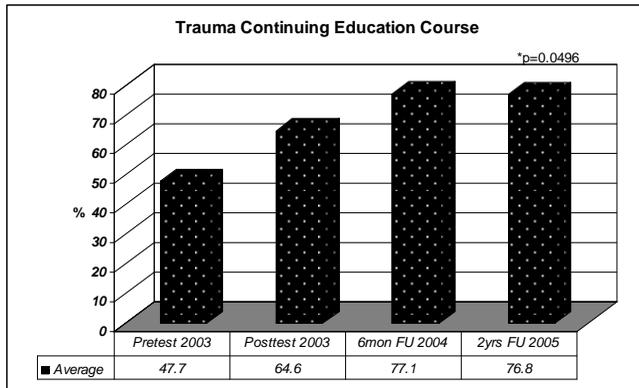


Fig. 2 Continual Medical Education Course

### Results

Data transmission was feasible across the electronic network. In one year (2005), prospective trauma data has been collected on 2,256 patients (40 - jungle hospital, 548 - rural hospitals, 1668 -urban hospital). Regional demographic data, as well as injury patterns, mechanisms and outcomes were collected. This is in contrast to the combined 3 year (2001-2003) rudimentary data from local statistics on 1,446 trauma cases that had been reported to the Ministry of Health from all the hospitals in the southeastern region. Figure1 one depicts the type of injury mechanisms identified. The collected data was used to implement multiple evidence based trauma management programs. Figure 2 depicts the result of a continual medical education course administered in the region [13].

### Conclusions

For “essential” if not “optimal” trauma care in the Latin American region, a validated and accurate trauma registry, driven by proper injury identification, surveillance, documentation and supervision is a crucial element where resources are scarce. Inexpensive telemedicine applications can improve injury surveillance systems and promote trauma system development. The implementation of a provincial data management network can be useful in the assessment of the burden of injury at the regional level.

## References:

- [1] E. Krug. Injury: A leading Cause of the global burden of disease (WHO/HSC/PVI?99.11). Geneva, Switzerland; World Health Organization:1999
- [2] M. Peden , K. McGee , G. Sharma. The Injury Chart Book: A graphical Overview of the Global burden of injuries. Geneva, Switzerland: World Health Organization; 2003
- [3] K. Hoffman , A. Primack , G. Keusch , S. Hrynkow . Addressing the growing burden of trauma and injury in low- and middle-income countries. Am J Public Health 2005 january 95(1):13-17
- [4] C. Mock , C. Arreola-Risa , R. Quansah . Strengthening care for injured persons in less developed countries: A case study of Ghana and Mexico. Injury Control and Safety Promotion. 2003;10:45-51
- [5] M. Joshipura , C. Mock, J. Goosen , M. Peden. Essential trauma Care: strengthening trauma systems round the world.Injury. 2004;35:841-845
- [6] G. Prada , M. Malagón , C. Moreno, M. Rue, X. Bonfilly. Analisis comparativo de mortalidad causada por violencia, entre Colombia y otros países hispánicos. Panam J Trauma 1998;7:98-103
- [7] J. Yunes, T. Zubarev. Mortality from violent causes in adolescents and young people: a challenge for the Region of the Americas. Rev. Bras. Epidemiologia 1999; 2:102-71
- [8] M. Richman, P. Shayne, S. Heron, D. Lowery , T. Knox. Injury Control in Honduras: a survey of injury mortality. Ann Emerg Med. 2000; 36(4):333-339.
- [9] M. FitzPatrick, H. Frankel, J. McMaster, L. Heliger, S. Auerbach, P. Reilly, C. Schwab. Integration of concurrent trauma registry and performance improvement programs J Trauma Nurs. 2000 Oct-Dec; 7(4):92-7
- [10] E. MacKenzie, F. Rivara, G. Jurkovich, A. Nathens, K. Frey, B. Egleston B, D. Salkever, D. Scharfstein. A national evaluation of the effect of trauma-center care on mortality. N Engl J Med. 2006 Jan 26;354(4):366-78
- [11] C. Michaud, C. Murray C. External assistance to the health sector in developing countries: a detailed analysis, 1972-90. Bull World Health Organ. 1994;72:639-651
- [12] M. B. Aboutanos. (unpublished)
- [13] M. B. Aboutanos, E. B. Rodas, S. Cone, F. Mora, L.G. Wolfe, T.M Duane, et al. Creation of Trauma Course in the Amazon Jungles of Ecuador. American College of Surgeons, Surgical Forum , 2004

# **A TELESCREENING OF THE POSTURE AND SPINAL DEFORMATIONS FOLLOWED BY TELEREHABILITATION PROJECT: CURRENT STATUS**

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***Abstract-* Spinal and thoracic deformities are underestimated problems in the society. Scoliosis and thoracic wall deformities are an evolving process which requires early detection and treatment. Telediagnostic systems may have two tasks to screen for deformations (i.e. scoliosis) and/or to monitor progress of the disorder. Affected patients of developed already deformations may experience some cardiac and respiratory function impairment and also pain syndromes. We present recently developed system that combines posture telediagnostic screening and Internet based videoconferencing for telementoring in rehabilitation. The pilot study describes an approach to various back and thoracic deformities that may occur in adolescence or in adults. The presented screening system operates remotely with telediagnostic technical team, implementing semi automated initial evaluation on site for screening examinations. Only suspected images are transmitted to telediagnostic center for final evaluation by specialist. Further diagnostics utilizing radiography, CT or MRI diagnostics follows initial telescreening if necessary for therapy planning. The evaluation is based on 3D shape measurement that utilizes structured light measurement method. GSM protocol (GPRS/EDGE/UMTS) serves for transmission of sinusoidal fringes and Gray codes representation. The telerehabilitation follows the**

**telediagnosis in distant location where the lack of specialists is permanent. Cost effective, Internet based videoconferencing is employed to mentor and monitor the physical therapy sessions in selected cases.**

### **Introduction**

The widespread occurrence of scoliosis or kyphotic curvature of the spine often becomes apparent in teenage years and/or elderly, with both cosmetic and functional consequences.

A chest deformity in various forms may affect about 1% of the population. Pectus excavatum is the most common thoracic wall deformation. Measurements are needed to detect the condition and for monitoring the progress of treatment. Screening tests are recommended for evaluation of the problem scale in the entire population. Spinal deformations may appear also later in older population due to osteoporosis. Various tests are utilized for deformity evaluation.

The forward bending test, widely used in scoliosis screening, is associated with high false-positive rates. Instrumentation is indicated for the qualitative and/or quantitative assessment of the human posture. Direct surface measurement of the human posture by digitization could increase the predictive value of detecting scoliosis without sacrificing sensitivity [4,5]. The 100% sensitivity and 85.38% specificity was found for previously developed Moiré topography cohort study by Karachalios et al. [6,7].

The most common thoracic wall deformations in various forms that may affect about 1% of the population may lead to some cardiac and respiratory function impairment and /or provoke psychological stress because of the appearance of the deformed chest in affected patients.

Improper posture can generate spine problems related to inadequate spinal support or poor posture developed by a subconscious maneuver to hide the chest wall deformity or a postural defect directly related to the thoracic wall deformation. Uncorrected posture may lead to concomitant scoliosis in almost 5% of children with a thoracic wall deformity.

Young children may remain asymptomatic. Scoliosis deformities are an evolving process which must be early detected and treated. Screening for scoliosis was common in schools and communities in past years. Several studies advocate quantification of the bending test or performing surface topography to reduce the referral rate and to increase the specificity of the bending test in screening for scoliosis.

Reduced exercise tolerance and fatigue are common in adolescents. However, these symptoms are probably more related to habitual inactivity than directly to the deformity. Diagnostic tests consist of plain postero-

anterior and lateral chest radiograph, lung function tests and clinical photographs, cardiac ultrasound if indicated. A non-contrast computerized tomography (CT) scan of the thorax and spine becomes the standard clinical way to record the three-dimensional anatomy of the deformity accurately. Moiré phototopography have been already used as a method of accurately measuring human body contours utilizing applied optics and has been used successfully in scoliosis screening programs. Moiré phototopography has proven to be a sensitive, reproducible, and easy to perform method of quantitating pectus deformities.

The aim of the study was to present recently developed system for chest and posture telediagnostic screening/assessment. The system designed for posture evaluation may be applied to children, adults and elderly. The pilot study depicts an approach to various shape deformities evaluation utilizing structured light technique.

The concept of proposed system is designed to cover whole territory of Poland for screening. The results should be stored in central databases located at Medical Universities. The scheme of proposed system is shown in figure 1. Stationary system with calibrated directional measurement modules captures whole 3D-shape of patient's body already in body shape lab. The measurement is based on determination of parameters of visible anatomical landmarks and calculation of clinically useful indexes and curves. All measured and calculated data are stored in database as a patient's record. Patient's data recorded and stored in Body Shape Laboratory are transmitted via Internet. Diagnostic module connected to database give the possibility to review patient's records for better posture diagnosis. Mobile systems manufactured with one or two directional modules, operated by technical staff only are designed for Mobile Team visiting distant schools, not supported by specialists on site. These modules are connected to database by slow GPRS/EDGE/UMTS protocol or Internet connection if available. The concept is to put on-line smaller patient's image and calculate final features from whole measurement data. Accurate measurement data in the form of cloud of points will be updated in database when measurement system will be connected to Internet by broadband connection.

### **Material and Methods**

A group of teenagers from selected schools were evaluated for postural deformities and few patients with thoracic deformities were examined.

## Measurement System

The system was designed for direct surface measurement of the human posture and scoliosis detection by digitization. The method of measurement is based on structured light technique with digital sine patterns and Gray codes projection. Measurement utilizing Algorithms of Directional Merging and Conversion (3DMADMAC) system was used to achieve complete functionality connected with the requirements of posture analysis. The system consists of Digital Light Projector (DLP) and CCD camera as a matrix detector. Set-up used for measurements includes DLP projector with resolution 1280x720 pixels and color digital camera with resolution 1600x1200 pixels. All measured and calculated data are stored in patient's record database. Data is transmitted from diagnostic mobile stand connected to database with GPRS/EDGE/UMTS protocol.

The system measures about 1 million points characterized with (x,y,z,R,G,B) co-ordinates from single measurement. Measurement volume equals to 2 x 1.5 x 1.5 m<sup>3</sup>. Single direction measurement takes 0.25 second. The measurement uncertainty corresponding with Root Mean Square (RMS) error for normal distribution (99% coverage) does not rise above 0.4 mm.

## Results

Otherwise healthy thirty teenagers attending middle school, additionally scoliosis and thoracic deformation patients were assessed utilizing described above system. The results for 30 children examined were obtained.

Kappa angle

Average	18,7653
Median	18,9654
Standard Deviation	5,45325
Minimum	9,90518
Maximum	29,9104

*Tab.1 Summary statistics of kappa angle*

The kappa angle represents the value of kyphotic curvature of the thoracic spine. For whole group average kappa angle was 19° but half of them have had lower values measured. Most typical value was within the range from 13° to 25° for this population. The shoulder position has revealed a little higher position of the right shoulder.

Measurements of thorax taken from patients examined due to the chest deformity in our preliminary series have shown the tendencies of the close correlations for measured CT and external diameters. Selected data files were prepared for transmission and sent for remote evaluation.

The videoconferencing module was developed for the telerehabilitation or telementoring in rehabilitation and implemented practically. Application based on Adobe Flash Player was set on videoconferencing system. The Real Time Messaging Protocol was implemented for multimedia communication. Telerehabilitation videoconferences seen in real time were of acceptable quality with the best resolution achieved on PC screen. Telerehabilitation team has delivered interactive videoconferences accessible through the Internet. A few participants accessed sessions from rural and suburban areas. There was no charge for participants during preliminary series of telerehabilitation. Good quality Web cameras were used to pickup video for the broadcast over the Internet. Center of Excellence “TeleOrto” rehabilitation team widely uses telemedicine approach in clinical practice as well teleeducation. Improvements in videoconferencing systems permit interactive distant communication and decrease their costs. Utilizing telemedicine videoconferences rehabilitation mentoring on remote was accepted by the staff of physiotherapists and patients (participants). Flash enhanced Web telerehabilitation may not replace in person rehabilitation but it may supplement the overall treatment.

### **Discussion**

Telemedical approaches are not common in orthopedics. We have presented recently developed system for chest and posture tediagnostic assessment. The pilot study have shown an accuracy of the approach to combined, modern and quantitative and low radiation thoracic wall and spinal shape deformities evaluation. The deformities may occur in childhood and adolescence and require early detection. The presented screening system may operate remotely with advance diagnosing team. An evaluation is performed on site of patient’s location with screening method and only selected and suspected images are transmitted to tediagnostic center and finally evaluated by the specialist. The evaluation is based on 3D shape measurement utilizing the method of structured light measurement. Data transmission may use GSM protocol (GPRS/EDGE/UMTS). Sinusoidal fringes and Gray codes projection produce a measurement cloud of (x,y,z) points as a result. Certain anatomical are located in the cloud and their positions are calculated. Quantitative evaluation allows screening or monitoring the thoracic shape. Computer-aided diagnosis of postural deformities and scoliosis is required for orthopedic screening of cohort studies. The technique finally may achieve the high classification rate. The system is designed for posture evaluation that may be applied to each patient independently to patient’s age. The concept of proposed system was designed to cover significant or whole area of country, with the

international participation in the study possible. The results would be stored in central database at Medical University. Developed system shall be used in a wide range of medical applications including, posture analysis, chest deformation assessment as well anatomical morphology. The wide application of the method is potentially even wider due to its safety.

The computer vision system may help to evaluate spinal as well thoracic wall deformations using images of the human back and chest. The moiré technique was widely accepted method convenient for detecting spinal deformations and simple, inexpensive, and not aggressive. The symmetry of fringes analysis was utilized for making the diagnosis.

Direct surface measurement of the human posture by digitization could increase the predictive value of detecting posture deformations without sacrificing sensitivity. The 100% sensitivity and 85.38% specificity was found for previously developed Moiré topography cohort study by Karachalios et al. for scoliotic deformations. Telerehabilitation that follows preventive and screening telemedical measures may become well accepted solution for rural and suburban population.

### **Conclusion**

3D MADMAC optometric system utilized in the study may operate telediagnostically and measure and evaluate the human thorax and back shape three dimensionally.

The new concept of chest and posture telescreening not only becomes concurrent to systems mostly based on moiré method but opens the method to national or even international studies epidemiological significance. The efficient, internet based videoconferencing module developed for the telerehabilitation or telementoring in rehabilitation was found as useful to support therapy providers in distant locations.

### **References**

- [1] Sitnik R., Kujawińska M., Woźnicki J., Digital fringe projection system for large-volume 360-deg shape measurement, *Opt. Eng.* 41, 443-449, 2002.
- [2] Osten W., Nadeborn W., Andrae P., General hierarchical approach in absolute phase measurement, *Proc SPIE* 2860, 1996.
- [3] Mitchell H.L., Newton I. Medical photogrammetric measurement: overview and prospects *ISPRS Journal of Photogrammetry & Remote Sensing* 56, 286– 294, 2002.
- [4] Hackenberg L., Hierholzer E., Poetzl W., Goetze Ch., Liljenqvist U. Rasterstereographic back shape analysis in idiopathic scoliosis after anterior correction and fusion *Clinical Biomechanics* 18, 1–8, 2003.
- [5] Karachalios T, Roidis N, Papagelopoulos Pj, Karachalios Gg. The efficacy of school screening for scoliosis. *Orthopedics.* 23(4):386-91, 2000.
- [6] Karachalios T, Sofianos J, Roidis N, Sapkas G, Korres D, Nikolopoulos K. Ten-year follow-up evaluation of a school screening program for scoliosis. Is the forward-bending test an accurate diagnostic criterion for the screening of scoliosis? *Spine.* 15;24(22):2318-24, 1999.

[7] Sitnik R, Glinkowski W, Licau M, Załuski W, Koziół D, Glinkowska B, Górecki A. Screening Telediagnosics of spinal deformities based on optical 3D shape measurement system and automated data analysis – Preliminary report Proceedings of the XI International Conference Medical Informatics & Technology Ed.: Piętka E, Łęski J, Franiel S. MIT, 241–245, 2006.

# **THE FEASIBILITY OF REMOTELY SUPPORTED MYOFEEDBACK TREATMENT (RSMT) IN WOMEN WITH NECK-SHOULDER PAIN DUE TO COMPUTERWORK**

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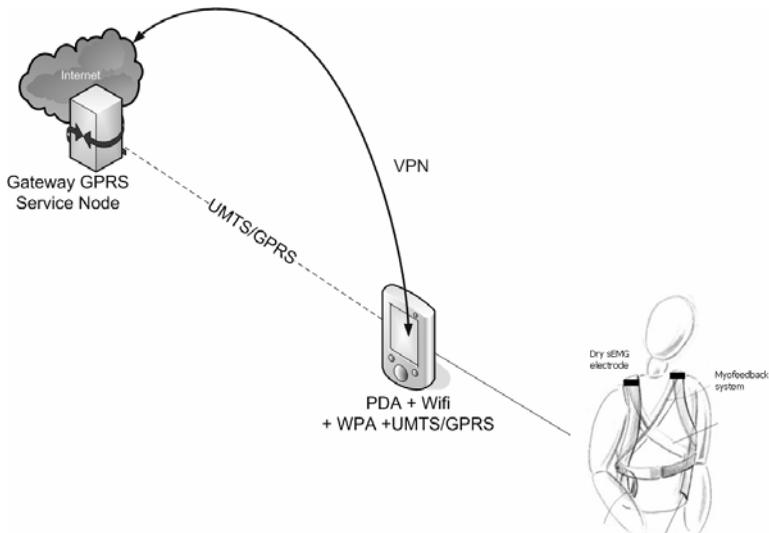
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**Abstract:** The technical feasibility and clinical effectiveness of remotely supported myofeedback treatment (RSMT) were examined. The study sample consisted of 10 female workers suffering from neck-shoulder pain related to computerwork.

## **Introduction**

The prevalence of work-related neck-shoulder pain among computer workers is high, particularly among female computer workers. Despite the conservative interventions such as physiotherapy and ergonomic adjustments at the workplace, in a majority of computer workers the complaints persist. Therefore, developing new developments is justified.

A relatively new intervention approach is remotely supported myofeedback. During RSMT, subjects wear a garment enabling continuous recording of the activation patterns (surface electromyography (sEMG)) of the upper trapezius muscle. The garment can be worn under the clothes during daily work. The garment is connected to a processing and (vibrating) feedback unit which is attached to a belt and worn at the waist. The unit provides feedback by means of vibration and a soft sound. In contrast to classical feedback during which subjects receive feedback when muscle activation is too high, Cinderella-based myofeedback provides feedback when relaxation is insufficient [1]. Because of the ambulatory character of the myofeedback system, continuous feedback (= high therapy intensity) can be provided in the workers own environment which facilitates the generalization of learning into a variety of work tasks and activities of daily living. On the visual display of a PDA, which is connected to the processing and feedback unit, subjects are able to view the sEMG parameters real time for both right and left shoulder.



*Fig. 1 Schematic overview myofeedback garment (including vibrating feedback unit) and infrastructure enabling wireless transmission of sEMG data to a secured server [2]*

The PDA has the ability to automatically send the muscle activation data (sEMG) via GPRS to a secured server, which is remotely accessible by for the myofeedback therapist at any time and any place. Thereby, weekly conservative in vivo counseling sessions can be replaced by remote (e-) counseling sessions. A schematic overview of the RSMT is provided in figure 1.

Previous research indicated a positive receptiveness for RSMT among professionals and patients [2]. Receptiveness is considered to be an important prerequisite for acceptance. Other prerequisites are the technical feasibility and clinical effectiveness, which have therefore been evaluated in the current small scale study.

## Methods

Twelve female workers suffering from neck-shoulder pain related to computerwork were included. Two subjects dropped out in the course of their treatment; one because of technical inconveniences with the myofeedback system (connectivity problems) and one due to family circumstances. In total, ten subjects wore the system for four weeks at work during which they noted their activities and pain intensity in diary. After the myofeedback equipment was explained (in vivo) a total of four counseling

sessions took place; the subsequent three counseling sessions were kept remotely (by telephone) and the final session took place *in vivo* and the equipment was taken by the therapist. Weekly counseling sessions with the myofeedback therapist took place during which the sEMG data from last week were discussed on the basis of the diary and pain intensity scores. During the counseling sessions subjects were taught about personal work style and manage stressors at work and at home that affect their musculoskeletal health.

The technical efficacy of the RSMT was assessed by measuring the amount of data available at the server for counseling purposes. In addition, a problem log was kept manually. The clinical effectiveness of the RSMT was assessed by measuring the amount of pain intensity and disability due to neck-shoulder pain before (T0) and after (T1) RSMT, and at one month follow-up (T2) on a 10-point rating scale varying from 0 (no pain at all) to 10 (worst pain ever experienced). The level of disability experienced by subjects in their daily life was assessed using the Neck Disability Index (NDI). The NDI consists of 10 items with a 5-point rating scale (0 not disabled, 5 severely disabled) [3].

## Results

With respect to the technical efficacy of the RSMT, it was possible to collect and transmit sEMG data wirelessly to a secured server. The median number of hours per week of sEMG data available at the server varied between 9.2 hours and 15.4 hours. In 31 out of 40 counseling sessions (78%) sufficient sEMG data (>8 hours per week) were available at the server for the myofeedback therapist. Technical problems encountered during the treatment were instability of the wireless connections, the relatively short battery life of the processing / feedback unit and the PDA.

With respect to clinical effectiveness of the RSMT, the median level of pain intensity score and disability was significantly decreased after four weeks of RSMT (T1) ( $p=0.015$  and  $p=0.021$ ). On a group level, the median pain intensity decreased from 6.0 (T0) to 2.5 (T1) for neck. In addition, subjects reported significantly lower levels of disability; median score of 13.5 (T0) to 8.0 (T1). Despite the fact that pain intensity and disability levels at one month follow up (T2) were lower compared to baseline (T0), these changes were not significantly significant ( $p=0.297$  and  $p=0.119$  respectively).

## Discussion

The present study investigated both the technical feasibility and the clinical effectiveness of remotely supported myofeedback treatment

(RSMT) in a pilot sample of female workers suffering from neck-shoulder pain related to computer work.

A sufficient amount of electromyographical data could be collected, transmitted wireless, and accessed by the myofeedback therapist at a secured server.

The level of neck pain intensity and disability was reduced significantly after RSMT. However, the small study sample and the fact that no placebo-control group or non-intervention group was included makes that the results need be interpreted with caution.

It is concluded that RSMT seems technically feasible and clinical effective. But it is recommended to evaluate the impact of overall impact of introducing the RSMT in routine health care instead of single endpoints (i.e access and quality) [4]. Therefore, a large scale randomized trial needs to be conducted assessing the improved quality (clinical outcomes), increase access (more patients can be treated simultaneously) and reduced costs (reduction in travel times in remote counseling) which are hypothesized for RSMT.

Aside from appropriate evaluation, other factors should be taken into account when striving for implementing RSMT among which are clearer definition of the service to be implemented, identification of stakeholders, adjustment of policies, and organizational issues [5]. A positive business model which is supported by all stakeholders could serve as “guidance for implementation”.

## **References**

- [1] G.M. Hägg, Static workloads and occupational myalgia: A new explanation model. In: Anderson P, Hobart D, Danoff J, eds. *Electromyographical Kinesiology*, Amsterdam, Elsevier Science Publishers, 1991, p. 141-3
- [2] M.H.A. Huis in 't Veld, G.E. Voerman, H.J. Hermens, M.M.R. Vollenbroek-Hutten, The receptiveness towards remotely supported myofeedback treatment, in press.
- [3] H.Vernon and S. Mior, The Neck Disability Index: a study of reliability and validity, *Manipulative Physiol Ther*, 14(7), 1999, p. 439-15
- [4] H.K. De Chant, W.G. Tohme, S.K. Mun, W.S Hayes, K.A. Schulman, Health systems evaluation of telemedicine: a staged approach, *Telemedicine Journal*, 2(4), 1996, p. 303-312
- [5] T.F. Broens, M.H.A. Huis in 't Veld, M.M.R.Vollenbroek, H.J. Hermens, A. van Halteren, L.J.M. Nieuwenhuis, Determinants for successful telemedicine implementation; a literature study, *Telemedicine and Telecare*, conditionally accepted.

# **TOOLS FOR GLOBAL HEALTHCARE FOR ALL, ANY TIME, ANYWHERE: UBIQUITOUS HEALTHCARE**

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**Abstract:** Information and Communication Technologies support the creation of ubiquitous organizations for global health care (uHealth) bridging the digital divide. A virtual combination of applications and services serves as the basic idea for the Virtual Hospital (VH). Services like acquisition and processing of medical images, data storage, data mining, simulations and modelling for therapy planning will profit strongly from the implementation of health Grid environments. Examples of promising medical applications of Grid technology are the real-time 3D-visualization and manipulation of patient data for individualized treatment planning and the creation of distributed intelligent databases of medical images.

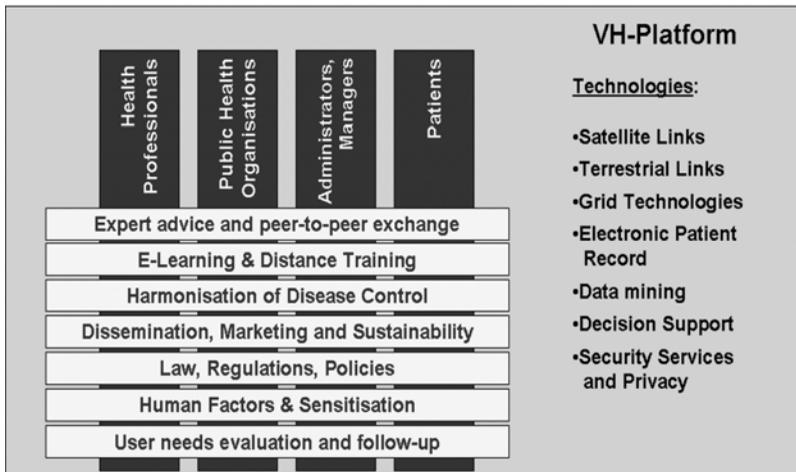
## **Introduction**

Telemedicine aims at equal access to medical expertise irrespective of the geographical location of the person in need; it promises equally good healthcare at any time from any location: best healthcare for everyone, anytime, anywhere. New developments in Information and Communication Technologies (ICT) have enabled the transmission of medical images in sufficiently high quality to allow for telediagnosis. ICT supports the creation of ubiquitous organizations for health care which are digital representations of the information and services of a physical organization (uHealth) [1]. Creating a ubiquitous organization amplifies the attributes of the physical organization by extending its power and reach. Instead of people having to come to the physical organization for information and services the ubiquitous organization comes to them wherever and whenever they need it. To integrate these concepts a Virtual Hospital (VH) will provide a heterogeneous integrated platform consisting of satellite links and terrestrial links for the application of various medical services, such as medical e-learning, real-time telemedicine and medical assistance [2-3].

## Methods

The innovative developments in ICT over the last decade with the aim of realizing uHealth bear the risk of creating and amplifying a digital divide in the world. Therefore we have analyzed how the objective needs of the heterogeneous partners can be joined with the result that there is a need for real integration of the various platforms and services. A virtual combination of applications serves as the basic idea for the Virtual Hospital (VH) (Fig. 1).

Within the VH the following services will be offered. In the Virtual Medical University the leading medical centers provide pedagogical material for synchronous and asynchronous e-Learning in their medical specialties. Real time telemedicine will offer second opinion, tele-teaching, tele-mentoring and optimization of the learning curve. Medical Assistance will improve the medical care of tourists and stimulate tourism. The Virtual Hospital will implement Evidence-based medicine and put emphasis on fellowship programs for multicultural and interdisciplinary education of young medical professionals. Moreover intelligent homeware will help to realize the smart home and distributed units in the network for diagnosis and therapy will assist export of patient data and import of best medical expertise.



*Fig. 1 VH platform. The technologies of the VH will be implemented as a transparent layer so that the users can use the services not bothering with technological details.*

Due to the character of the Virtual Hospital, data and computing resources are distributed over many sites. Therefore Grid infrastructures become a useful tool for the successful deployment of medical applications.

## Results

Services like acquisition and processing of medical images, data storage, archiving and retrieval as well as data mining are common requirements within the medical application domain. In addition simulations and modeling for therapy planning and computer-assisted interventions and large multi-center epidemiological studies are typical clinical services that will profit strongly from the development and implementation of suitable health Grid environments [4].

The main challenge in the domain of grid-based tools and applications is given by hiding the complexity of the underlying Grid infrastructure from the application developer by integrating higher level tools and services for grid application development.

The main reason for the lack of Grid-aware applications appears to be a gap between the Grid infrastructures and their developers / operators on the one side and the developers and end-users of Grid-based applications on the other side. To bridge this gap a user-driven approach needs to be implemented, which includes all stakeholders (Fig. 2).

One example of a promising application of Grid technology within the Virtual Hospital is given by the real-time 3D-visualization and manipulation of medical images (patient data) for individualized treatment planning and training purposes.

To enable fast 3D visualization and interactive inspection of CT, MRT and US patient data after semi-automatic segmentation and reconstruction Grid technology comes into consideration. Currently, using the existing View Sphere Rendering software about 5000 views on an imaginary sphere enclosing the data cube (CT, MRT) can be displayed as a result of off-line pre-calculation of the views [5]. Using grid resources an on-line calculation of the view sphere would be possible thus enhancing operation planning facilities considerably. Also Grid services like the Grid

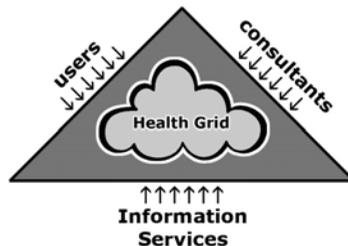


Fig. 2 The invisible Grid for health services: Hide the Grid complexity from application developers and end-users

Visualization Kernel (GVK) [6] can be used for 3D visualisation.

Another promising example of a Grid-based application is the MammoGrid project, which developed a Europe-wide database of mammograms to facilitate a set of first priority healthcare applications. Key aspects here are standardisation of mammograms, design of an appropriate clinical workstation for the end-user, as well as the distribution of data, images and clinical queries across a Grid-based distributed database. Beyond these specific applications, a more generic goal was to explore the potential of Grid to support effective collaborative work (in particular for collaborative medical image analysis) between healthcare professionals located at geographically dispersed sites across Europe.

### **Conclusions**

For successful deployment of the various medical and clinical services in the Virtual Hospital, the development and implementation of Health Grid services appears crucial. The Virtual Hospital will foster region-wide cooperation between the leading medical centres of the participating countries by establishing a permanent medical and scientific link.

### **References**

- [1] C. Dario, A. Dunbar, F. Feliciani, et al., "Opportunities and Challenges of eHealth and Telemedicine via Satellite", *Eur J. Med. Res.* Vol. 10, Suppl I, Proceedings of ESRIN-Symposium, July 5, 2004, Frascati, Italy p. 1-52, 2005.
- [2] G. Graschew, T.A. Roelofs, S. Rakowsky, P.M. Schlag, "VEMH – Virtual Euro-Mediterranean Hospital für Evidenz-basierte Medizin in der Euro-Mediterranen Region", In: A. Jäckel (Ed.), *Telemedizinführer Deutschland*, Ausgabe 2006, Medizin Forum AG, Bad Nauheim, p. 233-236.
- [3] G. Graschew, T.A. Roelofs, S. Rakowsky, P.M. Schlag, "eHealth and Digital Medicine in the Virtual Hospital of the Future", *Proceedings of Med-e-Tel 2006*, Luxembourg, 5-7 April 2006, pp. 49-52.
- [4] G. Graschew, T.A. Roelofs, S. Rakowsky, P.M. Schlag and P. Heinzlreiter, D. Kranzlmüller, J. Volkert, "Virtual Hospital and Digital Medicine – Why is the GRID needed?" In: V. Hernandez et al. (Eds.) *Challenges and Opportunities of HealthGrids*, Proceedings of HealthGrid 2006, Valencia, 7-9 June 2006, IOS Press, Amsterdam, 2006, p.295-304.
- [5] G. Bellaire, G. Graschew, F. Engel-Murke, M. Krauss, P. Neumann, P. M. Schlag, "Interactive telemedicine in surgery: Fast 3-D visualization of medical volume data", *Min. Inv. Med.* Vol. 8, pp. 22-26, 1997.
- [6] P. Heinzlreiter, D. Kranzlmüller, "Visualization Services on the Grid – The Grid Visualization Kernel", *Parallel Processing Letters (PPL)*, Vol. 13, No. 2, pp. 135-148, 2003.

# VISUALIZATION OF MULTIDIMENSIONAL BIOMEDICAL DATA USING GRID TECHNOLOGIES

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**Abstract:** A huge number of medical data normally used for daily clinical practice need novel technologies for analysis aiming better clinical interpretation. Institute of Psychophysiology and Rehabilitation is involved in the Lithuanian Grid project "LitGrid" which aims to extend computing power in research and education. Lithuanian Grid will be integrated into the emerging European Grid infrastructure supporting the entire range of scientific disciplines falling within the scope of the European Grid infrastructure. This paper presents the developed system that aims to use Grid technology to visualize multidimensional biomedical data stored on remote machine.

## Introduction

For the contemporary medical diagnoses huge amount of data collected by different physical measurements and biochemical analyses are used and the reports of analysis contains a big amount of digits, tables and graphs. Visualization of multidimensional biomedical data requires huge computational resources and secured access to the heterogeneous data bases.

As a new parallel and distributed computing infrastructure, the Grid enables sharing of computational resources, provides scientific collaborations, and access to data, instruments, etc. which are geographically distributed all over the world. Virtual organizations (VO) based on Grid provide a highly controlled environment to allow specify exactly who is allowed to access what resources, and under what conditions. Such VO allow people with shared goals provide collaborative research, which is made possible by the sharing of resources such as data, instruments, computation, people's expertise etc.

## GRID technologies

Today there are needs for applications of the existing Grid technology for computing intensive problems and knowledge discovery in health services. Grid technology may be used to connect databases of heterogeneous content enabling new knowledge discovery, better guidance and information to healthcare professionals and increase computing power for imaging, simulation and modelling.

The cluster developed at the Institute of Psychophysiology and Rehabilitation (KMU-PRI-LCG2), shown in Fig. 1, and clusters of leading universities and research institutions of Lithuania form national Grid infrastructure so called LitGRID. To connect distributed resources to the Grid environment gLite middleware has been used. Grid middleware gLite on each site has a computing element (CE) – a batch queue on a site's computers where the user's job is executed, a storage element (SE) – provides large-scale storage for files, information system – collects characteristics and status of CE and SE, user interface – the place where users logon to the Grid, and a resource broker (RB) – matches the user requirements with available resources on the Grid.

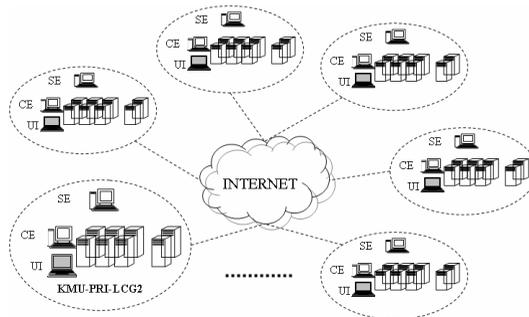


Fig. 1 KMU-PRI-LCG2 cluster in Lithuania Grid infrastructure

### Visualization of multidimensional data

One of the most important tools of extension of heuristic abilities of medical experts to multidimensional space of estimated parameters is visualization of biomedical multidimensional data. Multidimensional scaling (MDS) is a method of the exploratory data analysis aiming to discover the structure of sets of objects using information on similarities/dissimilarities between those objects. The idea of MDS is to map a set of  $n$  dimensional vectors to a two dimensional plane preserving as

much as possible the mutual distances between vectors [1]. Mathematically this problem can be formulated as minimization of a fitness criterion, e.g. the so called STRESS function:

$$S(X) = \sum_{i < j}^n (d(x_i, x_j) - \delta_{ij})^2, \quad (1)$$

where  $X = (x_1, \dots, x_n)$ ;  $d(x_i, x_j)$  denotes the distance between the points  $x_i$  and  $x_j$ .

MDS is a difficult global optimization problem. STRESS function normally has many local minima so the minimization problem is high dimensional: number of variables is  $N = n \times m$ . The hybrid global optimization algorithm [2] has been used for visualization of multidimensional data.

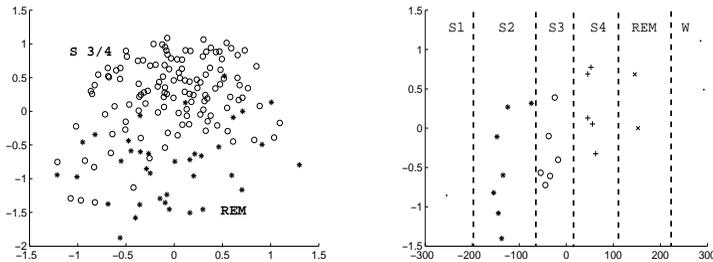
### **Multidimensional biomedical data**

Multidimensional scaling can be applied for analysis of different multidimensional biomedical physiological data (e.g. heart rate, stroke volume etc.) as well as for psychometric testing from different questionnaires such as Pittsburgh Sleep Quality Questionnaire, Medical Outcome Short Form 36 for assessment of quality of life, Hospital Anxiety and Depression Scale etc. can be visualized into two dimensions. In Grid infrastructure it is possible to enable the software components as Grid services so that they can act. Heart rate and stroke volume data obtained from clinical practice [3] has been stored on KMU-PRI-LCG2 cluster's storage element as Grid service and can be accessed by various collaborative researchers authenticated in Grid environment and VO.

### **Results**

Large sets of multidimensional data can be analyzed by means of MDS. Visualization of multidimensional data is a large scale numerical problem which is time consuming and difficult to solve on a single personal computer. The Grid is an excellent candidate for providing the infrastructure needed for solving such problems. An example of visualization of multidimensional biomedical data containing heart rate characteristics during different sleep stages is shown in Fig. 2. MDS algorithm allows to discriminate the clear-cut clusters of points (HR data), representing individual sleep stages, in a two-dimensional plane. For visualization we used parameters of RR interval, its variability ( $\sigma_{RR}$ ) as

well as power spectrum components (VLFC, LFC, and HFC), and nonlinear dynamics parameters (ApEn, DFA).



*Fig. 2 Visualization of heart rate (HR) data in different sleep stages*  
*Left side, visualization of HR data during stages 3-4 (circles) and REM*  
*sleep (stars) of the first sleep cycle in a group of subjects; Right side,*  
*visualization of HR data during different stages of the first sleep cycle in*  
*one subject.*

We consider a problem of feature extraction from heart rate data related to the diagnosis of sleep disorders and diseases. It is a one of problems of recognition of sleep stages from heart rate time series. Multidimensional scaling is an efficient technique to investigate structures of multidimensional data sets in an appropriate view.

### Conclusions

Methods based on Grid technology have been proposed and implemented. They were applied for visualization of multidimensional biomedical data. These methods enable to share between virtual organization members biomedical data, to perform computations, and to obtain results of visualization on different remote computers.

### Acknowledgement

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### References

- [1] Mathar R, Žilinskas A. "On Global Optimization in Two-Dimensional Scaling", *Acta Applicandae Mathematicae* 1993; 33: 109-118.
- [2] A. Varoneckas, A. Žilinskas and J. Žilinskas. "Multidimensional scaling using parallel genetic algorithm". In: I.D.L. Bogle, J. Žilinskas (Eds.), *Computer Aided Methods in Optimal Design and Operations*. Vol. 7 of Series on Computers and Operations Research, World Scientific, 2006, pp. 129-138.
- [3] DataBank, <http://www.pri.kmu.lt/datbank/>.

## **MOBILE EHEALTH SOLUTIONS**

# A TELEMEDICAL THERAPY-MANAGEMENT-SYSTEM WITH RULE-BASED ACTIVE PATIENT-FEEDBACK

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**Abstract:** The work presents a system, which was designed to support both the patient and the physician with the optimization of the treatment of diabetes mellitus. This support is based on automated examination of the patient measured values (blood sugar, insulin dose, etc) and periodical rule-based feedback messages so as to increase the quality of the treatment by detecting and notifying the patient of deviations with respect to the individually adjusted algorithms.

## Introduction

Patients suffering from chronic diseases like diabetes mellitus usually need lifelong treatment. To prevent or at least postpone worsening of the disease as long as possible, individual adjustment [1] and continuous monitoring of the therapy is required. Therefore, affected patients are often asked by their caregivers to record their key parameters into lists, tables or diaries, in order to have solid data as a basis of guiding the patient to the best possible health status. Using these conventional methods for therapy management, patients' compliance is often poor and the interpretation of hand written data is time-consuming

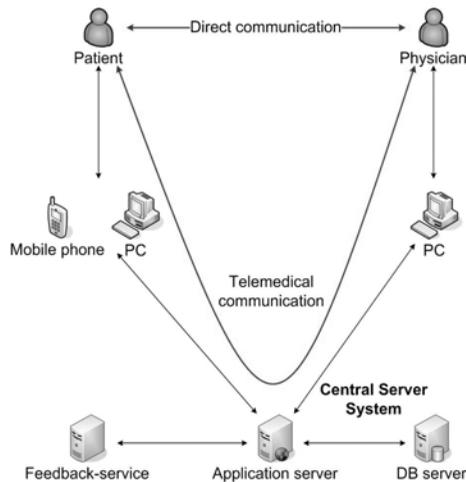


Fig. 1 Components of the therapy-management-system (user terminals, central server system extended with feedback-service) and supported communication channels (direct and telematical communication)

and error-prone [2]. To increase the quality of data interpretation electronic solutions to administrate and present medical data have become quite common. Due to their high dissemination and the advantage of mobility, mobile phones used as patient (monitoring) terminal have gained much attention [3]. Thus server-based data administration combined with mobile phone monitoring appears well suited to solve problems occurring with data collection and interpretation. Aim of this work is to enhance a server-based therapy-management-system with automatic patient-feedback to close the open-loop process of managing chronic diseases with active involvement of patients in their treatment.

### **Methods**

Targeting to support the optimized treatment of patients suffering from insulin-dependent diabetes mellitus (type I and II) the following three key elements were designed and developed:

- Frequent recording and transmission of health parameters like blood glucose values, insulin dosage, carbohydrate intake, etc. carried out at home by the patient using mobile phones.
- Server-based storage, visualization, statistical analysis and rule-based interpretation of the data recorded by the patient to prepare and support an appropriate therapeutic reaction by the physician.
- Active feedback (using the rule-based interpretation mentioned above) informing patients about their actual conditions and giving directives to improve their state on a regular schedule. This text-based feedback is transmitted to the patients' mobile phone once it has been released by the physician.

The communication channels connecting patient, physician and monitoring centre and the system components are illustrated in Fig. 1.

#### ***Mobile phone as patient-terminal***

To assist patients in frequently recording of relevant health parameters and the intake of prescribed medications a J2ME (Java 2 Platform Micro Edition) application was developed. After installing this java application on the mobile phone, it can be used as patient terminal with a graphic user-interface to store measured health parameters (blood glucose, weight, blood pressure, etc.), intake of medication, activity and the personal condition of the patient. Using the mobile phones' Internet connectivity these stored datasets can be transmitted to the server-based monitoring centre on demand.

The J2ME application was also designed to enable the monitoring centre to interact / communicate with the patient. Once there is a new unread mes-

sage (text-based feedback) available on the server, the patient is informed and has the option to download the message.

### ***Monitoring centre***

The central system was implemented as secure server system hosting a central data base (PostgreSQL) and an application server (Zope) to receive, store and administrate patients' medical data. It supports the attending physician in managing patients (storage of examinations with clinical parameters, individual medication, target areas for home measured values) and provides a graphical presentation of the patients' home measured values.

### ***Rule-based interpretation of health parameters***

The central server system was extended with the ability of rule-based interpretation of the patients' medical data. This was accomplished with the implementation of a Java servlet (running on an Apache Tomcat servlet container) for the execution of several tasks. For the rule-based interpretation of patient related data the open source and standards-based business rules engine JBoss Rules (JBoss, a division of Red Hat, Atlanta, USA) was embedded into the servlet. The rule engine is matching facts of the working memory (working memory elements) against rules of the production memory (rule base). After asserting the patient's data to the working memory the initial rules are executed (fired). Their target is to inspect the completeness of essential data (target areas, individual algorithms) and to initiate the statistical analysis needed for the generation of further feedback information if applicable. Subsequent to this initial preprocessing that modifies the working memory and provides this new statistical information, the text-generating rules are fired. Depending on individual target areas and transmitted home measured values, feedback information about the actual condition of different health parameters (blood glucose, blood pressure, weight, activity, etc.) and directives for the patient to improve his/her state are generated. Both, the statistical summary of the measured values and the text-based feedback are transmitted to the central server via XML-RPC.

## **Results**

The whole system was implemented and technically validated using data from 10 real patients (each patient recorded data over a period of at least three months) from a previous clinical trial which utilized a similar data acquisition concept but did not include patient feedback (open loop).

The weekly text-based feedback-service was implemented for patients suffering from diabetes mellitus (type I and II) based on a rule base with 27 different rules for the generation of 26 different combinable feedback components, containing a (statistical) summary and text-based assessment of the

current state with directives. This numeric (statistical) summary comprises the number of recorded blood glucose values, the mean value of blood glucose with the percentage of high, low and normal values, the number of recorded hypoglycaemias, the mean systolic and diastolic blood pressure, the mean dosage of basal and prandial insulin per day, the mean carbohydrate intake per day, the mean activity per day and the mean weight.

The text-based feedback part incorporates mean and fluctuation of blood glucose, allocation of blood glucose measurements (high, low, normal), wrong dosage of insulin, mean blood pressure, activity and weight.

### **Discussion**

The usage of mobile phones simplifies the recording of health data, facilitates the transmission of measured values and provides the possibility to receive feedback information and thus is the patient terminal of choice. A monitoring centre supports the physician with the administration of patients and simplifies the evaluation of acquired data by using, e.g. graphical forms of presentation. However, an important challenge for optimizing the treatment of chronic diseases remain, which is to ensure frequent and correct transmission of health parameters as a precondition for individual adjustment. This problem can be solved by providing patients with periodical (weekly) feedback to keep their compliance on a high level.

The process of testing the system using existing patient data revealed quite frequent and large deviations of the recorded values (e.g. dosage of prandial insulin) from the individual therapy regimens as suggested by the physician. By giving a feedback containing information about these deviations, a significant positive effect on the degree of metabolic control can be expected. This hypothesis will be evaluated in the course of a randomized controlled trial.

### **References**

- [1] K. Howorka. "Functional Insulin Treatment: Principles, Teaching Approach and Practice," 2. ed., Springer, Berlin Heidelberg, Germany, 1996, pp. 20-128.
- [2] H. Holman, and K. Lorig. "Patients as partners in managing chronic diseases," *British Medical Journal*, vol. 320, pp. 526-527, 2002.
- [3] D. Scherr, R. Zweiker, A. Kollmann, P. Kastner, G. Schreier, F. M. Fruhwald. "Mobile phone-based surveillance of cardiac patients at home," *J Telemed Telecare*, vol 12(5), pp. 255-261, 2006.

# CONCEPTS AND STRATEGIES FOR PERSONALIZED TELEMEDICAL BIOFEEDBACK-THERAPIES

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***Abstract:* Mobile telemedical microsystems can automatically measure and transmit physiological parameters of patients. Presented are new examples and strategies for the integration of such systems in individualized feedback therapies with accepted clinical relevance.**

## Introduction

Mobile telemedical microsystems can automatically measure and transmit physiological parameters of patients. On the one hand, cellular phones equipped individualized sensors can improve the therapeutic efforts by monitoring compliance associated parameters. On the other hand, the mobilization of intrinsic personal stimuli can be realized.

An advantage in telemedical care is the combination of sensors adapted to the individual patient's requirement. For example, in the case of heart insufficiency, continuous measurement and visualization of the blood pressure data and body weight data allows almost instantaneous identification of any change in a patient's condition. The current research projects in telemedicine of the Heinz Nixdorf Chair for Medical Electronics are continuing in this vein and increasingly focusing on individualized, personalized and miniaturized diagnostic and treatment systems [1].

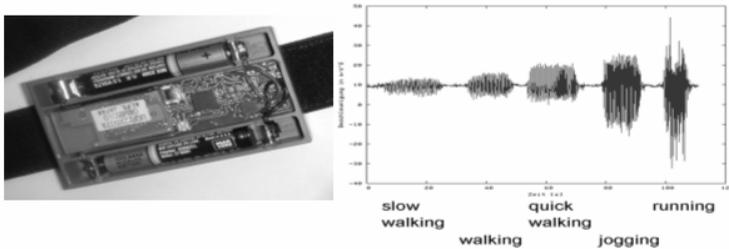
## Concepts for personalized Biofeedback-Therapies

### *Activity Monitoring*

An example is the development of a system for acquiring personal movement data. Regular detecting and monitoring movement or activity is an important control instrument in weight-reduction programs. At the same time, activity is an important parameter for human vitality. Selected and sufficient movement is a suited long-term prevention means especially

for diabetes and cardiovascular diseases.

The system is especially expedient when registering the course of individual kinematic movements while simultaneously correlating them to pulse



*Fig.1: Torso belt with integrated acceleration measurement, real-time clock, elevation measurement, ECG recording and Bluetooth transmission. The vertical acceleration of the torso detected by the chest belt for different types of exercise*

frequencies. Such a system was implemented at the institute in the form of a chest belt (fig. 1, left). Thus it is now possible to recognize types of movement and types of stress telemetrically (fig. 1, right).

The system is able to evaluate patient activity for prevention programs objectively and in a measurable way. Furthermore, it can be used for medical care applications to monitor long term changes in health status. In future it will be possible to download individual training programs into the System. The training programs can automatically be individualized by the sensor using the latest training values combined and referred to the experience of a prevention database.

### ***Virtual Lab***

Interactive mobile-telephone-aided medical expert systems can help improve the quality of medical care and decrease costs. Today all mobile phones are high-performance multimedia devices with extensive features. Cameras and MP3 players are meanwhile standard features. As a consequence there is an additional information channel available. In this manner an additional information channel can be used and in combination with parameters obtained by the sensors, it is possible to get a comprehensive picture of the respective patient's situation. The technical back channel opens further treatment possibilities, such as introducing feedback systems. To do so, the possibilities and limits of biofeedback treatments were analyzed in a virtual laboratory (fig. 2). As is known the quality of the obtained physiological data from humans is quite dependent on time and place. The well-known "white-coat effect" is just one example of how psychophysical

reactions can influence the measured physiological signal. In a first attempt, the laboratory presently comprises ten mobile-phone-assisted data gathering units

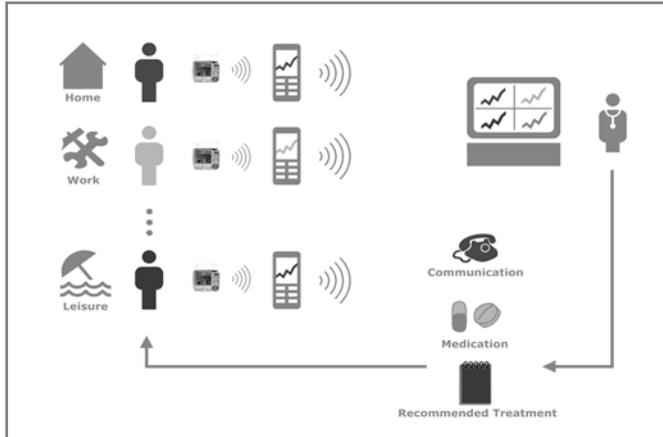


Fig. 2 Interactive medical expert system with back channel for feedback control

capable of transmitting physiological data via corresponding sensors.

Underarm-blood-pressure measuring devices are used as basic modules that allow autonomic or on-demand blood-pressure measurement. The virtual lab permits obtaining authentic data patterns in the patient's personal surroundings and in this way for the first time to get an immediate real impression of the intervention structures. Any sort of intervention is feasible through the two-directional transmission path via language or data communication in the form of text, image and sound between the physician and the patient or vice versa.

As the system is not limited to measuring the blood pressure any desired physiological data can be gathered and transmitted, it can also be employed for other physical or chemotherapeutical feedback therapies. For example, in clinical research it is of interest to check the time a medicine was taken and the response in authentic surroundings. The data gained with this electronic assistance provides important infor-



Fig. 3: Wireless platform for sensor-implants developed at the Heinz Nixdorf-Chair for Medical Electronics

mation for introducing new products. In order to individualize treatment, it is essential to evaluate gender-specific effect and compliance structures. The virtual lab environment, therefore, is an ideal development and test platform for personalized treatment.

### ***Wireless Platform for miniaturized Sensor Implants***

A biocompatible sensor carrier for wireless connection of miniaturized sensor implants was realized at the Heinz Nixdorf Chair for Medical

Electronics [2]: This sensor platform (fig. 3) acquires and sends processed data from the body of the patient to a data logger. From the data logger the data can be read out by a PC at the doctor's place or transferred through a mobile phone to the internet. A bidirectional communication was established, thus it is possible to send information for control, data acquisition and thresholds to the data logger and the sensor implant.

The realized sensor carrier is able to send measured data for half a year. The data can be analog or digital. The long lifetime of the sensor is achieved by a smart energy management controlled by thresholds, times and low power consumption components. The biocompatible system is able to handle bidirectional communications. The dimensions for data processing and transmitter unit including battery are only 2x8x40 mm.

The modular platform makes it especially easy to implement different kinds of miniaturized sensors such as temperature, ph-value, bio-impedance or others. A biofeedback is realized through the data logger. It is possible to give an audio signal, vibration alarms or visual feedback. This feedback can be used for therapies or enable completely new kinds of biofeedback therapies. In this way both diagnosis and monitoring occurs in the comfort of the patient's home environment without influencing the quality of the patient's sleep and thus the measuring results. The sensor carrier developed as an example for the oral cavity can be implanted in other parts of the body and can be used, for instance, to screen cell activity.

### **Conclusion**

All the previously described systems permit any authorized user to easily obtain comprehensive data. The database-aided expert system is, therefore, essential for convenient and individualized evaluation. Profiles can be drawn up for any desired monitored periods, thereby permitting systematic diagnosis and improved treatment.

### **Acknowledgment**

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### **References**

[1] [www.lme.ei.tum.de](http://www.lme.ei.tum.de) [2] [www.senseinside.com](http://www.senseinside.com)

# CONTEXT-AWARE MOBILE TELETREATMENT FOR PATIENTS WITH CHRONIC PAIN

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***Abstract: New ambulant treatments need to be developed to be able to treat all our chronic pain patients in future. The Awareness project [1] develops and validates new mobile health services aiming at remote monitoring of health functions and free health treatment concepts***

## Introduction

Pain is major problem for the western industrialized countries. On average, almost 1 on 5 (19%) of the European citizens experience chronic pain complaints which is about 75 million people in total. 13% of these subjects experience moderate pain and most of them have chronic complaints. The capacity of our current health care system is insufficient to treat all subjects with (chronic) pain in face-to-face treatments. This means that new, more effective and more efficient ways of treatment need to be developed and implemented. The availability of ubiquitous (public) wireless network infrastructure creates the possibility to deploy new mobile health care (M-Health) services; e.g. tele-monitoring or tele-treatment services. It is expected that tele-treatment services are more efficient and effective as intramural care can be replaced by less costly extramural care and patients can train much more intense because they are not bound to the available treatment hours of the therapist. The Awareness project [1] attempts to make a step forward into this new kind of mobile health services by realizing remote monitoring of health functions and by demonstrating the feasibility of free health treatment concepts.

## Methods

To develop mobile health services aiming at remote monitoring and treatment, research is needed into which contextual information is relevant to combine in a meaningful way and how this information can be sensed in a reliable way. In a trial in which 29 patients and 20 asymptomatic controls participated, the best way of sensing the health status of patients with chronic pain has been investigated. For this, a cross-sectional study was

performed in patients and controls. Body movement was measured by means of a Health Body Area Network (BAN). This BAN incorporates a MT9 sensor and is worn by the patient, in-doors and out-doors, so that ambulant remote monitoring of patients and controls is possible. The MT9-sensor of Xsens Technologies B.V. (Xsens 2004) is a sensor that measures bodily movement. Participants were instructed to wear the BAN for seven consecutive days, during waking hours, except during water activities. The experimental protocol was approved by the Medical Ethics Committee of the Roessingh Enschede, the Netherlands.

A second key issue for mobile health services aiming at remote monitoring and treatment is research and development of a M-health service platform that enables a continuous bi-directional data stream between the patient and a healthcare professional. In the Awareness project requirements are defined and a platform is developed subsequently using the service platform of the European projects Mobihealth [2] and HS24 [3] as starting point.

### **Results**

Results of the cross-sectional study show that the overall activity levels of patients (mean 0.67; sd 0.44) are comparable and not significantly different from those of controls (mean 0.62; sd 0.37). However the pattern of activities over the day is different; patients have significantly higher activity levels in the morning ( $p=0.000$ ), comparable activity levels during the afternoon ( $p=0.369$ ) and significantly lower activity levels in the evening ( $p=0.001$ ) as compared to controls. This means that continue recordings of activity during a day are necessary and that feedback on daily activities should be provided multiple times during the day to enable a good distribution of activities over the day. Based on this results, algorithms have been developed for both monitoring and feedback of activity patterns which will be implemented in the M-health service platform.

The M-health service platform is shown in figure 1. The platform consists of a personalized BAN for remote monitoring of activity pattern and a Mobile Base Unit (MBU). Data of the subject are sent to the MBU, which relays this data wirelessly (e.g. GPRS, UMTS, WiFi) to the M-Health Service Platform BackEnd server. This platform consists of software that is (partially) deployed on the MBU and (partially) on the secure BackEnd server. In addition, the platform provides web-based access to the BackEnd services, enabling care professionals to review collected data off-line, but also instantaneously on-line. Based on the performance in combination with context parameters like whether, location, presence etc personalized feedback can be given to the patient to enable him to increase his awareness of daily activities and to achieve a balance in his individual activity pattern. The

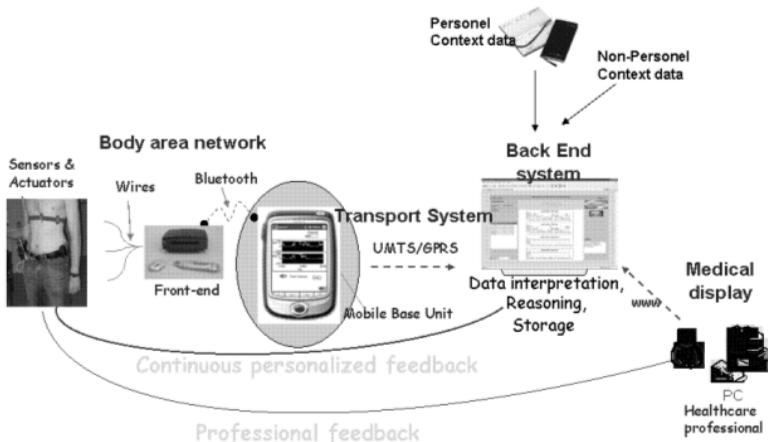


Fig. 1 Context aware health service platform

MBU GUI is designed in such a way that the patient with chronic pain gets continuous visual information about his/her health status but the GUI also displays the feedback at regular moments. Besides the continuous feedback received by the system the patients also receives as much as needed professional feedback from the health care professional who is treating him

### Discussion

Results of the Awareness project so far show the feasibility but also the necessity of continuous reliable sensing of biosignals in every day life in the development of adequate teletreatment services. Besides for monitoring these biosignals will also be used to provide feedback to patients with the goal to change their condition. However more research into feedback strategies that enables optimal treatment effects in teletreatment services is needed. At this moment the algorithms for monitoring and feedback are being implemented in the service platform and a trial to evaluate the full teletreatment service in a group of patients with chronic pain will be performed this year.

### References

- [1] <http://awareness.freeband.nl>
- [2] <http://www.mobihealth.org> and [3] <http://www.healthservice24.com>

# MOBILE/WIRELESS FOR E-HEALTH PROVISION IN AFRICA: OPPORTUNITIES FOR GSM-BASED PATIENT-CENTRIC SERVICES

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## Introduction

Mobile computing and wireless computing devices have been available for many years. However, with the introduction and adoption of cellular phone technology around the world, there are exciting possibilities for the use of these technologies in many areas of endeavour. Already there have been vast increases in the range of services that are available. In European Organisation for Economic Cooperation and Development (OECD) nations there is extremely high market penetration of mobile phones with around 82% people in the European Union (EU) [1]. In Africa, despite enormous increases in subscriber numbers, only about 20% of the population is a mobile subscriber – however, this rate is far above the access to fixed telephone lines [2]. As mobile services become more prevalent around the world, the opportunities increase to use them to support healthcare. They comprise part of mobile and wireless e-health also known as m-health [3].

In this particular paper the emphasis is on the management of chronic disease. According to the World Health Organisation (WHO), 45% of the worldwide burden of disease is non-communicable, including diabetes, cardiovascular disease and cancer [4-5]. These diseases are often seen in Europe as maladies affecting the older population. However, in Africa, the effect of chronic infection is also important in young people, for example HIV and tuberculosis. In chronic disease, people literally have to live with their disease, and the aim for current therapies is disease *management* rather than *cure*. Thus, people with chronic disease will generally be living at home rather than in an institution, with intermittent contact with health professionals. The role of mobile services is of interest to both Europe and Africa. For example, Challenge 5 of the EU 7<sup>th</sup> Framework for research includes a number of topics related to personalized healthcare and mobile Telehealth [6-7]. The primary objective for any work on Information and Communication Technologies (ICTs) and healthcare must be to use the

technology in an efficient and effective way to reduce suffering. Living with a chronic condition often limits economic and social activity, and affects people who do not actually suffer from the condition themselves. The economic costs of common chronic conditions in USA have been estimated as amounting to US\$306 billion in 1996 when health and economic costs (such as work days lost) are taken into account [8]. African nations do not in general have insurance-based systems to pay for healthcare, and the burden of costs of disease falls on the household. A recent study [9] shows that, on average, households in a number of African nations have around 10% of their income consumed by costs associated with HIV/AIDS, TB and malaria. End-stage AIDS can raise this to 100%. These economic losses do not include lost opportunities for national development, which are great. Therefore reduction in spending on chronic disease, by better management, is a priority for both developed and developing nations. Obviously solutions that increase the cost burden are not welcome, so the objective in developing mobile technology e-health is to reduce costs and suffering while imposing minimal extra costs. A number of objectives then become clear. ICT systems can support healthcare in this environment by:

- increasing quality of life, and lifespan of the sufferers
- reducing dependence of the sufferers on others
- assisting with economic reintegration of the sufferers
- preventing excessive healthcare spending
- reducing incidence of chronic conditions – prevention rather than cure

It is plain that these objectives apply equally to western nations and African ones, although the chronic diseases being managed are different. Using ICT to reduce health spending is particularly being promoted in the USA at present [10]. With these objectives in mind, the potential contribution of mobile services to personal healthcare will be examined later.

This paper deals with discussion of some objectives in this area, followed by a background to African mobile services, particularly GSM (Global System for Mobile Communications), some applications in the general area of mobile services, and in particular health-related work, and then an agenda for work supporting personal healthcare with mobile systems.

### **Mobile ICT in Africa**

Using ICTs has been promoted as one of the ways of achieving the eight United Nations Millennium Development Goals (MDGs) – three of which are directly related to health issues [11]. The use of mobile technology has been regarded as a major technological player needed to meet these targets [12]. The GSM Association (GSMA) billed GSM as the most ubiquitous

and beneficial communications technology in history and a major driver of development [13]. Africa has been reported to have the fastest-growing mobile market in the world, especially in the last five years and only 19 years of the first cellular call on African soil [2]. As of early 2005, there were 83 million mobile users in Africa which is twice the coverage of fixed lines [14] but has doubled to 177 million as of November 2006 [15]. This almost geometric progression illustrates the rapid uptake of mobile telephony in Africa. However, the mobile teledensity is relatively low when compared to Europe and even Asia.

### ***GSM Impact in Africa***

A report from the GSMA evaluating the impact of mobile phones in Africa suggested that mobile phone usage impacted positively on the economic growth of many countries, and this was reported to be double that in developed country [2]. The beneficial effect of GSM networks is demonstrated by their use in a number of developmental projects. The First Year Progress Report of the GSMA Development Fund chronicled several projects with considerable benefits [13]. These projects included the “Emerging Market Handset (EMH)” programme, an initiative to make mobile phones financially accessible to the masses, and the “Shared Access to Voice” scheme that involves the development and deployment of a portable GSM-wireless box-phone complete with solar charging accessories to imitate a commercial public phone booth. The hardware and software innovation permits the sharing of a single phone by multiple users. The project, “Shared Access to Data”, involves the use of higher GSM protocols such as GPRS (General Packets of Radio Services), EDGE (Enhanced Data rates for GSM Evolution) and 3G networks to provide access to internet in rural communities via Community Information Centres and Internet Cafes.

The most notable project showcased was a rural telemedicine scheme. This involved the use of an EDGE-enabled low-cost videoconferencing system that efficiently supported surgical and medical treatment by a health team on a floating hospital in Bangladesh. The system enabled the health team to seek informed second opinions through teleconsultations from local and international specialists. Another health initiative employed GSM mobile phones and Personal Digital Assistants (PDAs) in a disease surveillance system to empower and enable health workers to report real-time disease outbreaks such as HIV/AIDS or avian flu for prompt logistical and administrative response. This was piloted in Rwanda and Indonesia. The Java software-based mobile health information system employs the use of GPRS and/or SMS as its transmission medium. The wide availability and presence of GSM networks and the low cost make it the best solution for voice and

data transmission in Africa [12]. However other wireless network protocols are being deployed in various parts of the continent [16].

### ***Complementary Wireless Networks***

Intel, one of the leading players in the WiMAX (Worldwide Interoperability for Microwave Access standard, IEEE 802.16), has commissioned a series of pilot developmental projects in some developing countries under its “World Ahead Programme”. A project in Ghana using WiMAX to connect an e-learning centre for teacher training is currently underway [17]. WiMAX offers direct competition to 3G in providing wireless broadband services, but it might not be widely available in the near future due to the already extensive presence of GSM infrastructure and because of its relatively high cost of deployment and limited end-user devices. Wireless Fidelity (WiFi) is specifically used for building Local Area Networks (LAN) within a small area of 100-150 metres radius (depending on the version) to connect directly to mobile devices such as mobile phones or PDAs. Recent innovations to extend the range of WiFi have been achieved, and its capability has been demonstrated in e-health projects in some developing countries. The EHAS telemedicine project for supporting health workers and health service provision in Peru has deployed a solar-powered 100 km long-range WiFi mesh-network [18]. Also, a joint initiative involving the University of Berkeley in the USA and Intel has developed a 70km WiFi-based Long-Distance (WiLD) network which has been piloted in India for a rural teleophthalmology health programme and in Ghana for a university-based tele-education system [19]. Although, these two wireless technologies have capacities for data and voice transmission, they are better used for “last mile” initiatives, i.e. to provide access to end-users within a limited range and space [20].

The use of VSAT (Very Small Aperture Technologies) satellites is another well implemented wireless technology in Africa. It is not regulated, but the limited range, high cost of implementation [21] and lack of direct connectivity to mobile devices are limiting factors in its wide usage. Another widely used wireless technology is Wireless Local Loop (WLL). WLL is more of a wireless connectivity concept, rather than a wireless technology protocol for providing data and voice transmission within a limited geographical zone. WLL has been used in Africa for tele-education. Recently, the European Space Agency (as part of the Africa-EU Partnership for Infrastructure initiative through a “Workshop on telemedicine for Africa”) identified the potentials of satellite technologies for the development of health-care systems in Africa. A Telemedicine Task Force constituted at the meeting later developed an agenda for the need to carry out situation analysis

and needs assessment on existing African countries' health and telecommunications infrastructure, existing telemedicine projects, and existing national e-health/telemedicine policies and strategies [22].

### **Health Applications in Africa**

The use of simple mobile applications like SMS for health promotion purposes has been demonstrated extensively in Africa. For example, in South Africa, SMS text messaging has been used to improve the drug compliance of TB patients undergoing treatment in their homes [23], to educate in HIV/AIDS prevention, to provide information support to pregnant women and breast cancer victims, and also to provide nutritional and health information [24].

Advanced wireless/mobile applications include projects like a pilot project in Uganda that tested a PDA-based Java 2 Platform Micro Edition (J2ME) system known as "Mobile AntiRetroviral Support" (MARS). It has been used for the provision of evidence-based care for people living with AIDS. The evaluation of the PDA-based clinical practice guidelines revealed considerable adoptability and usability by a small sample of different low-level health workers with the main benefit being a reduction in the time they spent making a decision about a patient's care [25]. A project in Kenya, involving the use of PDAs connected using a WiFi network within a hospital, provided doctors with access to the web-based medical knowledge system "Map of Medicine" to manage clinical cases of malaria, tuberculosis, HIV/AIDS, abdominal pains, diarrhoea and typhoid fever [26]. In another project in South Africa, a combination of VSAT, WiFi and Voice Over Internet Protocol (VOIP) has produced a sustainable rural telemedicine programme [27]. A malaria eradication project deployed VSATs as a connectivity model to connect health researchers in Africa with their counterparts in the USA. This has been operational for the last 10 years [28].

The most ambitious, large scale and successful wireless or mobile health information system has been implemented in Uganda over the last three years. The Uganda Health Information Network (UHIN) employed over 350 PDAs to empower health workers with access to continuing medical education, for collecting routine health data, and e-mail for communications. This system is built on the existing GSM wireless network forming a District Health Information System in three health districts [29]. Another ambitious and successful project is the Cell-Life project in South Africa, a rapidly expanding project with multiple applications combining the use of GPS (Global Positioning System), GIS (Geographical Information Systems) and GSM for a range of activities such as HIV/AIDS drug tracking, patient management, HIV/AIDS Voluntary Counselling and Testing (VCT), health

laboratory administration system, clinical administration and to empower [30] community health workers for peer to peer support for HIV/AIDS sufferers. Even, the World Health Organisation (WHO) is moving some of its public health tools to mobile devices. The “Health Mapper tool”, a computerised public health information system for disease surveillance system involving the use of GIS and satellite technology has been recently been adapted for mobile use. This PDA-based system combined with GPS has been used by low level health workers in Zambia and Uganda to collect data on health services availability and for HIV/AIDS prevention data in schools and workplaces within the community [31-32]. In another recent development, WHO has implemented a mobile child growth and development monitoring system deployable on PDAs. This “WHO Anthro 2005 Software” is made up of an anthropometric calculator, individual assessment, and nutritional survey components for on field data collection. The various applications of mobile and wireless technologies in Africa presented above demonstrate the feasibility and viability of deploying these for health purposes. There are various developments, especially in the GSM arena, that present arrays of opportunities to leverage these technologies for empowerment and support of chronic disease sufferers in Africa. The next section will present some potential future applications of these technologies for patient-centric e-health purposes.

### **Models for the Future**

#### ***A model for future work – Mobile patient-centred services***

Patient-centred services have three main elements that can be supported by mobile devices.

Firstly, there is access to health professionals via voice or other data transmission. The UHIN and the Cell-Life projects are already employing this model [29-30]. This access may be by the patient themselves or by someone on their behalf. Mobile devices can be located in or near people’s homes, and allow communication with health professionals who may be unable to visit. The community telecentres or the “Shared Access to Data or Voice” concept provide a platform for this approach [13].

Secondly, there is access to health related information, which may be general, dealing with health issues, for example in a particular geographical area or in terms of a particular risk or more personalised in response to a specific query or identified need. Mobile devices can use low-cost SMS messaging for automated query-answering or ‘push’ information dissemination, e.g. in diabetes [33]. This can be used to support HIV/AIDS and TB patients in Africa. The illiteracy rate in Africa could be a barrier to the read-

ing of SMS text messages, but the new voice SMS concept can be used to deliver messages in local languages [12].

Thirdly, mobile devices can be integrated into a care plan so that data from a patient phone is transmitted to health professionals or automatic systems. Examples of these systems include for smoking cessation, which may encourage healthier lifestyles to prevent chronic disease [34]. This approach might be applicable for AntiRetroviral Therapy (ART) compliance monitoring system or for TB drugs reminders. More advanced systems may also collect information to allow disease management, for example in the case of asthma [35]. The similarity between asthma and TB could make this system applicable to the management of TB patients in Africa. By interfacing physiological monitoring devices to the phone, heart rhythm (for example) can be monitored remotely [36]. This might not be feasible presently in Africa, but with the rise in cardiovascular diseases in the affluent population of urban areas, this might not be far-fetched.

Mobile phones have an intrinsic degree of location awareness, as they need to identify which cell they are using. This has been used to provide context-appropriate information in hospitals [37], but could also be extended to the community, for example in the identification of local health resources, or issuing advice in the case of pandemics.

There is an assumption in Europe and elsewhere that each person has exclusive access to their own personal mobile phone. In Africa, despite enormous recent increases in subscriber numbers, only about 20% of the population is a mobile subscriber, but it is often the case that mobile phones are used in a communal sense, with phones being 'rented' or lent to others. This inhibits them being used as individual devices. However, even high penetration rates do not equate to universal access, and older people and people with disabilities may not wish (or be able) to use conventional mobile devices. Again, the "Shared Access to Data and Voice" project could present a way of overcoming this barrier. However, there are a number of barriers to the use of mobile phones. Cost of the handset and services, although smaller than previously, remains a barrier for people with low incomes. As mentioned earlier in this paper, the EMH initiative of making mobile phones financially accessible to everyone could be a way of circumventing this barrier. Health applications are only part of the use of the phone, so the hardware and service connection must be generic in terms of the services available and the other uses of the phone. Shared phones are not useful for delivering personalised messages that need to be responded to in a short time, and issues of privacy, for example as to HIV status, may be important. Users of phones may not be able to read text messages, or accurately enter text on conventional phone keypads. The language used in terms of techni-

cal terms and in multilingual environments needs to be appropriate for the user. Training for the user, and realisation of the potential impact on them, is particularly important, and user experience is paramount [38]. Battery life and robustness, especially with regard to use in remote locations, are important issues. Most importantly, the degree to which an M-health solution actually benefits users and allows for cost-effective health improvements must be studied in a structured and consistent way [39].

## References

- [1] "OECD Communications Outlook," Organisation for Economic Cooperation and Development 2005
- [2] Vodafone, "Africa: The Impact of Mobile Phones," Vodafone March 2005.
- [3] S. Tachakra, X. H. Wang, R. S. H. Istepanian, and Y. H. Song, "Mobile e-Health: The Unwired Evolution of Telemedicine," *Telemed. J. and e-Health*, vol. 9, pp. 247-257, 2003.
- [4] World Health Organization, "Facts related to Chronic Disease," vol. 2006, 2006.
- [5] WHO, "Facts related to Chronic Disease," vol. 2006. Geneva: WHO, 2006.
- [6] EC, "A Theme for research and development under the specific programme "Cooperation" implementing the FP7 (2007-2013) of EC for research, technological development and demonstration activities: WP 2007-8" Europe's Information Society, Helsinki 21-23. 11.2006
- [7] IST Event, "ICT and Ageing - Accessible and Inclusive ICT," Europe's Information Society, Helsinki 21-23.11.2006.
- [8] B. G. Druss, S. C. Marcus, M. Olfson, T. Tanielian, L. Elinson, and H. A. Pincus, "Comparing the national economic burden of five chronic conditions" *Health Affairs*, vol. 20, pp. 233-241, 2001.
- [9] S. Russell, "The economic burden of illness for households in developing countries: a review of studies focusing on malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome," *Am. J. Trop. Med Hyg*, vol. 71, pp. 147-155, 2004
- [10] T. Bell, "High-Tech Methods to Cut Medical Costs," in *The Institute*, vol. 2006: IEEE, 2006.
- [11] InfoDev, "E-Ready for What? E-Readiness in Developing Countries: Current Status and Prospects toward the Millennium Development Goals," brigdes.org, Cape Town 2005.
- [12] Ericsson, "Communication for All," Ericsson AB October 2005.
- [13] GSMA, "Development Fund Annual Review," GSM Association 2005.
- [14] GSMA, "Regulation and the Digital Divide," GSM Association 2006.
- [15] L. Goering, "Africa Embraces a Wireless Way of Life," 27 November 2006.
- [16] ITU, "World Telecommunication/ICT Development Report 2006: Measuring ICT for social and economic development," International Union of Communication., Geneva 2006.
- [17] Intel, "Bringing broadband where it was once thought impossible," 2006.
- [18] A. Rendon, A. Martinez, M. F. Dulcey, J. Seoane, R. G. Shoemaker, V. Villarroel, M. Lopez, and J. Simo, "Rural Telemedicine Infrastructure and Services in the Department of Cauca, Colombia," *Telemed J E Health*, vol. 11, pp. 451-9., 2005.
- [19] S. Lakshminarayan, S. Sonesh, P. Rabin, "Rethinking Wireless for the Developing World," 5 *Workshop on Hot Topics in Networks (HotNets-V)* Irvine, California: ACM SIGCOMM, 2006
- [20] H. Galperin, "Wireless Networks and Rural Development: Opportunities for Latin America," *Information Technologies and International Development*, vol. 2, pp. 47-56, 2005.
- [21] ITU, "'Bridging the digital divide, providing digital opportunities for all'," International Union for Telecommunications, Geneva 2002.
- [22] ESA Telecommunications, "Telemedicine initiative for sub-Saharan Africa," June 2006.
- [23] J. Husler, "Evaluation of the On Cue Compliance Service Pilot: Testing the use of SMS

- reminders in treatment of tuberculosis in Cape Town, S. Africa.," Bridges.org, Cape Town 2005
- [24] GenderIT.org, "HIV/AIDS and mobile technology: sms saving lives in Africa," 03.2005.
- [25] G. Woods, W. Grimson, G. Stephens, P. Coakley, M. Ryan, C. Merry, J. Grimson, "Applying Mobile Devices to Promote Evidence-based Practices for HIV/AIDS in Resource Deprived Environments," *IST-Africa*. Nairobi: IIMC Intern. Info Management Corp., 2006.
- [26] Cisco, "Rural Kenya Adopts Wireless Technology and Unique Medical Map to Improve Patient Care and Student Education," Cisco Systems 2006.
- [27] X. Vuza, "An IP based Multi-Modal Semi-Synchronous Rural Tele-health Service: Adding Video Messaging and Conferencing to MuTI," presented at Proc. South African Telecommunications Networks & Applications Conference, (SATNAC 2004), 2003.
- [28] J. Royall, M. Bennett, I. Schayk, and M. Alilio, "Tying up lions: Multilateral Initiative on Malaria Communications: the first chapter of a malaria research network in Africa," *Am J Trp Med Hyg*, vol. 71, pp. 259-267, 2004.
- [29] IDRC, "The future of Africa is mobile," International Development Research Centre 2004.
- [30] "Cell Life," Civil Engineering Department of University of Cape Town, Cape Town 2006
- [31] WHO, "Service Availability Mapping (SAM)" World Health Organisation, Geneva 2006.
- [32] "WHO Anthro 2005 software and macros," World Health Organisation., Geneva 2006
- [33] A. E. Wangberg SC, Andersson N., "Diabetes education via mobile text messaging," *Journal of Telemedicine and Telecare*, vol. 12, pp. 55-6, 2006.
- [34] A. Rodgers, T. Corbett, D. Bramley, T. Riddell, M. Wills, R. B. Lin, and M. Jones, "Do u smoke after txt? Results of a randomised trial of smoking cessation using mobile phone text messaging" *Tob Control*, vol. 14, pp. 255-261, 2005.
- [35] J. Anhøj and C. Møldrup, "Feasibility of Collecting Diary Data From Asthma Patients Through Mobile Phones and SMS (Short Message Service): Response Rate Analysis and Focus Group Evaluation From a Pilot Study," *J Med Internet Res*, vol. 6, pp. e42, 2004.
- [36] B. Woodward, R. S. H. Istepanian, C. I. Richards, "Design of a telemedicine system using a mobile telephone," *Information Technology in Biomedicine, IEEE Transactions*, vol. 5, pp. 13-15, 2001
- [37] M. D. Rodriguez, J. Favela, E. A. Martinez, and M. A. Munoz, "Location-aware access to hospital information and services," *Information Technology in Biomedicine, IEEE Transactions on*, vol. 8, pp. 448-455, 2004.
- [38] B. Niman, T. Sund, A. Rodriguez-Ascaso, S. Brown, "User experience design guidelines for ubiquitous, mobile telecare services," presented at Healthcom2006, New Dehli, 2006
- [39] C. J. Fitch, J. S. Briggs, and R. A. Beresford, "System issues for telemedicine systems," *Health Informatics Journal*, vol. 7, pp. 222-230, 2001.
- [40] T. S. Parikh, P. Javid, K. Sasikumar, K. Ghosh, and K. Toyama, "Mobile phones and paper documents: evaluating a new approach for capturing microfinance data in rural India" *Proceedings of SIGCHI conference on Human Factors in computing systems* Montreal: ACM Press, 2006 pp. 551-560
- [41] Y. Gai, H. Wang, and K. Wang, "A virtual mouse system for mobile device," presented at Proceedings of the 4th international conference on Mobile and ubiquitous multimedia Christchurch, New Zealand 2005
- [42] H. Kato and K. T. Tan, "2D barcodes for mobile phones," presented at Mobile Technology, Applications and Systems, 2005 2nd International Conference on, 2005.
- [43] J. Lai, S. Mitchell, M. Viveros, D. Wood, and K. Lee, "Ubiquitous Access to Unified Messaging: A Study of Usability and the Use of Pervasive Computing," *International Journal of Human-Computer Interaction*, vol. 14, pp. 385-404, 2002.
- [44] Y. M. Kim, F. Putjuk, E. Basuki, and A. Kols, "Increasing patient participation in reproductive health consultations: an evaluation of "Smart Patient" coaching in Indonesia," *Patient Education and Counseling*, vol. 50, pp. 113-122, 2003.

# MOBILE ECG: A NEW EHEALTH SOLUTION FOR TELECARDIOLOGYBASED ON EHIT HEALTH GATEWAY PLATFORM

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**Abstract:** It is often difficult for the patient to tell the difference between angina symptoms and heart attack symptoms, therefore it is very important to recognize the signs of a heart attack and immediately seek for medical attention. This paper presents a mobile solution, which makes use of a wearable wireless ECG miniature sensor in combination with a mobile phone to collect, store and forward ECG data to a cardiologist for analysis. A practical case of remote consultation is also described.

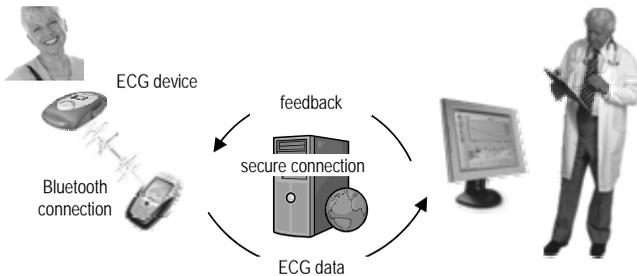
## Introduction

Coronary heart disease is by far the most common cause of death in many countries [1]. Every few seconds, someone in Europe is suffering of chest pain caused by an insufficient supply of blood to the heart. While a short-term oxygen scarcity usually origins angina pectoris, a long-term severe lack of oxygen causes a myocardial infarction. A large damage may generate abnormal ectopic contractions of ventricle, which may eventually lead to a cardiac arrest. Therefore it is very important to identify a heart attack and immediately seek for medical attention. Instead heart attack victims, wait on average two hours or more after the beginning of symptoms, before they seek medical help.

The electrocardiograph is certainly the most effective tool to identify anomalies in the cardiac activity. Since the earliest interpretation of a human electrocardiogram (ECG) given by British physiologist Augustus D. Waller 120 years ago [2], the analysis methods have been dramatically improved. However today diagnosis is still made by analyzing fractions of wave patterns and irregular rhythms recorded for several minutes.

Portable cardiograph practically exists since 1949 when physician Norman Jeff Holter developed a system used to record ambulatory ECGs over a long-term recording [3]. But it was only less than 10 years ago that researchers from Texas demonstrated the feasibility of transferring ECG data via wireless technology to hand-held computers where it can be reliably interpreted by cardiologists [4].

### Overview of the proposed system



*Fig. 1 Remote ECG monitoring with immediate feedback*

The eHIT Health Gateway mobile electrocardiograph offers a simple yet efficient way to be in contact with health professionals anytime and almost anywhere.

The system consists of a wearable wireless 3-lead ECG miniature sensor, which continuously measures the heart activity and wirelessly transfers the data directly to the mobile phone of the patient. The information is then automatically transferred in real time to the health care provider by using a secure wireless connection such as GPRS, GSM, CDMA, or 3G.

The received information is stored into the Health Gateway server where it is available to the health care professionals for immediate analysis [5]. Authorized personnel of the health care provider can examine the received data and send an immediate feedback directly to the mobile phone of the patient. The mobile phone also keeps a record of the registered events, which will be available for future reference.

### Handling of security and privacy issues

The transmission of binary data is often seen as a possible security threat. Because of its nature, a binary transmission can contain any sort of data including for example viruses or other malware. Therefore it is extremely important to positively authenticate the sender when exchanging binary data. The system proposed exchanges binary data by using unique session keys and secure protocols.

The first step is the authentication of the sender (mobile phone), which is performed by using a secure HTTPS connection. After authentication, the sender requests a session key from the Health Gateway server. This unique session key is then used to open a binary connection to a secure socket on the server. The socket communicates by using a Transport Layer Security protocol ensuring that third part cannot eavesdrop or tamper with the content of the message.

The session key is then used to open the data transmission session and the transmission of binary data can begin. In case the connection is lost during data transferring, the sender can resume the transmission by using the same session key. When all of the data is transferred, the sender closes the current session and the key is invalidated. A new session, can only be initiated by starting a new authentication procedure and by requesting a new key.

A similar procedure is followed when downloading the information from the Health Gateway server to the remote workstation in use at the cardiologist. Additionally, the unique session key is also used in all the transactions to ensure the correct association between binary data and the initial context i.e. patient data.

### **The ECG sensor**

The ECG sensor used by the proposed system can be equipped either with integrated or external electrodes. It has a resolution of 12 bits and an adjustable sampling rate, which can reach the exceptional value of 5000 Hz. The adjustable sampling rate makes possible the optimization of the data load for the precision required by the application. For instance a sampling rate of 1000Hz or higher can be utilized when accurately measuring heart rate variability, while sampling rates of 500Hz or less may in some cases be adequate to define the R wave. The microprocessor onboard the sensor is capable of elaborating the received data on line and can for instance calculate Heart Rate Variability (HRV) and other parameters such as the depression of ST segment and QRS interval. The calculated values can be immediately transferred to the mobile phone or stored in a local memory for later downloading.

The electronic sensor is also equipped with a parametric digital filter, which is capable of cleaning the signal from possible noise. This is particularly significant in substantially reducing noises generated by muscle activities (EMG signals).

### **A practical use of the proposed system**

The system proposed is in use in a study, where ECG data are recorded over several hours without disturbing the routine daily life of the subjects. The collected data are then remotely analyzed by specialists, and correlated to a database of anonymous data.

The study focuses on the fine fluctuations of the R-R intervals, which are analyzed and processed by using a particular algorithm specially created for this purpose. The result is a single parameter called index  $\mu$ , which expresses the variability of the heartbeats. Although a large number of studies

have been made on HRV, the  $\mu$  index is calculated in a completely new method, which allows sensitive detection of HRV in an innovative way.

For each measurement session the algorithm also generates an image in colors representing the individual characteristics of the heart. These computer-generated pictures greatly differ from one subject to another and vary with the age of the patient and possible abnormal conditions of the heart.

### Conclusion

A complete examination of the heart status should always be carried out with a full (12 lead) ECG, however the system proposed can quickly provide important information that would otherwise be missed. In fact this solution offers the subjects the capability of recording and simultaneously transmitting the ECG signal whenever they feel pain in the chest or heart irregularities.

Additionally, the feeling of being in virtual contact with the health care professionals provides a sense of safety to the subjects, without the hassles of permanent monitoring.

According to the preliminary results of the case study described, several measurements sessions taken in different situations are important to assess the condition of the heart. This wireless ECG miniature sensor combined with the Health Gateway platform offers a valuable tool for easy measurement of ECG without interfering with everyday's life.

### References

- [1] The European Health Report 2002, WHO.
- [2] A.D. Waller, "A demonstration on man of electromotive changes accompanying the heart's beat". *J Physiol (Lond)* 1887.
- [3] Holter NJ, Generelli JA. "Remote recording of physiologic data by radio" *Rocky Mountain Med J*. 1949.
- [4] Pettis KS, Savona MR, Leibrandt PN et al. "Evaluation of the efficacy of hand-held computer screens for cardiologists' interpretations of 12-lead electrocardiograms." *Am Heart J*. 1999.
- [5] A. Holopainen, F. Galbiati, K. Voutilainen, "Use of modern mobile technologies to enhance remote self-care services," in *Proceedings of the 6th Nordic Conference on eHealth and Telemedicine*, Finland, 2006.

# TELEMEDICINE IN A COMPLEX OF SOCIALLY SIGNIFICANT SERVICES TO THE POPULATION IN RUSSIAN AND CIS COUNTRIES

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**Abstract:** This paper is devoting to the telemedicine services in a complex with others services to the population by usage of multifunctional mobile units systems.

## Introduction

Russia, that has joined in implementation of the Okinawa Charter on Global Information Society, the final documents of the World Summit on Information Society, the European-Russian Road Maps, builds its information society as a component of the world information society. Similar to other countries of G-8 and European Union the Russian Federation has its related state program – “Electronic Russia (2002-2010)”.

Development of an information society oriented to the interests of a man is a common target for the state and municipal authorities, private sector and civil society. It should be realized on the basis of cooperation and partnership relations among all interested parties.

At present the most important targets for the information society in Russia are:

- Development of a man-oriented open, legal information society in which each has an access to the information and necessary socially significant services;
- Utilization of a potential for provision of a wide spectrum of services for attainment of the objectives of the socioeconomic and cultural development of a country, improvement of people life quality.

## **Complex Services to the Population**

A democratic state should express the needs, interests and purposes of the life of all its citizens and promote their satisfaction which is necessary for expanding the possibilities of each individual and sustainable progressive development of the society and the state proper.

At present the building of such socially-oriented state may be efficient only on the basis of new economics, on the principles of power transparency on all levels, provision of wide services by the state to the population. And the efforts of the state to meet the vital needs and interests of the citizens involve application of high technologies, first of all, information-communication ones. This reduces costs, widens a spectrum of participants, reduces time and resolves the problem of distances.

The citizens that take advantage of the information-communication technology may anticipate that the state will provide services in the on-line mode, quickly and simply, and that they will be able to control the related administrative process. This should lead to a greater quantity of services and their better quality and also to greater transparency of state and municipal institutions.

“Electronic government” that organizes state management on the basis of electronic means for information processing, storage and dissemination should ensure equal rendering of a complex of state services to all categories of the citizens: pensioners, workers, businessmen, state and municipal employees and others.

The most important constraint of development of services on the basis of the information-communication technologies in the present-day world for elimination of which the concerted efforts of the world community are aimed at is the digital breakup among various categories and groups of the population (by educational, property, age, territorial and other features).

In Russia and other CIS member states this digital breakup is curbed largely by the following factors:

- Inadequate development of the information-communication infrastructure;
- Application of the information-communication technologies by a few of the population;
- Gaps in the legislation.

Therefore, the access to differences services for representatives from different categories, groups or strata of the community in Russia and CIS countries is not identical.

In addition, various services are provided by different organizations, within different time and in different places. In fact, there is no possibility

to obtain all necessary services from the state in one place and in a certain fixed time period.

In other words, there is no real possibility for the most of the population to get simultaneously an access to a complex of necessary services, in particular in the rural area, low-populated territories and not easily accessible regions.

In Russia and CIS member states in order to overcome the digital breakup the pressing issue is to elaborate and implement projects on creation in the regions (especially in rural areas, low-populated areas and not easily accessible areas) of multi user access points (MAP) to Internet with a view, first of all, to organize efficient information interaction of the state with the citizens and organizations that have no Internet access of their own. PMA to Internet are usually located in post offices and telecommunication establishments, educational and cultural institutions, public organizations, etc.

In Russia in 2005 within the framework of the “CyberMail@” Project over 10 thousand MAP were opened in all regions in post offices and telecommunication establishments. More than 3.5 million people used them with the average visiting rate of these points being approximately 300 thousand people.

In fact, the “cybermail” points start turning into centers for provision of telemedicine, tele-educational, banking, insurance, logistic and other services to the population and organizations, which is most important for rural areas, low-populated areas and not easily accessible areas.

Obviously, the quantity of such stationary “cybermail” points is not sufficient to cover the whole population with the necessary socially significant services for which, among other things, there are objective reasons (infrastructure, economic and others). This urged to develop and introduce “cybermail” multifunctional mobile complexes (MMC) that may be deployed for some time as stationary points or used as mobile points.

A telemedicine laboratory is the most intricate part of MCC that should meet the most specific requirements to its maintenance and operation for efficient provision of telemedicine services.

### **Telemedicine Services**

Medicine services in Russia and CIS countries are at present the most important kind of services provided to the population which, apart from other most important tasks on improvement and development of the social component of the state, require healthcare promotion. Improvement in healthcare should be realized, primarily, through development of “electronic healthcare”.

The CIS countries establish joint national telemedicine consultancy-diagnostic systems with a view of a follow-on integration of the national systems into a single telemedicine system of the CIS member states and in the future – inclusion of such telemedicine system into a worldwide telemedicine system.

“Electronic healthcare” in the CIS countries covers, first of all, the following directions:

- National information medicine systems and corporate systems of healthcare management;
- Telemedicine systems and telemedicine services;
- Electronic medicine passports and electronic medicine cards of patients.

The most urgent issues in electronic telemedicine for the CIS countries are the following:

- Carrying out of periodical health examinations and mass preventive surveys of the population, in particular in rural areas, low-populated areas and not easily accessible areas;
- Development of telemedicine in the system of specialized medical aid;
- Creation of urgent medical aid in emergency situations during disasters and terrorist acts;
- Development of distant education within the framework of continuous professional training of the personnel of public healthcare establishments.

These tasks are resolved applying a complex of information-communication technologies and other technologies that help to ensure mobility of medical aid, which gives a possibility to get consultancy from competent medical specialists distanced from the patients.

Russian experience has demonstrated the economic and social feasibility of organization, first of all, of the following telemedicine systems:

- General civil purpose;
- A disaster medicine service for provision of urgent medical aid to the population in the course of liquidation of the consequences of emergency situations;
- A system of multifunctional mobile complexes (MMC) for provision of a complex of social services to the population with the medical services being dominating.

One of the main factors that curb the wide-scale application of telemedicine is insufficient development of the issues related to functioning of telemedicine systems. In addition, now in Russia the schemes of telemedicine

system operation ensuring different economic efficiency are proposed for use.

The analysis of various schemes has indicated that the optimal organizational-financial scheme of provision of telemedicine services being shaped at present is a scheme developed and applied by the National Telemedicine Agency (Russia).

This organizational-financial scheme is based on independent providers of telemedicine services purchasing medical consultation and diagnostic services from duly licensed medical consultancy centers and selling these services to the provider's clients in accordance with the declared tariff plans and regulations. Herewith the clients of a provider of telemedicine services are treatment and preventive-treatment establishments, private practicing doctors, insurance companies and private persons.

In Russia a telemedicine system comprising stationary and mobile telemedicine centers is repaid during two years.

Some CIS countries assigned appropriate finance and got down to operation of telemedicine systems, too.

The CIS telemedicine specialists know about practical, socially and financially successful results of two-year operation of an integrated telemedicine network in the Ural Federal District and in the Perm Area of the Russian Federation that was established by CJSC National Telemedicine Agency (NTA) of Russia.

NTA has chosen as a basis a perspective scheme of a state-commercial partnership.

The company creates a telemedicine system at its own expense and using bank credits. The financial inputs are repaid from provision of medical services to the population through a telemedicine system. The payment for the services is charged by state tariffs stipulated in the national legislation on state guarantees of medical servicing of the population from local budgets, the budget of the Obligatory Medical Insurance Fund, polices of voluntary health insurance, private capital.

Two years of operation of telemedicine systems in the Ural Federal District and in the Perm Area of Russia which peculiar feature was establishment of a system uniting telemedicine points organized in stationary medical institutions of different levels and mobile telemedicine laboratories (MTL) designed to cope with various medical tasks gave the following results:

- Increase by 20% of the people who got access to medical aid;
- Widening of a range of in- and outpatient assistance to the population, in particular in rural areas;

- Quicker introduction of new methods of treatment, including high-technological and costly;
- Improvement of the medical personnel qualifications;
- Improvement of an epidemiological situation, in particular in relation to TB and AIDS, due to detection of primary sick persons on the early stages;
- Increased rate of detection (from 10% to 20%) of oncologic patients on the early stages;
- Lowering of temporary disability to 20%;
- Lowering of a death rate by 5% and corresponding increase of an average life span;
- Decrease of the average number of years of “not reaching” the pension age by approximately one year.

The economic efficiency assumes attainment of the aforementioned medical and social indices at much less expenses that would be required for obtaining of the same indices by traditional methods without application of telemedicine technologies. Optimal expenses are achieved due to transformation and widening of a scope of primary medical-sanitary aid in accordance with the existing standards, the kinds and nature of which match the sick rate, requirements and expectations of the population; optimal utilization of the quotas assigned to treatment of the population in the federal medicine centers by the RF Ministry of Public Health and Social Development. The idea of combining the mobility with telemedicine technologies turned out rather efficient.

### **Conclusion**

At present more than 15 options of mobile telemedicine laboratories (MTL) are developed in Russia and the further works are in progress.

Further development of systems for integrated provision of socially significant services to the population irrespective of places of their living, social status and educational level requires rallying of forces of state authorities of different levels, public organizations and business for pushing and ensuring wider awareness of application of information-communication technologies in various fields of activities, first of all, in public healthcare.

Healthcare organizers and medical professionals should take actions to improve the medical and economic requirements to electronic healthcare systems and to be their main users.

Specialists on information-communication technologies should ensure more efficient functioning of the systems for integrated provision of services to the population as systems of mass servicing.

# THE MOBILE DOCTOR: AMBIENT MEDICINE<sup>®</sup> THROUGH SENSOR-AIDED PERSONALIZED TELEMEDICAL DEVICES

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**Abstract:** Economic constraints in health care, innovative health care legislation and new developments in medical engineering have led to improved and at the same time cost-effective care for the chronically ill. Modern information and communication technology can make an essential contribution to organize the care process more efficiently. Presented is the Telemetric Personal Health Monitoring Platform developed at the Heinz Nixdorf Chair for Medical Electronics and put in a medical context using case studies.

## Introduction

The present situation in health care is characterized by continuously increasing expenditure with little cost transparency accompanied by decreasing quality.

A possible solution could be personalized sensor-aided information systems, which provide the patient, on the one hand with the necessary diagnostic certainty and on the other hand with quick, cost-effective intervention when needed [1,2]. Not only the elderly but also a growing number of chronically ill or people feeling temporarily indisposed require automatic knowledge-based systems for self-diagnosis and assistance in the healing or therapy processes.

Hitherto, as far as technical measuring instruments are concerned the average household confined itself to the thermometer. The present state of biosensor measuring technology permits analyzing much more complex health situations which in combination with knowledge-based feedback systems can also provide concrete advice regarding behavior, medication and therapy. Based on our year long experience in developing biomedical sensors and instruments for biotechnological systems [3], we started to put our experience to use in developing personalized biomedical measuring

systems and set up a knowledge-based biomedical assistance system via database systems (fig. 1). The following examples demonstrate selected applications.

### Telemetric Personal Health Monitoring Platform

Based on a concept for transmitting critical health situations, particularly for high risk and chronically ill patients [4] that was awarded a prize in the 1999 BMBF competition in medical engineering, we developed a telemedical platform and implemented it, as an example, to determine blood pres-



*Fig.1: Telemedical health care platform developed at the Heinz Nixdorf-Chair for Medical Electronics for individualized, personalized medicine sure and lung function values and other biomedical parameters.*

#### **Blood Pressure Measuring System**

In blood pressure self-measurement, the quality of the gathered data increases considerably if the blood pressure is measured in real surroundings, preventing the “white-coat effect”, also referred to in medicine as practice hyper tonicity. In order to make self-measurement more flexible, the Heinz-Nixdorf Chair for Medical Electronics in collaboration with Omron developed an individualized, fully automatic, mobile blood pressure measuring system with database access (fig. 2). The patient’s measured data are automatically transmitted from the blood pressure measuring device connected with a communication dongle via Bluetooth to a mobile phone and from there by an email service via GPRS or UMTS to the physician. The two-directional transmission path permits immediate intervention and flexible adaptation to personal, individual

situations. Successfully tested by the doctors and patients at many rehab-clinics, the mobile blood pressure measuring system [5] is presently in use there.

In addition to automatic data gathering, the telemetric blood pressure

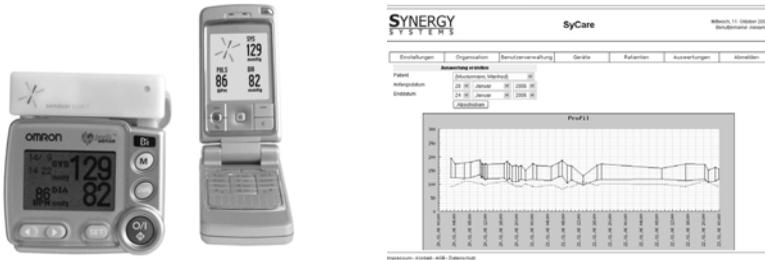


Fig. 2: The telemetric blood pressure measuring system developed at the Heinz Nixdorf Chair for Medical Electronics

measuring system also permits controlling the patient’s intake of medicine and adjusting the patient’s circadian rhythm or dosage.

**Lung Function Measuring Device**

Other mobile patient-specific diagnostic systems on this basis were also developed, in particular the first telemedical spirometer [5] for measuring lung function parameters (fig. 3). Asthma and chronic obstructive lung disease (COPD) are widespread and afflict about 150 million people worldwide with increasing tendency. Patient monitoring is a crucial aspect of treatment. The spirometer which measures the lung function values, determines patient’s condition respectively the state of the respiratory disease. In order to judge the course of treatment, a record needs to be kept of the other treatment measures. The time the medication was taken, the pollen count in different regions as well as the outdoor climatic conditions can influence the

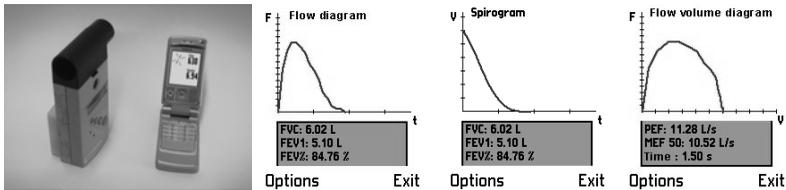


Fig.3: The telemetric lung function measuring system developed at the Heinz Nixdorf Chair for Medical Electronics and various graphs measurement shown on a mobile phone display

treatment success treatment considerably.

A commercially available spirometer from Vitalograph was equipped with

a Bluetooth communication dongle that transmitted the values determined following peak-flow measurement automatically to a mobile phone and then to the database. If combined with an inhalator, the telemetric lung function measuring system can simultaneously document and monitor medication intake. These data permit judging patient compliance and also help in training behavioral change.

### **Systemic Telemedicine**

Development of such sensor-aided, personalized telemedicine systems must be accompanied by setting up a database-supported call center staffed by medically trained personnel. The call center can then, based on patient-specific physiological measuring data, obtain additional information from patients by asking standard structured questions and comparing the answers with a knowledge database. As is well-known patients' compliance diminishes between visits. Automatic monitoring of vital parameters and regular contact to patients between visits or contacts fills in an information gap for the attending physician and the individualized care proven raises compliance. The described possible scenarios indicate the desired positive health care and personal aspects. The outlined method would contribute to emancipating the patient and reducing costs significantly. The concept also doesn't necessarily constitute technology-oriented machine medicine. Depending on patient's preferences, he/she can choose a conventional medical, homeopathic, psychosomatic service or can compare the corresponding information. As shown the convergence from medical micro sensors and modern information technology at this stage places medical support at users' disposal anytime, everywhere – this is Ambient Medicine®.

### **Acknowledgment**

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### **References**

- [1] B. Wolf, Mobilfunk-gestützte medizinische Wissensbasis mit sensorisch interaktiven Mobiltelefonen, *Biomedizinische Technik, health technologies* 2, 156-158, 2005.
- [2] A. Scholz, Der Arzt im Gepäck: Vitalsensorik für mobile Patientenüberwachung, in Jörg Eberspächer, Arnold Picot, Günter Braun (Hrsg.): "eHealth: Innovations und Wachstumsmotor für Europa", 261- 268, 2005.
- [3] J. Wiest, T. Stadthagen et al., Intelligent Mobile Lab for Metabolics in Environmental Monitoring, *Analytical Letters*, Volume 39, Issue 8, 1759 – 1771, 2006.
- [4] B. Wolf, Einrichtung zur Früherkennung von kritischen Gesundheitszuständen, insbesondere bei Risikopatienten, Offenlegungsschrift DE 100 06 598 A 1, Deutsches Patent- und Markenamt, 2001.
- [5] [www.sendor.de](http://www.sendor.de)

**EHEALTH FOR DEVELOPING COUNTRIES:  
LESSONS LEARNED**

# AN ELECTRODERMAL ACTIVITY PSYCHOPHYSIOLOGIC MODEL

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**Abstract:** To study the changes on the electrical characteristics of the skin several problems have to be solved. We present a model for the electrodermal activity (EDA) that provides the means to detect and quantify four event types: a discrete event; a pair of events overlapping in the increasing zone; a pair of events overlapping in a decreasing zone; and an isolated small event. The presented EDA model is derived following morphological evidences found in the collected database of EDA signals conducting to a low cost computational model. We provide the algorithmic steps to extract the EDA parameters.

## Introduction

Electrodermal activity (EDA) is a psychophysiologic signal capable of being used for extraction of clinical and psychological relevant information. In this work we present the steps taken in the development of a new mathematical model for the electrodermal signal.

The electrodermal activity is related to the change in the electrical characteristics of the skin [1]. The sudomotor glands when activated via the sympathetic chain start to produce sweat that creates momentary and long-term alterations to the skin conductivity. The control of the sympathetic

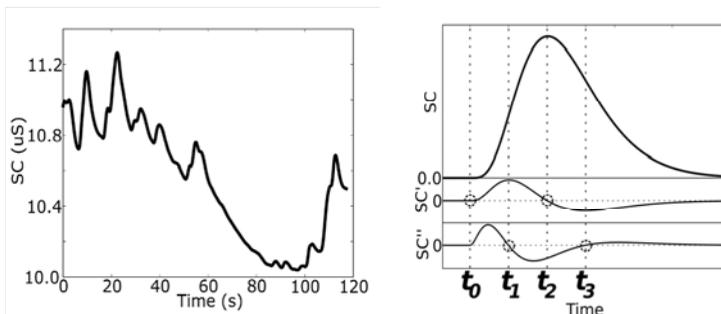


Fig. 1 EDA signal collected over two minutes (left). EDA event with first and second derivative (right)

chain is performed both by the primary brain functions for temperature regulation (in the hypothalamus) and by higher order brain structures related to emotion and cognitive processing (mainly in the prefrontal lobes of the brain) [2].

The EDA signal is composed by a tonic and phasic activities. The slowly varying base signal is the tonic EDA part also called the skin conductance level (SCL). The faster changing part (phasic activity) is related to exterior stimuli or non specific activation, are the bumps that appear in the signal. In figure 1 (left) we present two minutes of EDA signal and in figure 1 (right) we show an example of an isolated phasic EDA event (SC) with the first (SC') and second derivative (SC''). The zeros of the first and second derivative are identified with  $t_1$ ,  $t_2$ ,  $t_3$  and  $t_4$ .

### **Electrodermal activity models**

To detect the changes in the EDA response, several approaches have been taken, from qualitatively observations [3], and empiric measurements to the recently application of complex models based on parameters optimization. The evolution in the different models found the motivation in the recurrent problems of EDA modeling. The problems occur when the phasic events overlap and the parameters extraction of the signal is corrupted by the occurrence of a skin conductance response (SCR) in the time vicinity of a previous one. This type of overlap some times occurs in a pair of events with distinct orders of magnitude, where the stronger event entirely masks the smaller one.

The current models used in EDA research pass by an initial step of identification of event occurrences followed by the modeling of each of these events. The first computational models used in EDA studies were based on the identification of peaks and valleys of the signal, using these values to retrieve the signal parameters without any consideration of the overlapping problems in EDA.

More recently a sigmoid-exponential model has been proposed [4]. The model uses a combined sigmoid-exponential version of two events plus the SCL to be able to work with overlapping events. The modeling procedure is performed via an optimization routine that is sensitive to the initial selected parameters proving to be hard to use since the parameters for pairs of overlapping events need to be very well selected to guarantee the convergence of the method.

Two other authors [5][6] have presented a bi-exponential model following distinct algorithmic steps. This model when compared to the real signal lacks some of the properties like the differentiability in the initial instant.

$$at^4 e^{-bt} \tag{1}$$

$$b = \frac{4}{t_3 - t_1} \quad a = b^3 \frac{f''_{t_1} - f''_{t_3}}{16e^{-2} + 432e^{-6}} \quad t_0 = \frac{2t_1 - t_3}{2} \tag{2}$$

**Algorithm Processing steps**

1. filter the signal with low pass filter (2-5Hz)
2. detect second order derivative zeros ( $t_1$  and  $t_3$ )
3. **for** each pair of zeros:
4.       compute  $a$ ,  $b$  and  $t_0$
5. compute SCL

Fig. 2 – Algorithm for EDA parameters extraction

**Proposed model**

The model being presented is motivated by the morphologic analysis of the EDA signal. We used a set of EDA signal collected in the context of 5 cognitive tasks from 26 subjects. Our proposal is a simple model that expressed the characteristics of the EDA signal. In equation 1 the base model is presented with a gain  $a$  and a decay constant  $b$ . More details in the model can be found in an internal report [7]. The model is computed by detecting consecutive zeros in the second derivative (see  $t_1$  and  $t_3$  in figure 1) and using equation 2 the parameters can easily be estimated. The model

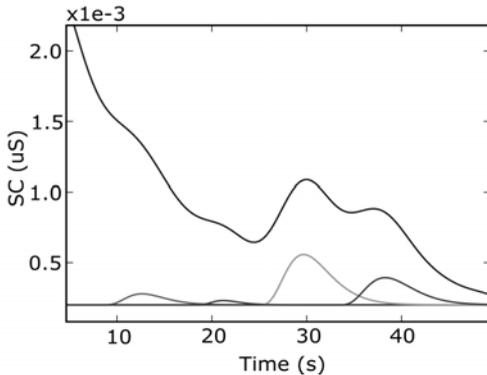


Fig. 3 EDA signal with the events extracted using the proposed model. The original signal is on top and the distinct EDA events on the bottom

is computed apart from the tonic skin conductance level (SCL). In figure 2 we present the algorithmic steps for the complete extraction of several overlapping and non overlapping EDA events.

**Conclusion**

The present model has the capability to overcome some of

the EDA modeling problems with simple computational steps with low time requirements. In figure 2 we show a small interval of EDA signal where 4 events were detected. The isolated events are presented in the bottom of the figure. The usage of the model in the collected data demonstrated that the model fits well into the real data and correctly identifies and separates overlapping and smooth events.

### **Acknowledgment**

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### **References**

- [1] M. E. Dawson, A. M. Schell, and D. L. Filion. The electrodermal system. In J. T. Cacioppo and L. G. Tassinary, editors, *Principles of Psychophysiology: Physical, social, and inferential elements*, pages 295–324. Cambridge Press, Cambridge, 1990.
- [2] H. D. Critchley. Electrodermal responses: What happens in the brain. *Neuroscientist*, 8(2):132–142, April 2002.
- [3] J. Healey and R. Picard. Digital processing of affective signals. In *Acoustics, Speech, and Signal Processing*, 1998. ICASSP '98. Proceedings of the 1998 IEEE International Conference on, volume 6, pages 3749–3752 vol.6, 1998.
- [4] C. L. Lim, C. Rennie, R. J. Barry, H. Bahramali, I. Lazzaro, B. Manor, and E. Gordon. Decomposing skin conductance into tonic and phasic components. *International Journal of Psychophysiology*, 25(2):97–109, February 1997.
- [5] C. Karenbach. Ledalab - a software package for the analysis of phasic electrodermal activity. Technical report, *Allgemeine Psychologie, Institut für Psychologie*, 2005.
- [6] D. M. Alexander, C. Trengove, P. Johnston, T. Cooper, J. P. August, and E. Gordon. Separating individual skin conductance responses in a short interstimulus-interval paradigm. *Journal of Neuroscience Methods*, 146(1):116–123, July 2005.
- [7] H. F. S. Gamboa, H. H. P. Silva and A. L. N. Fred. HiMotion Report -December 2006, Internal report, Instituto de Telecomunicações, Lisboa Portugal. URL: <http://ana.lx.it.pt/publications/HiMotionReport.pdf>

# AN INTRODUCTION TO NEXT GENERATION DIGITAL HEALTHCARE SERVICES

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## Definition

Next Generation Digital Health Care Services (NGDHS) is a set of personalized healthcare services provided by medical experts, based on EHR (Electronic Health Record) technology, telemedicine technology and Intel Digital home for health technology. NGDHS provides services such as healthcare consulting, health management and hospitalization guiding services for its members based on personal health record - EHR. With the help of NGDHS, members can have a complete understanding of their health circles and make appropriate personal health plan. NGDHS actually makes passive health tending turn into active health management and efficiently keeps the health of its members in a perfect level.

## Introduction

A report presented by WHO (World Health Organization) pointed that, one third of human disease could be prevented by preventive health care, one third of illnesses could be well controlled by early discovery and one third of sicknesses could be well cured with the help of information exchanging. Lots of people start to understand that preventing diseases is much more important than curing them. The cost reduction on medical treatment could be as five times or even more as what we invest in health care.



Fig. 1

NGDHS is right designed for this purpose. To provide personal medical information service, health care service and hospitalization guiding service for social members, NGDHS utilizes many new technologies such as EHR technology, broadband communication technology, Intel Digital Home technology, multimedia

technology, medical information technology and Peer-to-Peer technology. More precisely, NGDHS constructs life long EHR for a large number of people, provides digital medical information service and remote visible health care consulting service, makes customized health care plan for its members

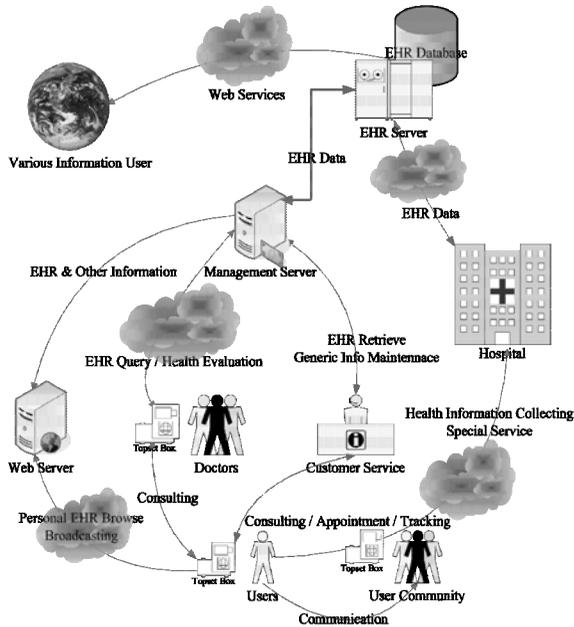


Fig. 2

and organizes public hygiene education. NGDHS is member centralized. It is a new pattern of medical services which focus on the idea of proactive health. As a complement to the traditional hospitals, this new pattern takes the full advantage of medical resources and reduces the total cost on health care and medical treatment, but most importantly, people could enjoy cheap but high level health care service at home with the help of NGDHS.

NGDHS does not belong to the future. In China, since all the technical and social requirements are met, NGDHS is ready to provide home health care and related consulting services. As a large developing country, China has to face the difference of many aspects between regions, including medical conditions. However, NGDHS can solve this problem by helping remote medical experts provide services for patients and promoting the efficiency of the usage of medical resources. What's more, NGDHS not only improves the health care condition for a large number of people, but starts a new industry with great future.

### Topology and technologies

- a) System topology

- i. Service Object: NGDHS members
- ii. Service Provider: General practitioner, nurses and other medical workers, medical experts and doctors and famous retired medical experts
- iii. Type of services:
  - 1. Construction and maintenance of EHR for individual member
  - 2. Health evaluation and management
  - 3. Provide diagnosis from medical experts and authoritative medical/healthcare consulting service
  - 4. Digital health care and hospitalization guiding service
  - 5. Personalized medical/healthcare services in different levels

b) Technologies

i. HER: EHR is defined to be patient centralized information resources which could safely, and timely be provided to doctors. It contains not only medical records, but the health record/history of the patient which could help us make right medical decisions. Its benefits are:

- 1. Improve the quality of health care
- 2. Reduce the difference of health between regions
- 3. Disease monitoring and security and privacy

And it will also be a future standard:

- 1. Foundation of future e-Health platform
- 2. President Bush proposed a goal of an EHR for most Americans in the next 10 years.

ii. Digital home for health

Intel is seeking to understand how technology can support behaviors that help prevent disease, foster independence, and improve quality of life. Digital home for health is the right technology to meet these goals. Some of its benefits are listed below:

- 1. Improving Care, Reducing Cost and
- 2. home-based technologies that focus on prevention and early detection of health problems
- 3. Improved compliance with care plans
- 4. Monitoring of older adults in their homes, and emergency response in the event of a fall or other health crisis
- 5. Proactive Computing Applications for the Aging

### References

- [1] [http://www.intel.com/research/exploratory/digital\\_home.htm](http://www.intel.com/research/exploratory/digital_home.htm)
- [2] <http://www.intel.com/research/prohealth/>

# **CREATING AN ECO SYSTEM FOR DELIVERY OF HEALTHCARE TO THE RURAL & REMOTE POPULACE USING SATCOM TECHNOLOGY - THE INDIAN EXPERINCES**

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***Abstract:* Creating an effective eco-system to connect the society with best medical services, technologies and capabilities available-today and tomorrow is a prerequisite for extending the healthcare services to every citizen irrespective of his/her geographical location. With TELEMEDICINE as a Service Integration Platform, the Indian Space Research Organisation (ISRO) has been successful in creating such an eco-system for eHealth in India. ISRO established SATCom based Telemedicine Programme. Approaches followed by ISRO in achieving the same and plans for future are discussed, which can be adopted by a developing nation.**

## **Introduction**

The provision of healthcare services to each and every citizen irrespective of his or her geographical location is the obligatory responsibility of the governments (both at the center and state) the same is not feasible practically with the current health care delivery infrastructure.

The Indian healthcare system is a three-tier hierarchical system of Primary, Secondary and Tertiary. There are about 23000 Primary Healthcare Centres (PHCs), 3000 Community Healthcare Centres (CHCs) and 670 District Hospitals (DHs) in addition to private institutions serving the population. While majority of the population resides in rural areas, medical fraternity and specialists prefer to practice in urban areas like their counterparts in many a country.

## **Indian Space Research Organisation (ISRO)**

The Indian Space Agency (Indian Space Research Organisation -ISRO), is known for its focus on utilizing the space technology for social benefits for the masses at the grassroots level, as laid by Dr. Vikram Sarabhai, the father of Indian Space programme. ISRO has built and operated multiple

communication, remote sensing and meteorological satellites and launch vehicle family. ISRO has been using the expertise in communication technology for expanding the reach of Television services and increasing the telephone density and also carried out experimental projects in developmental and educational services using satellite technology.

### **ISRO Telemedicine Programme**

Realizing the dichotomy in healthcare infrastructure in the country, ISRO has initiated Telemedicine programme in 2001 for providing Telehealth to the un-served and the under-served. This was achieved blending Information and Communication Technology (ICT) with medical sciences, to supplement the general healthcare infrastructure.

Telemedicine has come as a novel use of Technology for a beneficial change in the practice of medicine in this country directly benefiting the rural patient and indirectly helping the rural doctor in improving his skills and redressing the issues of professional isolation.

ISRO's telemedicine pilot project was started as a part of proof of concept technology demonstration programme connecting the Rural Hospitals/ Health Centres with Super Speciality Hospitals for providing expert consultation to the needy and under-served population.

Technology of Telemedicine consists of customized medical software integrated with computer hardware, along with medical diagnostic instruments connected to the commercial VSAT (Very Small Aperture Terminal) at each location. Generally, the medical record/history of the patient is sent to the specialist doctors for providing diagnosis. The video conferencing system is the mainstay of a Tele-consultation between the remote hospital and the specialist hospital that creates a virtual environment for emotionally connecting the patient and doctor in a true sense.

### **Approach followed by ISRO**

ISRO has followed a multi-pronged approach in conceiving the programme, planning the implementation and execution of the same.

- Pilot projects in different parts of the country evoking interest in the user segments (both patients and practioners).
- Development of national standards and guidelines for practice of Telemedicine involving of multiple agencies [1]
- Technology evolution and adaptation for the rural needs
- Developing and nurturing of industries meeting techno-commercial requirements
- Efforts to optimise the clinical requirements for evolving a suitable e-heath technology

- Efforts to minimise costs to bring in affordability and maximise reach
- Encouraging new models and efforts like innovative insurance schemes for operationalisation of the programme and long-term sustainability
- Integrating the healthcare administrators, planners, technologists and entrepreneurs and bringing all the stake holders to a common platform
- Training and handholding to the users (doctors and technicians)
- Workshops and seminars for creating awareness
- Initiating policy guidelines towards charge-free consultations to the rural patients, through (a) providing bandwidth from ISRO without charge for societal purpose (b) bringing in speciality hospitals to provide tele-consultation as a social service
- Developing Mobile healthcare system for reaching the doorsteps of the rural population in the areas of Tele-ophthalmology, community health and diabetology
- Sensitising the health care administrators for adopting the innovative technology at the national level

#### **Thrust areas of ISRO's Telemedicine programme**

- Providing Telemedicine Technology & connectivity between remote/rural hospital and Super Speciality Hospital for Tele-consultation, Treatment & Training of doctors & paramedics.
- Providing the Technology & connectivity for Continuing Medical Education (CME) between Medical Colleges & Post Graduate Medical Institutions/Hospitals.
- Providing Technology & connectivity for Mobile Telemedicine units for rural health camps especially in the areas of ophthalmology and community health.
- Providing technology and connectivity for Disaster Management Support and Relief.

#### **ISRO Telemedicine Network**

Presently ISRO's Telemedicine Network consists of 186 Hospitals – 152 Remote/Rural/District Hospital/Health Centre connected to 34 Super Speciality Hospitals located in the major cities and 5 mobile vans. Shortly ISRO's Telemedicine Network will be reaching the mark of about 200 Hospitals including 5 to 8 Mobile Telemedicine units for tele-ophthalmology and community health.

### **Formation of National Task Force (NTF)**

A National Task Force has been constituted by the Ministry of Health & Family Welfare to work out the various aspects of implementing Telemedicine in the country's Healthcare system including a draft national policy on "Telemedicine and Tele-medical education" and prepare a central scheme. The NTF has submitted a detailed proposal to the union Ministry of Health & Family Welfare, about forming a National telemedicine Grid (NTG) for a nation wide connectivity and an e-health web portal as a national repository of health/medical information generally not available in the Internet.

### **Conclusion**

ISRO's efforts resulted in creating an ecosystem in the country for eHealth as an effective supplementary mechanism for healthcare delivery to the rural and remote populace. The creation of such eco-has not only brought the technology and medical care nearer, it also integrated the stakeholders and the community with greater awareness. To make the system work [2], it needs to be taken forward through necessary plans for implementation by various government and private agencies.

### **References**

- [1] B.S.Bedi and RLN Murthy, "Standards and Guidelines for Telemedicine", Telemedicine Manual – Guide Book for Practice of Telemedicine, ISRO,2005: 26-32.
- [2] David Nicolini, "The work to make telemedicine work: A social and Articulative view", social science & Medicine, Vol.12, 2005.

# **EHAS PROGRAM: EXITOSO PROJECT IN TELECOMMUNICATIONS OR IN TELEMEDICINE?**

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**Abstract:** This article presents part of a research and articles' review published in the "Memory of First Iberian American Forum of Rural Telemedicine", done in February in the Cuzco city – Peru. The result of this analysis helps us to affirm that they are contributing to the concept of Telemedicine, to any solution of *TIC* (Communication and Information Technology) which happens in health area, from a simple office to complex unities as Hospitals, for any reason. This affirmation happens because Peru have already had the *TIC* and, principally, a meaning net of VHF radios, what have allowed the minimal integration of the different health unities of a specific region and/or country. The results highlights the fundamental fact, despite they are using the *TIC* for the internet access and for consultation to different information bases in the diagnosis support, its greater use have been to quell the professional's isolation, in as much as – following reports and indicators of Health Ministry of Peru - there still are basic problems in the model of Primary Attention (as in Brazil – our note) and that they would deserved to be privileged

**Key-words:** Telemedicine, Program EHAS

## **Introduction**

Now matter how much it seems simple and easy, to conceptualize and to understand Telemedicine has became, each time more, an important issue in academics discussions, not only by the concept itself, but, mainly, in the way its results are being applied and disclosed[1][18].

By Telemedicine-TM, in general we can understand the clinical practice of diagnosis, questioning and management of attention services and health care in a synchronal or a synchronal way that has used any form of Communication and Information Technology - *TIC*.

In literature in general [2 - 5], telemedicine has received the attribute of a enormous potential of promoting and of adding social economics benefits to society while:

- Promoting the access to the health services,
- Creating opportunities of improvement (education) to the professionals,
- Promoting the improvement of health indicators, with the usage of different applications/solutions;
- Improving the attention and quality of life, besides of course, to help in the organization of suppliers (institutions and companies).

In this paper, we will analyze these points under the experience of EHAS Program[10], in special, the review about the articles registered in the Memory of First Iberian American Forum of Rural Telemedicine[1], done in Cuzco – Peru, in the period of February 27 and 28 and, March first of 2006. Representatives of South and Central America as Argentina, Brazil, Colombia, Costa Rica, Cuba, Ecuador, Mexico, Panama, Venezuela and of Europe, with Spain participation, were in this Forum. As an analysis axis here used, we will deal, in special, with projects which has had financial support and investment of EHAS (*Enlace Hispano Americano de Salud*), that is based in Spain and, has as a foment group the NPO(Non Profit Organization) – *Asociación Madrileña de Ingeniería Sin Fronteras* (Engineers Without Borders - Spain).

### Methodology

For this paper was considered the review of all presented articles in Forum in Cuzco, registered in configuration of Forum Memory [1], research in complementary literature and, electronic documentation of EHAS Program.

Because of our participation in the Forum, we also have chosen to elect Peru, as space for this analysis due to the initial results. In a complementary way, interviews were realized with participants of EHAS and, in particular of Health Ministry of Peru, formalized by email, since, the first project introduced by EHAS was and is structured in Peru. Our questioning is fundamental in radio base installed nowadays in Peru, what can be assured in Table 1. All the papers presented in the Forum – therefore approved, read and analyzed, were classified, considering the following criteria:

EHAS – If the article has said that the research and/or the researchers were receiving financial support by the EHAS; HW/SW – If the discussion was focused in SW – Software, H – Hardware or HS, Software and Hardware; Evaluation – It was considering if during the article there is a mention of metrics for evaluation – qualitative or quantitative, before or

Region*	Health Ministry			Radio	Telephone		
	Population per region	Hospital	Health Center	Post Health	Health unities with HF	Place in	Mobile
Amazonas	157.224	2	31	260	66	0,9	0,24
Ancash	1.098.178	12	51	339	106	3,63	4,29
Apurimac	437.906	6	34	198	111	1,07	0,39
Arequipa	1.129.574	4	54	190	97	7,46	12,09
Ayacucho	796.041	8	49	292	105	1,8	1,1
Cajamarca	1.117.242	8	103	518	132	1,19	1,93
Callao	830.728	3	50	3	-	NL	NL
Cuzco	1.199.549	4	47	209	109	3	3,68
Huancavelica	442.084	1	45	241	73	0,43	0,07
Huánuco	821.219	4	21	210	57	1,32	0,8
Ica	680.565	6	34	98	29	5,46	5,83
Junín	1.233.149	7	51	395	40	3,2	3,61
La Libertad	1.541.427	8	44	158	94	5,56	8,23
Lambayeque	1.156.998	2	43	108	27	4,64	6,31
Lima	8.221.512	30	205	427	100	13	20,09
Loreto	942.243	3	51	276	78	2,56	1,99
Madre de Dios	92.179	2	12	97	32	2,39	0,78
Moquegua	154.606	1	25	33	48	5,3	5,75
Pasco	251.960	3	16	220	40	1,09	0,9
Piura	1.603.178	4	72	307	87	3,05	4,13
Puno	1.242.376	11	79	345	124	1,39	2,36
San Martín	821.400	13	43	296	77	1,95	0,65
Tacna	301.200	1	17	54	23	5,84	14,29
Tumbes	209.513	1	12	29	44	3,55	3,53
Ucayali	468.785	2	14	169	57	2,77	1,66
<b>Total</b>	<b>26.950.836</b>	<b>146</b>	<b>1203</b>	<b>5472</b>	<b>1756</b>	<b>6,31</b>	<b>9,18</b>

**Tabela 1- Distribuição Unidades Saúde e Rádio no Peru**

Fonte: Min Salud - Oficina Gen de Estadística e Informática - Nov/05

after implantation of solution and/or project; Health Indicators – In this point, we aimed to observe if there are indications that the solution improved the health indicators; Pilot – If the introduced project was in pilot phase or, already could be considered in production; Consultation – If there is an indication of realization of teleconsultation, in other words, the final user – patient or health professional, is using the solution for doctor appointment at a distance; 2<sup>nd</sup> Opinion – If the doctor of the health unity is using the appointment and/or support/guide of another specialist doctor; Videoconference – If the solution was being used as a tool of

videoconference without specific aim as 2<sup>nd</sup> opinion, and, at last; Education – The solution use only as tool of *e-learning* and/or digital inclusion.

After the reading and indications, about the presence of analyzed items, we did the selection and separation of articles which received the financial support of EHAS for a new analysis. Of selected and analyzed articles, we highlight 13, which mentioned exclusively EHAS program and its projects, representing 46% of articles approved by the scientific committee.

As the first didactics understanding of the selected articles will be presented, according to the origin country of the authors, the analysis in blocks. Thus, we have 6 articles from Spain, 3 from Peru, 3 from Colombia and 1 from Cuba.

The articles from Spain, headquarters of EHAS, 4 articles mention software, in other words, the focused attitudes in the solutions and in the equipment and, no in the end objective: the user. Another 2 articles mention investigation techniques of the process, to evaluate if the results were reached. The 3 articles from Peru, 2 mention technology (software and hardware) and 1, education. Of Colombia, 2 mention the training and qualification and 1, the system of collection of epidemiologic data, which could be resumed to the *mensageria* service, in other words, service of indicators sending to national bases of that country. The article from Cuba refers to the software of digital image transmission, related to medical exams. The first confirmation, reinforced in results analysis, which we highlight the fact that, any article or computerized solutions were considered need criteria of people meanwhile the health solution, at least there wasn't evidence in the articles of this preoccupation.

Another factor that deserves to be highlighted, to the results' understanding, is the understanding of the own EHAS Program and its aims. Basically, we can affirm that the main aim of EHAS [10][11][12] is to improve the health services in rural areas of Latin America countries, through the telecommunication and computerized solutions.

To reach this aim, they understand that this project must be introduced in development countries, must providing communication nets of low costs and, offer different information service through its nets, using basically technologies of dynamics communication based in Wi-Fi, VHF and UHF.

## Results

As the first and main result, we can say that: **Yes, the EHAS programa has reached its aims, when we look just and only low cost solutions of telecommunication.** The developed solution introduced by the EHAS with the partnership with Health Ministry of Peru – Minsa was positive – in the managers vision, so the could introduce in 39 health institutions of a total of

7 micro nets (Figure 1), the different interventions and solutions proposed in the program. Following the EHAS, the checked results by categorie11], which deserves highlights after 9 months of introduction are [12]:

**Effectiveness of EHAS-Peru Project**

- They have reduced the travel time of health workers (75%), therefore the reports and statistical documents started to be sent through e-mail, and not more by technician journey;
- Technician's qualification through e-learning was approved by 95,2%;

**Trustiness**

- The fact of having the support of a voice system (radio), generated a trust rate about the solution of 97,3%;

**Usefulness**

- The evaluation was pointed in a facility of the use of the equipments – computer and radio, by the professionals of the health unities; therefore, they have approved the project;

**Clinical Process Impact**

- Even if count with concrete number indicators, the participant's sensation is that there is an improvement in the patients' diagnosis (this sensation happens because, if it is necessary, they can access the internet and consult any pathology, but there is not, a specific entry of improvement documents – our note);
- 61,3% of interviews has affirmed that the system – voice and data facilitate the medicine search in other unities to patients' care, when there is a lack in his/her unity;

**Health Impact and Well Being of Patient**

- Prior example, the improvement sensation occurs because of the notifications of compulsory sickness, so, possibility to foresee enemies and, facility of access of organization in case of transference of urgent patients for international in the Hospitals of reference; and last,

**Accessibility Impact**

- though assessable Internet tools and radio, isolation sensation of the unities hasn't decreased a lot; there are reports about the radio use to communication among the unities, in a daily way, in other words, 8 of 10 contacts among the unities are done through radio, preferably;

Considering the methodology quoted by us since the beginning, the articles' analysis which indicated support from EHAS, we can highlight that the results presented in the Forum have:

- a) 46% of the articles have partial of introduced solutions. In general, indicators are from the period after the introduction of the solution. There are not prior data to the introduced solution that allows prior data a implantação da solução que permita a comparação de evolução, como recomendado por Martinez [17];
- b) none of 13 articles, in other words, 46% of the articles presented in the Forum didn't have any improvement indicator of health and/or community life;
- c) 61,5% of articles indicated that they were "Pilot Project", in other words, the methodology was not consolidated;
- d) The majority– 85%, mention Hardware and Software, meanwhile solution for the communication among the unities and not the caring and diagnosis of the patient. Here, it deserves regard that in discussion with the representatives of EHAS, they understand that the great part of health improvement is a result and not the aim, in its turn, again affirm that the origin and the mission of *Ingenieria Sin Fronteras* NPO;
- e) Another indicator that deserves to be highlighted is the articles that mentioned software, these were related to the education and training of the users, in other words, 38% of the articles;
- f) As for the questioning done to Minsa about the importance of the EHAS Program and its improvements from the introduction, there was not answered until the end and submission of this article.

Of the Forum – amplifying now to the setting of 28 analyzed, only two of them showed results with improvement indication of life and health conditions. These projects were developed by the Mexican govern and its positives results were realized and registered already in the pilot phase.

### **Discussion and Conclusions**

The interpretations about the analysis above done until this time, lead us to affirm that is contributing to TM concept, every and all TIC solution, and that some reason it happens in health space, a simple doctor's office to a complex unities as Hospitals. We start the discussion with this affirmation since Peru have already had TIC and, mainly, a meaning net of VHF radios (Table 1), what allows a minimal integration among the different health unities of region and/or country.

It is import to observe that if we consider the installed net, the possibility to do *up grade* of the actual net, or evaluate the main existing difficulties in

its utilization, can be so or more meaningful that the investment in solution to the communities and new participant unities of EHAS.

The results highlight a fundamental fact: in spite of being used TIC to a internet access and consult to a different information bases in the diagnosis support, the bigger use have been to mitigate the professional isolation, since there already is – following reports and indicators of Minsa [99], basic problems in Primary Attention model (as in Brazil – our note) and, would deserve to be privileged.

We can not forget the fact that the geography of Peru doesn't allow the care in Health Institutions or Hospitals in small time; however, we could privilege other intervention techniques which could be introduced and far monitored, then, the realization of TM.

Coming back to the initial questioning pointed by us, we have:

- The EHAS program, by what we analyzed, promotes the TIC access and, by its turn, will can to promote the access to the health services,
- regarding the improvement, the results showed that this is the main reached result with the program, then, further to decreased the isolation of the communication of the unities and, of doctors, have conquered the digital inclusion of the communities through internet use and, the improvement of the health professionals in every levels;
- Considering the proposed and introduced solutions by EHAS, we did not find evidences from health indicators, so, we can not - still, to validate the model by its turn – with modifications, to reply the solutions to other regions;
- Regarding the improvement of attention and life quality, beyond of course, to help in supplier organization (institutions and companies), there are results of improvement, as can be registered with tool creation for collecting data from epidemiologic indicators - mensageria.

In fact, in any moment, we will have to revisit the Telemedicine concept and, consequently, to differ as we are talking about solution of diagnosis support, attention and health care– therefore, TM; and when we are talking about TIC solutions in health. Until this moment, still would be to perfect this affirmation, we are more focused to the use of TIC in health that, in a proper way, we are worried with health promotion, in other words, “to save lives”. We would like, to finish, to let registered that we worked as promoted by organizations as EHAS, @lis (European Community), among others, **are fundamentals to the development and science evolution and, in particular, the Telemedicine of Brazil and the world.**

Though, in this article, we are questioning their benefits, we understand and reinforce that the actions as these – done by institutions of teach and, of social development promotion social, must be continued existing that we can know the better practices and, consecutively, to reproduce them– when it is possible, for the regiões with more need. We understand this as our paper of research, to promote the social development.

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### Referências

- [1] Memórias I Foro Iberoamericano de Telemedicina Rural – Cuzco – Peru; ISSN 1818-728X; 2006; 220p.
- [2] Viegas, S F; Dunn k – Telemedicine – practicing in the information age. New York; lippincott-raven publishers; 1998. 381p.
- [3] Khouri, S G EL – Telemedicina: análise da sua evolução no Brasil, São Paulo, Faculdade Medicina USP, 2003, 230p Dissertação (Mestrado em Ciência).
- [4] Maheu, M. M., Whitten, P., Allen, A. – E-Health, Telehealth, and Telemedicine – a guide to start-up and success –New York, Jossey-Bass health series, 2000, 375p.
- [5] Novaes, M A. A Telemedicine project in Brazil, planning a cost-effective solution; <http://www.lika.ufpe.br>
- [6] Whitten, P S, Mair, F S, Haycox, A, May, C R, Williams, T L, Hellmich, S – Systematic review of cost effectiveness studies of telemedicine interventios; *BMJ*, 2002;324:1434-7; jun/02.
- [7] Finch, T L, May, C R, Mair, F S, Mort, M, Gask, L – Integrating service development with evaluation in telehealthcare: an ethnographic study; *BMJ* 2003;327:1205, nov/03.
- [8] Bynum, A. B.; Irwin, C. A; Cranford, C. O.; Denny, G. S – The impact of Telemedicine on Patient’s Cost Savings: Some Preliminary Findings. *Telemedicine Journal and Telecare*, v. 9 (4), p.361-367, 2003.
- [9] Telemedicine for Healthcare in Developing Countries – Rural Telemedicine for Primary Healthcare in Developing Countries – Martínez, A; Villarroel, V.; Seoane, J.; Del Pozo, F.; Disponível em <http://www.patmedia.net/tbookman/tchsoc/martinez.html>. Acesso em: 16/05/2006.
- [10] EHAS – Enalce Hispano Americano de Salud – Proyectos Piloto – EHAS Peru. Disponível em <http://www.ahas.org/proyectos/>. Acesso em: 16/05/2006.
- [11] EHAS – Enalce Hispano Americano de Salud – Resultados – EHAS Peru. Disponível em <http://www.ahas.org/resultados/>. Acesso em: 16/05/2006.
- [12] EHAS – Enalce Hispano Americano de Salud – EHAS: programas libres para apoyar el sistema de salud em zonas aisladas de América Latina - Martínez, A; Villarroel, V.; Seoane, J.; Del Pozo, F.; Disponível em <http://www.ahas.org/ahas/>. Acesso em: 16/05/2006.
- [13] Ministério de Salud Peru – Oficina General de Estadística e Informática – Boletín; 15/12/05; Volumen 5- 2005; Disponível em <http://www.minsa.gob.pe/>.
- [14] Ministério de Salud Peru – Estadística; Disponível em <http://www.minsa.gob.pe/estadisticas/estadisticas/recursos/032002DI00.htm>. Acesso em: 22/05/2006.
- [15] Ministério de Salud Peru – Estadística; Disponível em <http://www.minsa.gob.pe/estadisticas/estadisticas/recursos/DI00.htm>. Acesso em: 22/05/2006.

- [16] Ministério de Salud Peru – Estadística; Disponível em <http://www.minsa.gob.pe/estadisticas/estadisticas/poblacion/012003DI00.htm>. Acesso em: 22/05/2006.
- [17] Martínez, A. – Bases metodológicas para evaluar la Viabilidad y el Impacto do Proyectos de Telemedicina. Washington – DC; OPAS; 2001. 138p.
- [18] Medeiros, R; Wainer, J. – Telemedicina: onde estão seus benefícios sócio-econômicos?; Ribeirão Preto; CBIS 2004.
- [19] Ministério da Saúde Brasil – Estatística DATASUS; Disponível em <http://www.datasus.gov.br>. Acesso em: 22/05/2006

# E-HEALTH IN IRAN: OBSTACLES AND SOLUTIONS

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**Abstract:** Considering rapid growth of eHealth worldwide and Iran's strong need for eHealth and telemedicine, this study has been done aiming at finding ways and means for this country to join other countries in this international trend. This article covers the topics: necessity of eHealth and current eHealth condition and infrastructures in Iran; obstacles on Iran's way to improve eHealth; ways to overcome the obstacles, and the ways this country can contribute to eHealth projects. Also this article suggests some projects, as the start point to make Iran practically involved in eHealth.

## Introduction

Considering Iran's geographical map and distribution of population in the country (in urban and rural areas) also concentration of physicians (especially specialists) as well as, large hospitals and well equipped medical centers in urban areas, particularly large cities, Iran can benefit from information and communications technology (ICT) to distribute health services to people in a much more efficient way, and make people have access to health services equally.

Also using ICT can be an effective, easy, and low cost way for Iranian physicians and health staff, to communicate with themselves and other health staff all around the world, to exchange knowledge and experience, especially at the time being that traveling to and from Iran is somewhat difficult.

Since the year 2004, decisions were made by Ministry of Health and other national organizations to implement eHealth in Iran and take advantage of ICT in health field. Since then some governmental organizations and some semi private institutes have been working on the field and studying ways to implement eHealth. ICT infrastructures also have been improved (by Ministry of ICT), and even some projects have been accomplished in the field, but still there is a long way to go, and ordinary people (as the end users of eHealth) have not received any significant services yet, and eHealth is not a familiar concept to them (Many physicians do not know much about it either.)

To name just a few obstacles in the way to implement eHealth in Iran, we can point out that;

- There are still many defects in ICT infrastructures, and considering the quality of the services, the prices are a little high (comparing to technologically developed countries).
- Although the rate of ICT users are growing rapidly, but still large number of people don't take advantage from this technology, and thus facilities like eCommerce and eHealth are not being used in people's daily life, especially among elder people who may be the most benefited ones from facilities like eHealth.
- There has not been enough investment in eHealth, both by government and private section.
- Private section does not have an active role in implementing eHealth in Iran.
- Iran does not benefit from cumulative contribution of its health care staff (physicians, nurses...) neither in private section, nor among government employees; an online survey among physicians of private section showed that their internet usage for medical purposes was not so high, and another survey showed that the percent of the physicians (both in private section and governmental section) who use internet at all regularly, was not so promising.

To overcome the obstacles, privatization can play an important role in all sections (private investment in ICT infrastructures, eHealth projects, medical e-learning projects, hardware and software). And this can not be possible unless government and national organizations, not only give permission to private sections to involve, but also encourage them to contribute by providing them with facilities. Especially foreign investment (by developed countries or international organizations) will have a greater effect on improving eHealth in Iran, not just because of their money investment, but in this way they also bring their knowledge and experience to this country too. Besides, eHealth concept will receive government's help and attention more than before.

Making physicians and medical staff in private section more involved in this field will sure have a great impact on expansion and improvement of eHealth. This can become true, either by encouraging them to participate in medical e-learning courses, or by some mandatory programs like e-prescription.

As physicians should attend some medical conferences annually in the framework of obligatory courses of national health organization, offering

them to participate in e-learning courses instead, will be welcomed by them, and this can be a start point to have their e-contribution.

Also as almost all the physicians, hospitals, laboratories, and imaging centers have contract with insurance companies, and their activities are in some way under tough supervision of those companies, it will not be difficult to have medical staff contribution in e-prescription. And as still many procedures are done manually in the traditional way by insurance companies, this project will be a guaranteed investment, and the insurance companies will be the ones which receive more benefit than others, thus it will not be difficult to persuade them to contribute in the project (no need to talk about other benefits of e-prescription). This project itself can be an opening to go through electronic health record and many other projects.

Common medical research projects, by cooperation of Iranian physicians and international organizations, research institutes or universities in developed countries (via electronic communication tools), can also be of great value for both sides; for Iranian researchers to get more and more involved in electronic world, and for those institutes to benefit from Iranian researchers' experience (for instance in endemic diseases, etc).

### **References**

- [1] A. Golchin, "Online survey on Iranians physicians' internet access, main usage purposes, and familiarity with eHealth", 2007
- [2] A. Golchin, "Surveys on major private and governmental hospitals interest in telemedicine usage", 2006
- [3] A. Golchin, "Surveys on insurance companies interest in e-prescription usage", 2005
- [4] A. Golchin, "Developing an E-learning system for physicians", Iran Medical University, Tehran, Iran, 2004
- [5] A. Golchin, M. Kaviani "Using ICT for gathering medical statistics in Shahriar district, as a pilot study" 2002, and 2006
- [6] A. Golchin, M. Kaviani "Solutions for e-prescription development in Shahriar district, as a pilot study" 2005
- [7] H. Sadeghian "Solutions For e-prescription development In Iran", Fourth Regional e-Health Conference: Building the Electronic Health Record, Tehran, Iran, 2004
- [8] S.M.R. Sadri, "Iran National ICT Report", 2005
- [9] World Health Organization, "Report of the WHO Global Observatory for eHealth", 2006

## PERSONAL ELECTRONIC HEALTH DIARY FOR DEVELOPING COUNTRIES (PEHD)

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**Abstract:** In this paper we propose PeHD, a personal electronic health diary system created on patients own interest and which will be managed by private hospitals. The main aim of PeHD for developing countries is to introduce an electronic health record in countries where there is no centralized health care system and where governments cannot maintain a database of health records of all citizens. This will be an initial step not only towards paperless health care systems, but also to empower patients through access to their medical information.

### Introduction

PeHD is a decentralized, patient centric, health record which provides an organized summary of personal medical information for presentation to health care providers [3]. It is multifunctional and multipurpose, includes text, images, sounds, and other multimedia content. It not only supports doctors to have access to the patients' medical records, but also for Hospital treatment purposes, Government bodies for statistical purposes, and research purposes.

The Health information is not only stored in a server but also stored in a USB drive for quick accessing of essential medical information where internet is not available [4]. And patients have to carry this USB drive along with him/her as an ATM card or credit card. As PeHD is used by different users (stakeholders), different interfaces are made so that only information required for that user can be accessed from patient's health information data.

In this era of ICT (Information and Communication Technology) no sector has been left untouched. Recent advancements in ICT have changed health care systems. The use of ICT through Telemedicine and e-Health tools has created bridges between space and time, this has been reflected on a "better access to health care and access to better health care, cost effectiveness, equity and efficiency of health care" [11]. These qualities of Telemedicine and e-Health services are attracting policy makers on health care from developing countries where there is a boom of health crises and

lack of infrastructures, human resources, and of course funding [2].

PeHD main goal is to help patients to become active participants in their own care, empowering them to acquire awareness of their or their family members, health status. The available literature does not yet seem to adequately describe the potential capabilities and utility of these systems in developing countries - “Unfortunately few systems have been described in the literature and fewer evaluated” [10] and “In addition, the lack of a proven business case for widespread deployment hinders Personal Health Records adoption” [3].

Most consumers and patients receive care from many health care providers, and consequently their health data are dispersed over much paper record of many hospitals. A fragmented system of storing and retrieving essential patients’ data impedes optimal care.

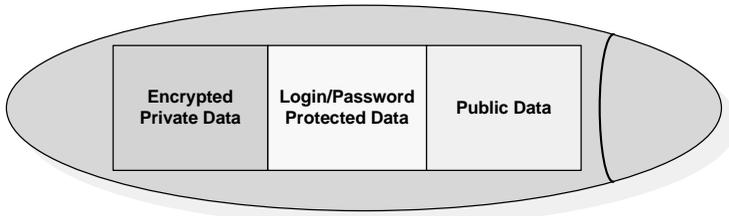
### **Present Scenario**

It is common to have patients visiting the hospital or GP without any previous medical reports, incomplete or very old and half torn reports. Sometimes reports are in good state but we aren’t able to read due to illegible handwriting [5]. Patient arrives in casualty with serious illness but don’t know anything about their previous treatment, they even don’t know which operation they underwent. Though they are on regular medicine they don’t know what it is. The only thing they can say is that they are on anti hypertensive medicine or anti diabetes and the colour of the tablets (red or white). It is usual for patients not to carry medical records. So just imagine in this situation how difficult it will be to manage the case. In the middle of an emergency, there’s no room for errors. And if anything goes wrong, Doctors are to be blamed.

We think it is now time to provide our colleagues a helping system which gives access to all medical information about their patient’s previous medical history. And we have found that PeHD is what we need to achieve our aim.

### **The Proposed Solution**

The proposed solution is called PeHD – Personal electronic Health Diary – and its internal structure is shown in fig1. PeHD is a decentralized, patient centric, health record supported by a simple device such as a pen drive (common designation for a solid state memory device with a USB interface) [6]. It is able to store not only the person’s own health information (a database), but also the technical means to read it (a computer application), and the necessary security mechanisms to protect it (encryption tools); making it a fully autonomous system. In fact this is now possible with the



*Fig. 1 Pen drive internal structure*

given capabilities of such devices which are able to store over 1 GByte of data. This could only be achieved, some years ago, with a non portable sized hard disk.

The information inside the pen drive is organized according to 3 security levels: public, protected and private. An application is stored inside the pen drive allowing the interaction with a PC without any additional software. While the public data is accessible by everyone, the protected and private data is only accessible by the authorized. Public data includes, for instance, blood type and allergies. The protected data is accessible by a login/password combination and includes medication, exams, vaccination, etc. The private information is accessed only when a unique access program (named a “key”) is used. Any telemedicine application, to be successful, must be economically feasible. Excellent ideas have never left the pages of scientific journals or conference proceedings. The low cost of this solution allows for an easy dissemination through both a public healthcare system and private companies.

This work is currently under development. Requirements have been completely identified, the system specification has been produced and its implementation is under way, with the aim of using Open Source technology and platforms. A prototype of a working product is expected in June 2007 (current year).

### ***Benefits to Users***

1. They can access to their own medical record for checking medication schedules (usually patients get confused when they have more then 4 medicines with different times to take them); for confirming dates of appointments or medical exams [7].
2. If they are elderly or unable to use the computer they can permit someone taking care of them by giving the pen drive to them.
3. They can access their medication (drug prescriptions) irrespective of their location (only a PC is necessary, even when no internet connection is present).

4. When admitted in the hospital the patient can have his PeHD accessed by clinical staff to check lab results, medication schedules, etc. Nurses can even leave notes to be read by the nurse in the next shift.
5. They can be reassured about medication schedule in case of confusion by sending email (if and when available) to their doctor, communication barriers are responsible for many adverse affects of drugs in out patient setting [8-9].

### ***Benefits to Providers***

1. Attract new clients: once people obtain a PeHD from this hospital they will be visiting the same hospital for treatment if needed in future (though this is not obligatory).
2. They can use this PeHD (medical record) integrated with the hospital's EPR (patient record) whenever this patient is admitted to the hospital.
3. Hospital may negotiate with the Health Insurance companies and offer free treatment for patients with PeHD by taking a premium amount which was mutually agreed between the hospital and the insurance company.
4. The PeHD can help maintaining up to date statistic databases for clinical research [10] with births, deaths, diseases, diagnosis, treatments, etc. by providing ready access to patients' data in electronic format from visits to the hospital.

### **Conclusions**

In this paper we have proposed a solution for the introduction of persona health diaries in developing countries, namely in regions where there is not a centralized system for EPR (Electronic Patient Records) and internet access is still limited amongst great part of the population. In this scenerious patients do not have a single point-of-care and are approaching different health care providers. With PeHD the patient is both given access to his/her own health information and the responsibility for it and this way empowering the patient and encouraging him/her to actively participate in maintaining his/her own health.

### **Acknowledgment**

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### **References**

- [1] M. Savard. "The Savard Health Record: A Six-Step System for Managing Your Healthcare", Alexandria, Va.:Time –Life, 2000
- [2] M. A.Ryan."Maintain your medical records. Today's Chemist at Work". Vol. 8(8) pp. 49-50,52-53. 1999
- [3] E. Spragins. "Get it writing", Newsweek Aug 24, pp. 62, 1998
- [4] Tang et al. "PHRs: Definitions to Adoption Strategies", JAMA Vol 13 Number 2 Mar/April 2006
- [5] P. C. Tang, E. H. Shortliffe."Traditional hospital records as a source of clinical data in the outpatient settings", proceedings of the symposium on computer application in medical care, Philadelphia:Hanley & Belfus, pp. 575-579, 1994
- [6] Paul et al. "Personal health records: Definitions, Benefits, and Strategies for Overcoming Barriers for Adoption", JAMA Vol 13 Number 2, Mar/April, 2006
- [7] D. L. Hunt, R. B. Haynes, S. Hanna and K. Smith. "Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review", JAMA, num. 280, pp. 1339-1346, 1998
- [8] T. Delbanco, D. Z. Sands. "Electrons in flight – e-mail between doctors and patients", N Engl J Med, num. 350, pp. 1705-1707, 2004
- [9] T. K. Gandhi, S. N. Weingart, J. Borus, et al."Adverse drug events in ambulatory care" N Engl J Med, num. 348, pp. 1556-15, 2003
- [10] H. S. F. Fraser et al "Implementing electronic medical record systems in developing countries", Informatics in primary care, num. 13, pp. 85-95, 2005
- [11] A.C. Norris. "Essentials of Telemedicine and Telecare", pp. 30-32, 2001

# **ROLE OF INTERNATIONAL ORGANIZATION IN THE PROMOTION AND MARKETING OF EHEALTH SERVICES FOR DEVELOPING COUNTRIES**

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## **Introduction**

The health of a nation is the product of many factors and forces that combine and interact. Economic growth, per capita income, literacy, education, age at marriage, birth rate, information on health care and nutrition, access to safe drinking water, public and private health care infrastructure, access to preventive health and medical care and the health insurance are among the contributing factors.

eHealth, the use of electronic ICT in health, allows physicians and health care specialists to diagnose and treat patients over distances – whether that span is across a street, a city, a region or an ocean. eHealth can prevent uncomfortable delays, high travel expenses and family separation by bringing specialized medical care directly to the people who need it. It is already being practiced in many developing countries. The World Health Report 2006 "Working together for Health" presented an estimated shortage of almost 4.3 million doctors, midwives, nurses and support workers worldwide. The poorest countries are worst hit, especially those in the Africa region with 24% of the global burden of diseases but only 3% of health workers commanding less than 1% of world health expenditure. The dramatic shortage of health workers resulting from years of chronic underinvestment in health services and training of personnel has been even more aggravated by the migration of skilled professionals. Africa finds itself at the epicenter of the global health workforce crisis. Let's take India as another example. A recent survey by the Indian Medical Society has found 75% of qualified consulting doctors practice in urban centers and 23% in semi urban areas and only 2% from rural areas whereas majority of the population live.

## **Contributions of the ITU**

For the first time the question about telemedicine has been raised in March 1994 by representatives of several developing countries in Buenos Aires (Argentina) where the Telecommunication Development Bureau

(BDT) of the International Telecommunication Union (ITU) convened the World Telecommunication Development Conference. The Conference has recommended that the BDT has to study the potential of telemedicine to meet some of the needs of developing countries in the improvement of access to the health care services.

The Conference approved a Question 6 (in 1998 it was renumbered into Question 14) on telemedicine which was assigned to the Study Group 2 of the ITU Development Sector, as well as Recommendation No.1 on Application of Telecommunications to Health and other Social Services. The Conference noted that "...the widespread use of telemedicine services could allow universal health access and consequently facilitate the solution of the principal health problems connected with infectious diseases, pediatrics, cardiology, etc., particularly in areas where medical structures are inadequate or non-existing."

In accordance with the decisions of the World Telecommunication Development Conferences, the Telecommunication Development Bureau (BDT) of the International Telecommunication Union has undertaken various activities related to the study of the potential benefit of eHealth applications in the health care sector of developing countries as well as the demonstration of these applications in implemented eHealth/telemedicine pilot projects in selected countries.

During the period 1996-2000, BDT/ITU organized several expert' missions to developing countries in order to identify their needs and priorities for the introduction of eHealth services taking into account the state-of-the-art of the local telecommunication networks and their evolution. The following countries were visited: Mozambique (1996), Uganda (1996), Cameroon (1996), Tanzania (1996), Bhutan (1997), Viet Nam (1997), Mongolia (1998), Senegal (1998), Georgia (1998), Uzbekistan (2000), Ethiopia (2000). The working method of any Study Group in the ITU is to study a Question by a team of volunteers from different countries - Member States and Sector Members. Therefore the ITU Study Group is able to present a worldwide experience and to share the information on best practice among countries. The ITU telemedicine group is unique in the world dealing with the needs of developing countries and it consists of experts from developed and developing countries.

The African Regional Telecommunication Development Conference (May 1996, Abidjan) considered the presentation from ITU-D study Group on "Telemedicine and Developing countries" and the Conference approved the Resolution 7: "Telemedicine in Africa". A telemedicine demonstration took place during the Conference in which doctors from Abidjan were consulting with medical specialists in Milan (Italy) and Toulouse (France)

via a satellite using an Inmarsat B mobile earth-station. The doctors were able to see live images of each other and – at the same time – discuss cardiographs and dermatological images and photographs of serious wounds. It was recommended to support the implementation of pilot projects in developing countries, the aim of which would be to demonstrate the potential, benefits and different approaches to the introduction of telemedicine services. It was also recommended to convene a World Telemedicine Developing Conference for Developing countries in order to exchange experiences and views on this subject.

At the Regional Telecommunication Development Conference for the Arab States, which took place in Beirut in November 1996, there were telemedicine demonstrations linking a hospital in Beirut with the European Institute of Telemedicine in Toulouse. A technically difficult coronary surgery was carried out by Lebanese surgeons with remote assistance from cardiac surgeons in Toulouse.

The issue of telemedicine was discussed during the Conference and resulted in the approval of the Recommendation: Telemedicine in the Arab Countries. This recommendation "...invites all Arab countries to promote collaboration between health-care officials and telecom operators in order to identify solutions to meet health-care needs, especially in remote and rural areas and for those on the move and for those who might not otherwise have access to the quality of care available in urban hospitals." The Conference demanded also that telemedicine services and delivery should be affordable, practical, profitable, self-sustaining and available to as many people in need as possible. The idea to convene a World Telemedicine Developing Conference was supported as well and this Symposium took place in Portugal in July 1997. The Conference decided to continue the study and the Recommendation on eHealth was approved advised to bridge the gap between the telecommunication and health-care communities at all levels.

The Second World Telecommunication Development conference (WTDC-98), which took place in Valletta, Malta in March 1998, was approved a Recommendation promoting telemedicine pilot projects which are intended to serve as case studies for other developing countries interested in the possibilities of extending health-care services to remote and rural areas by using telecommunications. The Rapporteur's Group on Telemedicine based on information received from many countries produced Report on Telemedicine and Developing Countries, which was published in the Journal of Telemedicine and Telecare in February 1998 and has sent to all Ministers of Health and Ministers of Telecommunications around the world. The work done by the ITU indicated clearly that developing countries have an overwhelming need for the provision of medical and

health care services, especially in areas outside the cities and that eHealth/telemedicine services could be an economic means of achieving national health policy objectives with regard to improvement and/or extension of medical and health care, especially to non-urban and remote areas. The third World Telecommunication Development Conference (WTDC-02) which was in Istanbul, Turkey in March 2002, examined a new report on telemedicine "*Fostering the application of telecommunication on health care: identifying and documenting success factors for implementing telemedicine*" and several contributions on this issue for the Conference received from the following countries: France, Japan, Mexico, Russia, Egypt. The importance of telemedicine was again broadly discussed and received support by the majority of developing countries. The Conference proposed to change name of telemedicine for eHealth given in this way to these services much broader definition. The Conference approved a new Resolution 41 on E-Health and telemedicine was included in the BDT Programme on E-Strategies and Applications. This Resolution is the background document for the development of eHealth policy. The Resolution requested also the Member States of the ITU to consider the establishment of a national committee/task force comprising representatives from telecommunication and health sectors in order to assist with awareness-raising at national level and with the formulation of feasible telemedicine projects. The recent World Telecommunication Development Conference took place in Doha, Qatar in March 2006. This was the first global development conference held in the wake of the World Summit on the Information Society, which met in Geneva in 2003 and concluded its deliberations in Tunis in November 2005. The Doha Action Plan takes on board several action lines set out by the Summit, specifically those related to information and communication infrastructure development and e-applications including eHealth.

### **The World Health Organization and eHealth**

In view of the rapid evolution in the information and telecommunication technologies and their increasing applications in the health care sector, the World Health Organization convened in December 1997 in Geneva the International Consultation Group in order to develop a telehealth/telemedicine policy in relation to the implementation of WHO "Health for All Strategy in the 21<sup>st</sup> Century". During the course of the Consultation, the proposal for Health Telematics Policy was prepared as it is formulated by the consultation group. Let us to highlight several key points from this document. It was recommended that WHO and Member States:

- Integrate the appropriate use of health telematics in the overall policy and strategy for the attainment of Health for All in the 21<sup>st</sup> century, thus fulfilling the vision of a world in which the benefits of science, technology and public health development are made equitably available to all people everywhere;
- Explore and promote the best use of health telematics for public health disease surveillance, prevention and control, health education, health promotion, health systems and service development, nutrition, water supply and sanitation, and environmental health, with particular attention to developing countries and specific population groups that are most in need or underserved.

The WHO has recently prepared a very important document on "Towards a World Health Organization eHealth Strategy" which was presented and discussed at WHO General Assembly in May 2005. The WHO is also going to make a comprehensive evaluation of already introduced eHealth services in developing countries in order to prepare the recommendation dealing with medical aspects of eHealth for health care professionals.

WHO plans to provide technical support to Member States in relation to eHealth products and services by widely disseminating experiences and best practices, in particular on telemedicine technology, devising assessment methodologies, promoting research and development, and furthering standards through dissemination of guidelines. Other actions include extension and activation of Health Academy in order to promote awareness of health and healthy lifestyles through eLearning, analyse the evolution of eHealth and its impact on health, anticipate emerging challenges and opportunities, and provide evidence, information and guidance in support of policy, best practice, and management of eHealth services.

URGES Member States have:

(1) To consider drawing up a long-term strategic plan for developing and implementing eHealth services in the various areas of health sectors, including health administration, which includes an appropriate legal framework and infrastructure and encourages public and private partnerships;

(2) To develop the infrastructure for information and communication technologies for health as deemed appropriate to promote equitable, affordable, and universal access to their benefits, and to continue to work with information and telecommunication agencies and other partners in order to reduce costs and make eHealth successful;

(3) To build on closer collaboration with the private and non-profit sectors in information and communication technologies, so as to further

public services for health and make use of the eHealth services of WHO and other health organizations, and to seek their support in the area of eHealth;

(4) To endeavour to reach communities, including vulnerable groups, with eHealth services appropriate to their needs;

(5) To mobilize multisectoral collaboration for determining evidence-based eHealth standards and norms, to evaluate eHealth activities, and to share the knowledge of cost-effective models, thus ensuring quality, safety and ethical standards and respect for the principles of confidentiality of information, privacy, equity and equality;

(6) To establish national centres and networks of excellence for eHealth best practice, policy coordination, and technical support for health-care delivery, service improvement, information to citizens, capacity building, and surveillance;

(7) To consider establishing and implementing national electronic public-health information systems and to improve, by means of information, the capacity for surveillance of, and rapid response to disease and public-health emergencies.

### **Conclusion**

In a broader sense, eHealth characterizes not only a technical development, but also a new way of working, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.

eHealth or telemedicine is a power tool, which has been in many pilot cases successfully implemented in several countries. And despite the growth of ICT equipment and tools in health sector, their impact depends largely on whether or not they are used, and how, when and where they are used, which in turn are greatly influenced by the organization of provider systems and the behavior of care givers. It is therefore only a matter of time before eHealth is fully integrated into healthcare. Telemedicine systems are no more expensive. The basic system consists of computer hardware, software and telecommunication link. In all these areas there has been a significant reduction in prices over the past few years. The system has to be progressively made more and more user friendly and economical. The operational costs can be further reduced if telecommunication costs can be subsidised. The provision of satellite communication without charge by ISRO has been an important factor that has facilitated the introduction of telemedicine services in India.

# **THE ROLE OF TELECOMMUNICATION IN EHEALTH SERVICES FOR DEVELOPING COUNTRIES**

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## **Introduction**

The World Summit on the Information Society (WSIS), which was held in two phases: the first in Geneva, 10-12 December 2003 and the second in Tunis, 16-18 November 2005, has included eHealth in Geneva Plan of Action as one of the important ICT applications and stated the following: "Promote collaborative efforts of governments, planners, health professionals, and other agencies along with the participation of international organizations for creating reliable, timely, high-quality and affordable health care and health information systems and for promoting continuous medical training, education, and research through the use of ICTs, while respecting and protecting citizens' right to privacy. Encourage the adoption of ICTs to improve and extend health care and health information systems to remote and underserved areas and vulnerable populations, recognizing women's roles as health providers in their families and communities".

In a broader sense, eHealth characterizes not only a technical development, but also a new way of working, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology. ICT can build the know-do bridge by removing distance and time barriers to the flow of information and knowledge for health, and providing just-in-time, high quality, relevant information to health professionals. The ability of eHealth/telemedicine to facilitate health-care irrespective of distance and availability of personnel on the site, make it attractive to developing countries.

## **World Telecommunication Development Conferences**

On the request from several developing countries, the question about eHealth/telemedicine was included in the agenda of the ITU-D Study Group

2 in March 1994 at the First World Telecommunication Development Conference (WTDC).

The working method of any Study Group in the International Telecommunication Union is to study a Question by a team of volunteers from different countries - Member States and Sector Members. Therefore the ITU Study Group is able to present a worldwide experience and to share the information on best practice among countries. The ITU telemedicine group is unique in the world dealing with the needs of developing countries and it consists of experts from developed and developing countries.

It was apparent from this work of this group and reports published, that telemedicine has considerable potential for developing countries. The second WTDC-98 approved a new study Question which was expected to bring a report based on the results of the telemedicine pilot projects and missions implemented in selected developing countries. Studies conducted by the eHealth/Telemedicine Group together with the discussions and recommendations of the African Regional Telecommunication Development Conference (Abidjan, 1996), the Regional Telecommunication Development Conference for the Arab States (Beirut, 1997) and two the World Telemedicine Symposium for Developing Countries (Lisbon, 1997, Buenos Aires, 1998), as well as reports on the missions to developing countries by telemedicine experts, all show that developing countries have an overwhelming need for the provision of medical and health care services, especially in areas outside the cities and that eHealth/telemedicine services could be an economic means of achieving national health policy objectives with regard to improvement and/or extension of medical and health care, especially to non-urban and remote areas.

The third World Telecommunication Development Conference (WTDC-02) which took place in Istanbul, Turkey in March 2002, a Resolution 41 on eHealth which is important document t for the development of eHealth policy. The Resolution requested the ITU

- To continue its efforts to raise the awareness of decision-makers, health professionals, partners, beneficiaries and other key players about the benefits of telecommunications for the e-health applications;
- To continue to support e-health projects in collaborations with government, public, private, national and international partners – in particular with the World Health Organization (WHO);
- To encourage collaboration on e-health projects on the national and regional level;

- To set up, within existing budgetary resources, a fund for telecommunication facilities for e-health, and introduce e-health training in the centers of excellence;
- To promote, facilitate and provide technical support and training in information and communication technologies for e-health;
- To work with the health sector to identify models for sustainability of eHealth applications, particularly in remote and rural areas of developing countries, exploring possibilities for sharing infrastructure with other services and applications.

The Resolution requested also the Member States of the ITU to consider the establishment of a national committee/task force comprising representatives from telecommunication and health sectors in order to assist with awareness-raising at national level and with the formulation of feasible telemedicine projects. Today this Resolution is still relevant. It is important goal to convert this Resolution into practical actions where the role of the ITU-D Study Group is extremely important.

The ITU-D Study Group 2 report "Making better access to healthcare services" summarized the experience in eHealth/telemedicine field from more than twenty developing countries. The Conference supported and recommended to continue the study "Telecommunication for eHealth". Today everybody knows that eHealth solutions and applications can play a very important role in health-care delivery, in particular in developing countries, where the acute shortage of doctors, nurses and paramedics is directly proportional to the enormous unsatisfied demand for health services, and that eHealth could not be achieved without using telecommunication facilities to get the objectives of the health-care system.

The new study Question shall:

- Take further steps to assist in raising the awareness of decision-makers, regulators, telecommunication operators, donors and customers about the role of telecommunication and information technologies in supporting health-care and healthy life in developing countries.
- Encourage 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 eHealth care applications.
- Disseminate experiences and best practices with the use of telecommunications in eHealth in developing countries.
- Encourage cooperation among developing countries in the field of telecommunications for eHealth.

- Promote development of telecommunication standards for eHealth application in conjunction with ITU-T and ITU-R in particular.

The output expected from the Question which is under study now are

- Report on how hospitals and other health-care institutions can benefit from the broadband telecommunication access infrastructure to be used for eHealth solutions.
- Report and guidelines with regard to the use of mobile telecommunications for eHealth solutions in developing countries.
- Collect and summarize the requirements and effectiveness of telecommunication infrastructure for the successful implementation of eHealth applications.
- Prepare, in cooperation with WHO, training courses for nurses and paramedics for primary health-care centers in developing countries. These courses will teach how to operate some simple eHealth systems and applications, where ITU will cover the telecommunication part and WHO the health-services part.
- Collect information on how eHealth can be useful for persons with disabilities and the handicapped.
- Global dissemination of eHealth information using the eHealth directory.

All World Telecommunication Development Conferences demanded also that eHealth services and delivery should be affordable, practical, profitable, self-sustaining and available to as many people as possible. When combined with organisational changes and the development of new skills, eHealth can help to deliver better care for less money. It can deliver significant improvements in access to care, quality of care, and the efficiency and productivity of the health sector. eHealth is today's tool for substantial productivity gains, while providing tomorrow's instrument for restructured health care systems, making it more citizen-centred.

Economic aspects of eHealth are very difficult and complicated subject. There is no one single solution. First of all it is important to understand that the introduction of eHealth in developed countries is not the same as in developing countries. Even main goals are different. In general, in developed and also in developing countries eHealth will help to improve the efficiency and productivity of the health sector. But the implementation of this goal depends very much on local conditions which are different.

There is evidence that many eHealth projects do not succeed and have little or no sustainability. Many reasons can be stated for why eHealth projects do not succeed. The World Health Organization has identified a number of factors in relation to national eHealth projects:

- Lack of proper needs assessment,
- Lack of vision, strategy and national plans,
- Lack of information and awareness about eHealth services,
- Computer illiteracy,
- Insufficient resources to meet costs,
- Limited experience in medical informatics,
- Weak information and telecommunications infrastructures,
- Absence of legislative, ethical and constitutional frameworks.

Today medical professionals who are unfamiliar with (or have limited access to) ICT and existing decision support and communication tools relevant to healthcare cannot function effectively either in private or public hospitals. They are unlikely to take full advantage of technology that is available to them or contribute innovative ideas for applying information infrastructure to population health.

### **Role of Telecommunication**

The role of telecommunication facilities can not be overestimated. It is a platform for any kind of eHealth services. Most of the communication and information technologies that can be applied to the health sector are common across other sectors or share common elements and solutions developed in sectors other than health could be adopted to solve problems in the health sector. The beauty of some eHealth services is that even simple telecommunication facilities can be used for introduction of them. For example, the ordinary telephone line can be used for successful transmission of ECG and this information is playing important role in cardiology. Nevertheless, analog modem technology is gradually being phased out in favor of digital transmission technologies with higher speed or bandwidth. All available transmission telecommunication technologies can be used for the delivery of medical information if the transmission speed/bandwidth is enough for required quality. In practice of eHealth, data maybe transferred in different forms, ranging from high-quality, two-way, full-motion video to sound and still images. The optical fiber links are an ideal media for high speed/broadband communications. But the satellite technology is useful to reach remote locations and rural areas. Today with the widespread of mobile communication, this technology will be used in eHealth as well.

The Internet is becoming a popular tool for doctors to read clinical journals and communicate with other doctors, though doctor-patient e-mail is not catching on as rapidly even in developed countries where the density of computers is much higher compare with developing countries. With the

general trend for next generation of telecommunication networks to move from circuit-switched technology to packet-switched technology, eHealth networks will be used modern data communication networks.

The role of telecommunication operators in the introduction of e-health services is much more important in developing countries than in developed ones. The main interest of telecommunication operators is not to provide an additional new telecommunication service for the Ministry of Health and to get a new revenue stream. It is more important the contribution of the telecommunication companies to the well being of the citizens of their countries by helping to improve and extend the access to medical services. Therefore telecommunication operators in developing countries are partners together with doctors in the introduction of eHealth services. There is a need to bridge the gap between the telecommunication and health care communities at all levels. National Ministries of Health and Telecommunications also need to work together towards introduction of a eHealth/telemedicine policy and achievement of universal service where emergency services, health and social information systems are concerned.

It is clear that the introduction of eHealth services has to be based on existed telecommunication infrastructure. Nevertheless many hospitals in developing countries have poor connections to the nearby telephone exchange and they often need assistance from local telecommunication operators on how this connection could be improved for high speed communication. Since eHealth relies heavily on Internet technologies, it is necessary to promote e-literacy. Consumer need to learn not only how to navigate the World Wide Web, but also how to critically evaluate the reliability, accuracy and the source of information, and services offered online. The Hospital Information System (HIS) is becoming the important and useful component of a modern hospital everywhere. This is a platform for eHealth services today and in the future. Not many developing countries can afford HIS in every hospital but the process of hospitals's "informatization" has already started everywhere and moving ahead. The limited information on uniform, international, multipurpose standards for the structure, content, and transmission of medical data seriously impairs the introduction of eHealth services in developing countries where interoperability is one of the most important requirements.

### **Conclusion**

The motivation and commitment to eHealth in developing countries is very strong. eHealth services may be perceived as more of a necessity in developing countries than they are in the developed countries, resulting in a greater willingness among the former to change established methods of

doctor-patient interaction and health care administration. If the decision-makers in the health sector wish to take into account eHealth services within the framework of the national health policy, they should consider at least four aspects of health-care where eHealth could play a role:

- Quality and efficiency of health care services;
- Health education for both medical staff and citizens;
- Reinforcing national health structures;
- Administrative.

The wide implementation of eHealth services will change the health care industry such as the structure, the management, its physicians and contact by and to society at large. eHealth has a great potential to improve access to care to for many population groups, especially those in underserved areas. Several additional issues related to eHealth that will need to be studied include confidentiality, quality of care, the effectiveness, etc. The medical doctors should take the lead in determining their needs and how eHealth might help. Of course, the implementation of such ambitious program would be done in several stages according to available resources but the vision and understanding of the problem for the whole country will give the chance to concentrate resources and avoid unnecessary duplication.

Introduction of eHealth services requires multidisciplinary collaboration with active participation of telecommunication operators and health care professionals. Therefore it is recommended according to the Resolution 41 of the WTDC-02 that the Member States of the ITU to consider the establishment of a national committee/task force comprising representatives from telecommunication and healthcare sectors. The national committees, associations, task forces and the like could assist the preparation of the National eHealth Master Plan. The latter has to be developed and it should be based on the modest step by step approach allowing the introduction of eHealth services together with training of doctors and nurses on how to use eHealth services. It is very important to make the right selection of a first pilot eHealth project which is playing dual role as a new tool for the delivery of health care and also as a component of promotion campaign to raise the awareness of decision - makers, health professionals, beneficiaries and other key players about the benefits of ICT for health care sector.

Countries can implement telemedicine services gradually based on lessons they have learned and on the experience of others. Successful introduction requires more than just the delivery of the right equipment to the users. Much more important in each case is to find the right way of how to incorporate telemedicine services in the medical practice and routine clinical consultations. This is also relevant to organizational and administrative matters as well as to efficient training.

Experience demonstrates that there is no single solution that will work in all settings. The complexity of choices of technologies and the complexity of needs and demands of health systems suggests that the gradual introduction, testing and refining of new technologies, in those areas of health care where there is a reasonable expectation that ICTs can be effectively and efficiently used, is more likely to be the successful way forward.

Effective governance of eHealth requires codes, regulations and standards to ensure satisfactions of the consumers. Issues in governance include legal liability, ethical standards, privacy protection, and cultural and social standards. Medical culture and practice can and do vary greatly from country to country and this has also be taken into consideration.

Successful eHealth services require more than just technology. For any eHealth system to work in practice – in a real clinical situation – suitable, committed personnel are essential. People with the necessary skills to undertake the clinical components are required at both ends of any telemedicine link. This means that there must be trained staff at the referring end of the link that is able to handle the patient contact required. They need prior training and are comfortable with this mode of care delivery, since eHealth will represent a clinical situation that they are not normally exposed to.

Curative and clinical medicine has played a role in improved health in general, but the vast majority of the improvement in life expectancy can be also attributed to public health measures. Most of public health involves the transfer of information. Public health measures provide facts about sanitation, nutrition, and maternal and child care, for example, which lead to improvements in health. If we can apply eHealth to preventive medicine, we can expect great improvements in health. Telepreventive medicine consists of the use of the Internet to bring and collect quantities of information from large number of healthy people to prevent disease.

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**ADVANCED SYSTEMS STRATEGIES FOR E-  
HOSPITALS**

# A FRAMEWORK TO SUPPORT INTELLIGENT HOSPITAL INFORMATION SYSTEMS

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**Abstract:** This paper presents the requirements, the architecture and the functionalities of a specialized framework, which is based on the JADEX java agent middleware platform and is targeted to support the development of intelligent hospital information systems.

## Introduction

Every professional working in the health care domain, especially in a hospital, needs to be quick and active. He also needs to cooperate with a large number of people and to access many different devices and pieces of information, all scattered in a volatile environment. In order to improve patient care through greater access to integrated clinical knowledge, patient medical records and examination results have become electronic during the last decade and many information systems, principally designed for hospitals, have been deployed. However, the lack of specialized solutions that satisfy the demanding requirements of health care sector, have hindered the extended adoption of intelligent context management systems, especially those using mobile technologies. Only during the last few years, a number of context aware systems that aim particularly to the health care sector have been presented [1] [2]. This paper presents a new and specialized framework developed in the context of WinHPN project [3], targeted at supporting the development of intelligent hospital information systems and evolves as follows: In the next section the system requirements are identified. Then, the architecture and the modules that comprise the framework, as well as their functionalities are presented. In the sequel, a sample operation of the system is provided and finally, the paper concludes with the benefits stemming from the usage of the proposed framework.

## System Requirements

An intelligent hospital information system needs to be able to incorporate and control a diverse variety of devices like location or wearable sensors,

microphones, special input or output devices. Therefore, one fundamental requirement is the ability to allow the easy exploitation and integration of the heterogeneous communication environment of a modern hospital and at the same time hide its complexity. The system has to be designed extendable and open, so as to be able to satisfy the demands of new types of services and to take advantage of new technologies in the future. It also needs to efficiently tackle with issues like devices mobility', resources and power limitations or restrictions in communication range. Finally it is desired to have increased reliability and scalability and to support incorporation of advanced reasoning mechanisms.

### **System Architecture and Functionality**

In order to fulfill the aforementioned requirements, the proposed system is built on a Java Agent middleware platform, namely JADE [4]. JADE offers the requested reliability and scalability [5], allows the loose coupling of the components and ensures their communication through the corresponding agent, which provides them with an interface to the rest of the WinHPN system. Since each agent is an independent software entity, it is free to join and leave the platform without any implications, while registration and discovery mechanisms endorse such actions. Moreover, the asynchronous exchange of messages facilitates small devices that may need e.g. to operate periodically. Each agent is actually a mediator between a hardware or software component and higher level system functionality. It is an abstraction layer that hides the underlying complex infrastructure, by letting e.g. developers to retrieve location information without really knowing if the component that supplies this information is based on RFID or Bluetooth or any other technology.

WinHPN framework offers various types of agents that are categorized according to their functionality, as it is depicted in Fig. 1. User Agents (UA) are mainly related to the graphical user interface presented to the hospital staff and can help at its personalization and handy information display. Context Input Agents (CIA) can handle devices like cameras, RFIDs, location sensors, microphones, and feed the corresponding input to the system. Core Agents (CA) are responsible for interactions with databases and other legacy functionalities that pre-existed and are incorporated into the system. Finally, Application Reasoning Agent (ARA) takes care of the information flow between applications and services. The role of ARA is essential, since it is the entity that receives input information from all over the system, processes it and is ready to supply it to any other interested part.

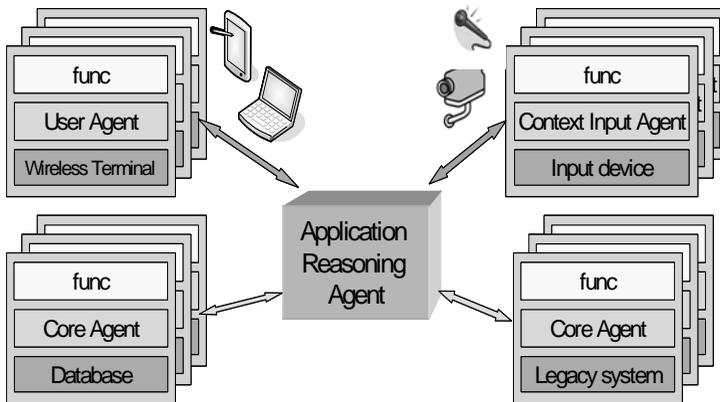


Fig. 1. Agents' classification

Moreover it applies various reasoning techniques, so as to act proactively and trigger services, launch applications or send messages. The latter task obviously implies embedded intelligence, which in this case is relying on JADEX [6], an add-on to JADE. ARA's behavior follows the Belief-Desire-Intention (BDI) model [7], which is supported by JADEX and is proven to be the most robust and flexible model for Intelligent Agent Systems. Actually, ARA is not the only intelligent entity in the system as any agent can exploit JADEX capabilities, if necessary, to support its functionality.

### Sample operation scenario

In the scenario depicted in Fig. 2, an ambulance has just collected a patient suffering from a heart attack. The patient owns a medical smart card that holds some essential data on his identity. The card is fed into a Context Input Agent i.e. a smart card reader, which then sends an alarm message to the ARA conveying this data. The ARA undertakes the responsibility to check upon the possible pre-existence of the patients' medical record by querying the respective CA of the Patient Database. The ARA identifies the criticality of the situation and sends an alert to the Emergency CA. Then, the Emergency CA conducts its reasoning engine in order to designate the appropriate specialty and alert the respective Doctor UA. The reasoning engine may also give priority to the specific patients' attendant doctor, if possible. At the same time and in an asynchronous manner as referred above, the ARA's embedded reasoning engine justifies the need to alert the Clinic CA for an expected hospitalization. The alerted Clinic CA after checking the hospital beds' availability automatically sends a message to the Accounting Services UA to take care for booking a bed and also for preparing other accounting stuff.

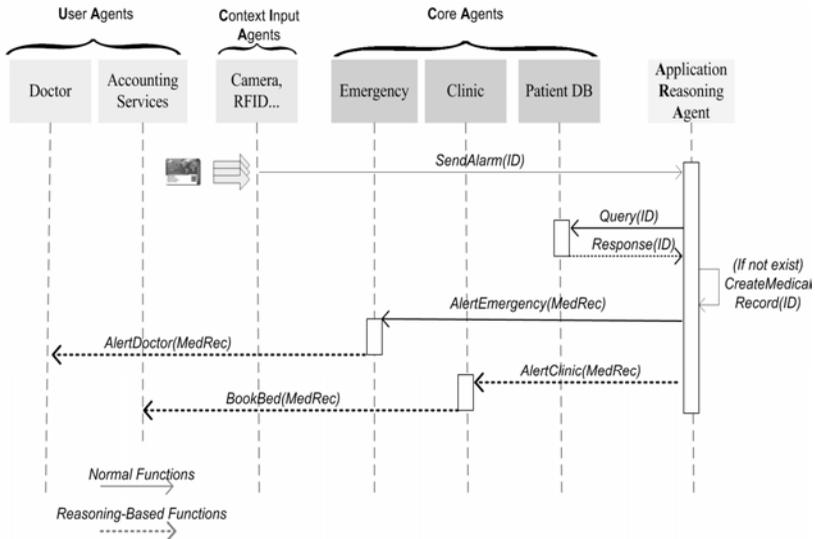


Fig. 2. Sample operation scenario

### Conclusions

WinHPN platform is an open and extendable framework based on well-proven technologies. It provides the means to incorporate into a hospital information system additional intelligence, as well as novel hardware components, enabling the provision of sophisticated services. Therefore the agility and the quality of the procedures and the patient care in general can be improved, while the job of all hospital personnel can be facilitated and be accomplished in a far more efficient way.

### References

- [1] J.E.Bardram and T.R.Hansen, "The AWARE Architecture: Supporting Context Mediated Social Awareness in Mobile Cooperation", Proceedings of the 2004 ACM conference on Computer Supported Cooperative Work, pages 192-201, ACM Press
- [2] P.M.Vieira-Marques et al, "Secure Integration of Distributed Medical Data Using Mobile Agents", IEEE Intelligent Systems, vol 21, pages 47-54, Nov.-Dec. 2006
- [3] WinHPN (Wireless INtelligent Hospital Premises Networks, Celtic Project, CP2-033, available at: <http://www.celtic-initiative.org/Projects/IMPULSE/default.asp>
- [4] Java Agents DEvelopment Framework, available at: <http://jade.tilab.com>
- [5] F.L.Piccolo, G.Bianchi, S.Salsano, "Measurement Study of the Mobile Agent JADE Platform", Proceedings of the 2006 International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM'06), pp. 638-646, 2006
- [6] JADEX available at: <http://vsiis-www.informatik.uni-hamburg.de/projects/jadex/>
- [7] M.E.Bratman, "Intention, Plans, and Practical Reason", Harvard University Press, Cambridge, MA, 1987

# AUTOMATIC MICROBIOLOGICAL LABORATORY-BASED SURVEILLANCE: THE MICRONET PROJECT

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**Abstract:** In Italy in 2004, the Istituto Superiore di Sanità (ISS), supported by Ministry of Health, started up an automatized surveillance system based on microbiology laboratories. It consists of epidemiological surveillance of infectious diseases based on computerized and early collection and transmission of data on infectious diseases, pathogens and antimicrobial resistance from microbiology laboratories LIS (Laboratory Information System). Micronet represents an important starting point for regional networks that could be merged into a national one. It serves as an important instrument for the rapid detection of epidemics and trends of infections, providing data more timely, complete and up-to-date.

## Introduction

In Italy the ordinary notification of case of communicable diseases is based only on clinical notifications that converge to official informative sources as Italian SIMI (infectious diseases computerized system) [1]. However this system covers a limited number of diseases, and, in order to know about etiological causes, special surveillance systems were activated (as for meningitis [2] or for antimicrobial resistance [3]), taking data from laboratories using paper forms. Furthermore, at local level there is a big effort to monitor hospital-acquired infections through laboratory data generated for medical assistance, since it has been demonstrated that hospital-acquired infections have a deep economic impact: infections affect 5% - 8% of inpatients [4]; each infection has an average cost of 17.2 additional days more in terms of LOS [5]; and infection episodes' that may be foreseen and avoided cover 30% of the total [4].

To bypass this addition of burden on the activities of clinical microbiologist, the Istituto Superiore di Sanità (ISS), the Italian National

Public Health Institute, with the collaboration of the Ministry of Health is developing an automatized surveillance project for multicentric collection of data from microbiology laboratories. It consists of an epidemiological surveillance system of infectious diseases based on computerized and prompt collection and transmission of results about the etiology of infectious diseases, of antimicrobial resistance and of hospital-acquired infections from the LIS (Laboratory Information System).

Micronet is designed to be a sentinel surveillance system that collects all laboratory (positive and negative) result from a sample of microbiological laboratories. The approach is based on clinical requests. All data are collected from the information system (LIS) of each laboratory. Before the transmission to the central server, all data are converted automatically in the Micronet data format using standardized tables. The data transmission has been designed to occur on a daily basis. This is promising in order to improve local and national monitoring of hospital-acquired infections.

## Methods

### A. *MicroNet's concept and overall architecture*

A group of microbiologists and epidemiologists produced 11 standardization tables in order to manage data exchange. Such tables are regularly updated and available on line. One of their key features is that they allow to focus on what is looked for, through each test, in terms of pathogen or group of pathogens. A flexible XML format was also defined as the format to exchange data from laboratory to the central server. All participant laboratories were asked to develop an exporting procedure complying with the provided specifications. In this way the software houses in charge of installing and maintaining the information system of every

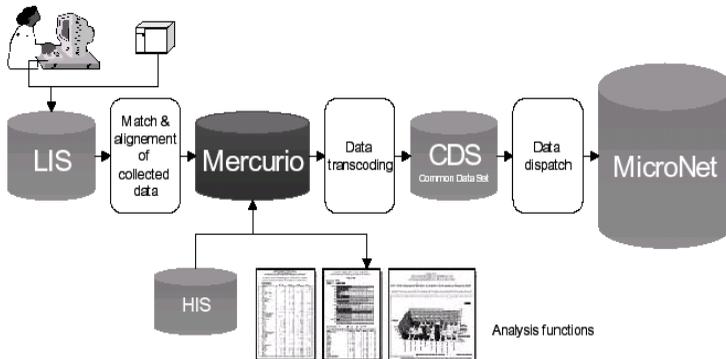


Fig. 1 Example of the process to feed MicroNet

laboratory were involved in the developing of the exporting procedures. All this information is available on the Internet for the participants or for those in need of more information to implement the system.

All data are stored into the Micronet central database, and a web site was set up to provide feedback through the analysis on aggregated data. All the laboratories recruited were in Piedmont (one of the 21 Italian Regions), and 6 of them were equipped with Mercurio, *NoemaLife*'s hospital-acquired infections' survey and monitoring system, allowing for an easier exportation to the Micronet format (Figure 1).

### ***B. Role and description of Mercurio***

Mercurio supports data dispatch to Micronet providing the laboratories tools for local analysis functions and, at the same time, the opportunity to exchange data with regional or national networks using the Micronet data format.

Mercurio aims at the valorization of the "Hospital's information" and supports risk management by integrating different systems. The integration is carried out by automatic processes which solve the problems of information coding, homogenization and standardization. Furthermore, as a distinctive characteristic, Mercurio allows availability of clean and consistent data, thus supporting every single laboratory and institution, in monitoring and surveying their own data.

Microbiology reports are the main information source for hospital-acquired infections monitoring and survey system; they are taken from the LIS or directly from the instruments' database. Data are properly filtered for a correct identification of the infectious episodes. Mercurio is modular and scalable and consists of:

- Epidemiological Observatory for Microbiology Data;
- Integration module with Hospital information System (HIS);
- Integration module with Pharmacy Information System (PhIS);
- Expert System for the identification of Alarm Events;
- Expert System to support microbiological reports validation;
- Active Survey Forms.

## **Results**

During the pilot test, the tables and specifications were implemented in 7 laboratories, sending data collected during three months corresponding to more than 50,000 records (removing duplicates). The majority of data collected were gathered from the Laboratory of the S. Anna Hospital in Torino (22.7%), followed by the Laboratory of Novara Hospital (20.2%),

corresponding to more than 20,000 records. The other five laboratories participated with around 30,000 records (Table 1).

All data are stored into the Micronet central database and a web site was set up to provide feedback in terms of analysis on aggregated data regarding tests, results, pathogens, antimicrobial resistance profile.

Table 1 Distribution of records for each laboratory

Laboratory	Number of records	%
S. Anna (TO)	11,530	22.7
Novara	10,239	20.2
Omegna	9,452	18.7
Molinette (TO)	7,167	14.1
Cuneo	4,340	8.6
Mondovì	4,211	8.3
S.G. Bosco (TO)	3,733	7.4
Total	50,672	100

### **Conclusions**

Micronet represents an important national network providing instruments for fast detection of outbreaks and assessment of microbiological trends.

The data collected, at a national level, might be compared to similar experiences in other European countries as The Netherlands [6], where a similar project was developed, although with some differences (e.g. only positive laboratory test results were collected). Furthermore, the Micronet project shows the important benefits of a synergy between the standardization and the hospital -acquired infection solutions as Mercurio, with a full meeting of interest. In fact, the rapid implementation of the 11 standardized tables by the coordination group, in this pilot phase, allowed for a timely analysis on merged data from different laboratories and institution given the opportunity to monitor and survey their own data.

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### **References**

- [1] Carrieri M.P., Salmaso S., Bella A., D'Ancona F., Demicheli V., Marongiu C., Niglio T., and Sellitri C. Evaluation of the SIMI system, an experimental computerised network for the surveillance of communicable diseases in Italy. *Eur J Epidemiol* 16 (10):941-947, 2000
- [2] Mastrantonio P., Stefanelli P., Fazio C., Sofia T., Neri A., La Rosa G., Marianelli C., Muscillo M., Caporali M.G., and Salmaso S. Serotype distribution, antibiotic susceptibility, and genetic relatedness of *Neisseria meningitidis* strains recently isolated in Italy. *Clinical Infectious Diseases* 36:422-428, 2003.
- [3] Fokas S., Boccia D., D'Ancona F., Giannitelli S., Lana S., D'Ambrosio F., and Salmaso S. Antimicrobial resistance surveillance in Italy: results of AR-ISS project. (Poster). *Clinical Microbiology and Infection* 9:249, 2003. (Abstract)
- [4] Moro M.L., Gandin C., Bella A., Siepi G., Petrosillo N., Indagine conoscitiva nazionale sulle attività di sorveglianza e controllo delle infezioni ospedaliere negli ospedali pubblici italiani. *Rapporti ISTISAN* 01/04, page 2, 2001
- [5] A. Lizioli, E. Alliaia, M.L. Panceri, F. Auxilia e V. Carreri, Valutazione dell'impatto economico delle infezioni ospedaliere in Lombardia: risultati di uno studio in 88 ospedali (Assessment of the economic impact of hospital infections in Lombardy: results of a study in 88 hospitals) *PharmacoEconomics. Italian Research Articles*. 5: 3, 2003.
- [6] M. A. Widdowson, A. Bosman, Straten E. van, M. Tinga, S. Chaves, Eerden L. van, and Pelt W. van. Automated, laboratory-based system using the Internet for disease outbreak detection, the Netherlands. *Emerg.Infect.Dis.* 9 (9):1046-1052, 2003.

# **SIMULATIONS AND USABILITY ENGINEERING IN THE EVALUATION OF PRE-HOSPITAL EMERGENCY CARE: A CASE STUDY**

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***Abstract:*** In order to ensure that various systems adequately meet the requirements and quality standards of health care, evaluations of these systems are necessary. The aim of this study was to develop and test an evaluation method for assessing the impacts of medical equipment in realistically simulated surroundings.

The whole working process of a pre-hospital emergency care patient case was carried out in simulated surroundings. Several methods were used in the evaluation: questionnaires, task analysis, measurement of elapsed times, and analysis of documentation. The following criteria were applied to estimate relevancy and feasibility of methods used: thoroughness, validity, reliability, cost effectiveness and clarity.

The test methods used produced comprehensive data providing valuable information for decision makers and system developers. This evaluation method using simulated surroundings proved appropriate and fulfilled almost all the relevancy and feasibility criteria.

## **Introduction**

The increasing use of technology within health care is usually predicated on the assumption that technology will facilitate care management and improve the quality of health care [1]. However, it is known that modern technology can create new demands and make the work more complicated [2]. Ultimately, the design of medical devices and information systems affects patient safety [3].

In order to ensure that systems adequately meet the requirements and information processing needs of users and health care organizations,

evaluations of health care information systems are necessary [4]. Many researchers have reported problems during evaluations [5]. It has been pointed out that conventional methods of evaluation, such as questionnaires and interviews, suffer certain limitations [6]. Methods arising from usability engineering are regarded as supplying one answer to this problem [7].

Usability is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [8]. Usability testing is the testing of a product with its real users, typically in simulated surroundings. Such testing provides direct information about how people use the products and exactly what problems arise for them [9]. Simulations at their best can imitate real world situations involving patient care. Usability assessment in simulated surroundings can reveal technology-induced errors. The advantage of this approach is that errors can be corrected before the systems are deployed in a real world context. It is also possible to conduct several tests in order to evaluate the products thoroughly. [7] In actual settings, the main difficulty is with the lack of controls on tasks the users perform. [10] In simulated surroundings, there are fewer problems with ethics and patient safety.

The aim of this study was to develop and test an evaluation method for assessing the impacts of medical equipment in realistically simulated surroundings. The evaluation method has been designed to cover the product life cycle from prototype to ready-made product, and to be suitable for both health care decision makers' and developers' purposes. The context of the research was pre-hospital emergency care. In this paper we assess the relevancy and feasibility of the methods used.

### **Evaluation study**

This study was based on the principles of usability ergonomics. The template of the evaluation was the definition of the framework of action.

The evaluation of the products was conducted in simulated surroundings. The subjects of the usability testing were 12 paramedics working in pairs. Of each pair, one paramedic was responsible for treatment of the patient (P1) and the other assisted and drove the ambulance (P2).

A whole pre-hospital emergency care patient case was simulated from raising the alarm to signing the patient over at the hospital. For the test, the simulated surroundings were furnished as the patient's home and the hospital. A real ambulance was used for driving to the patient's location and for transportation. The paramedics were equipped with all the equipment they carry in a real working situation. The test task was based on a commonly occurring pre-hospital patient case.

The test users used two separate products: a portable information system for documentation and a specially designed rescue covering for the patient. The subjects performed the test task (1) with conventional equipment related to real emergency care settings and (2) with the conventional equipment replaced by the equipment under evaluation. The order of the tasks was randomized between the pairs in order to minimize the effect of learning. After conducting the test scenarios, the paramedics completed a questionnaire giving their subjective opinions of the product. The usability testing was recorded using a portable digital video camera. The task analysis and the calculation of elapsed times of different sub-tasks were performed with the help of recordings. A comparison was made between manual and digital patient charts. Mean values for times and questionnaire answers were calculated along with standard deviations. The Wilcoxon test was used to determine the significance of the results (p-values).

### **Assessment of the evaluation method**

The following criteria defined by [10] were applied to estimate the relevancy and feasibility of the evaluation method: thoroughness, validity, reliability, cost effectiveness and clarity.

#### ***1. Thoroughness: the method should find as many usability problems as possible.***

The thoroughness of the evaluation is highly dependent on the number of test users [6]. According to [11], 10 test users can find up to 90 % of the usability problems. The present number of test users was 12 and therefore it can be stated that the thoroughness criterion was fulfilled in this respect.

Triangulation in evaluation research means the multiple employments of various sources of data, observers, methods and theories in the investigation of the same phenomenon. It has been shown that the comprehensiveness of results can be supported by triangulation [12]. Several methods were used in the evaluation: The questionnaire was tailored for each product separately in order to obtain detailed information. The subjective opinions recorded in the questionnaire comprehensively revealed information about the usability of the products. However, it is impossible to compare the results with other studies because of our use of a non-standardized questionnaire.

With the help of task analysis, we reached a thorough understanding of the impact of the evaluated products on the emergency care process. However, in the future the task analysis should be carried out in more detail using a severity classification. Measurement of elapsed times was designed to include an indication of time effort for sub-tasks of the emergency care process using different products. Statistically significant differences were

revealed, although the results can only give a hint of the truth because of the small sample size. Analysis of the documentation revealed positive and negative features of the electronic and manual documentation. It should be assessed whether a classification would also be applicable here.

**2. Validity: the problems discovered should also occur in real use.**

A simulation can never comprehensively imitate real life, and thus circumstances can affect the results. For this reason, the simulation consisted of sub-tasks which are based on actual events in pre-hospital emergency care. The simulation also provided a thorough investigation since the test task was conducted several times.

There were no changing variables included in the testing, which provided to the opportunity to compare user performances reliably. The usability test settings include no faults resulting from the test set up, and so the procedure was standardized.

**3. Reliability: the results should be independent of the individual performing the task.**

The test users were representative of the end-users. All had a license to work at the advanced life support level in pre-hospital emergency care. All performed the patient care according to national guidelines. Since the test users were volunteers, they may have had a positive prejudice in favor of new technology and innovations. However the test users were critical, assessing the products as individuals but also as representatives of their profession.

**4. Cost effectiveness: the method should be as cost effective as possible when used by trained evaluators.**

Conducting a usability test requires training and expertise. Usability testing is cost effective providing that the test has been properly prepared. Test users and post-test analysis of the tests are necessary, but when thoroughness and validity are good this criterion is fulfilled [6]. In this respect it can be said that the evaluation method is cost effective.

**5. Clarity: the results should be understandable and usable for decision-makers.**

The clarity criterion has two aspects: (a) how the results are presented and (b) what information the results provide [6]. The methods that were used in this study offer answers to the following questions:

- How does the product affect the working process?
- How does the product affect the treatment of the patient?
- What are the positive and negative features of the product and how should it be developed?

The data produced are valuable for both decision makers and developers and therefore usable. The clarity of usability testing is high, as both thoroughness and validity criteria were fulfilled [6]. Consequently the clarity in this study is high.

### **Conclusions**

The increasing use of technology in health care demands rigorous usability evaluations of technological products. The evaluation method described in this paper produced comprehensive data offering valuable information for decision makers and developers. An extensive understanding of the usability of the evaluated products and their impacts on working processes was acquired.

It can be concluded that the evaluation method proved appropriate and fulfilled almost all the criteria of relevance and feasibility. Realistically simulated surroundings provide an ideal research environment for studying the usability of products in cases where the real working context suffers too many disadvantages. The development of the evaluation method will continue by optimizing the methods used in the usability testing.

### **References**

- [1] M. Pose, S. Czaja and J. Augenstein. "The usability of information technology within emergency case settings," *Computers and Industrial Engineering*, vol. 31, pp. 455-458, 1996.
- [2] N. Sarter, D. Woods and C. Billings. "Automation surprises." in *Handbook of Human Factors & Ergonomics*, New York: Wiley, 1997.
- [3] D. Berwick and L. Leape. "Reducing errors in medicine," *Journal of Quality Health Care*, vol. 8, pp. 145-146, 1999.
- [4] A. Kushniruk and V. Patel. "Cognitive and usability engineering methods for the evaluation of clinical information systems," *Journal of Biomedical Informatics*, vol. 37, pp. 56-76, 2004.
- [5] E. Ammenwerth, S. Gräber, G. Herrmann, T. Bürkle and J. König. "Evaluation of health information systems - problems and challenges," *International Journal of Medical Informatics*, vol. 71, pp. 125-135, 2003.
- [6] E. Liljegren. "Usability in a medical technology context assessment of methods for usability evaluation of medical equipment," *International Journal of Industrial Ergonomics*, vol. 36, pp. 345-352, 2006.
- [7] E. Borycki and A. Kushniruk. "Identifying and preventing technology-induced error using simulations: application of usability engineering techniques," *Healthcare Quarterly*, vol. 8, pp. 99-105, 2005.
- [8] ISO 9241-11, "Ergonomic requirements for office work with visual display terminals, part 11: Guidance on usability," 2000.
- [9] J. Nielsen. *Usability Engineering*. Boston, MA, USA: Academic press, 1993.
- [10] H. Hartson, T. Andre and R. Williges. "Criteria for evaluating usability evaluation methods," *International Journal of Human-Computer Interaction*, vol. 13, pp. 373-410, 2001.
- [11] R. Virzi. "Refining the test phase of usability evaluation: how many subjects is enough?" *Human Factors*, vol. 34, pp. 457-468, 1992.

[12] J. Greene and C. McClintock. "Triangulation in evaluation: design and analysis issues," *Evaluation Review*, vol. 9, pp. 523–545, 1985.

## THE ROMANIAN – ITALIAN TELEMEDICINE PROJECT

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**Abstract:** Telemedicine projects have big qualities that consist in removing barriers between peoples, countries and regions. Our project reflects interregional telemedicine cooperation between Italy and Romania. The communication between hospitals is based on an infrastructure that implements a virtual private network connecting the hospitals, the universities and a server farm (located in Brescia, Italy). The communication between partners has at its ends the software Clinical Image Integra<sup>®</sup> that ensures functionalities specific to a telemedicine project. With this project we promote the vision of e - Europe regarding access to healthcare services and the increasing mobility of patients.

Nowadays, at the beginning of the XXI<sup>st</sup> century, any responsible individual involved in medical assistance should be confronted, more or less, with three challenges, namely: promoting high quality medical services, with the lowest costs possible, and with a high accessibility.

The e-health concept is more and more a reality, tending to become a day-to-day utility. E-health is playing an important role in the EU e-Europe strategy and one of the important activities to support this is the deployment of health information networks based on fix and wireless broadband and mobile infrastructures. Telemedicine offers the possibility to increase the role of physicians, by direct dialog person-to-person, using modern IT techniques, like internet, tele-consulting, videoconferences and not at last offers for the patients' possibility to achieve a universality of the health care [1-5].

A bilateral project that sustains this vision and finances the activities has started between regions from Romania and Italy. The cooperation started

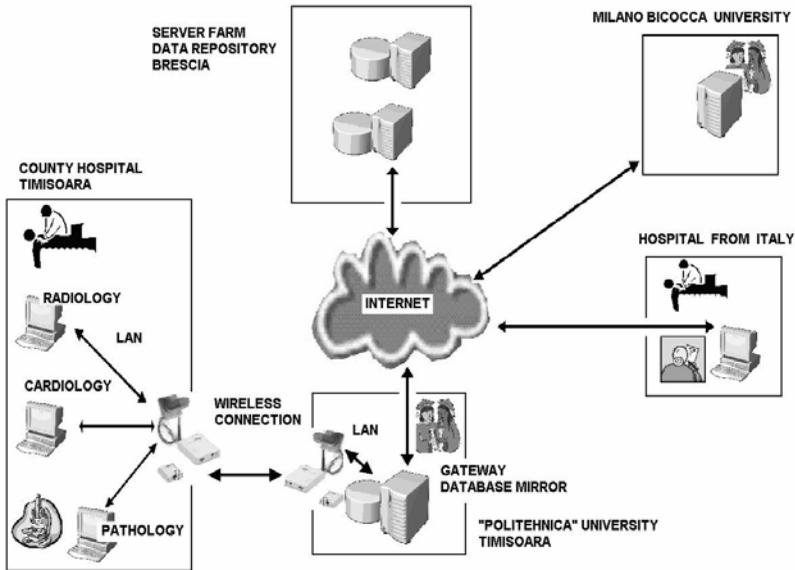


Fig. 1 The structure of the telemedicine system

between Lombardy and Toscana regions (Italy) and Timis County (Romania) with the intention of enlargement.

This bilateral project that is functional since December 2004, is supported by the Italian Ministry of Foreign Affairs, and the project leader is the @ITIM – Associazione Italiana di Telemedicina e Informatica Medica. The University “Politehnica” from Timisoara, Romania and the University Milano-Bicocca from Milan, Italy, ensured the design of the architecture and the technical support (fig.1).

The project had as result the development of a healthcare network between a Romanian hospital, the Emergency County Hospital Timisoara and an Italian Hospital, the Careggi Hospital from Florence.

The aim of this study is to increase the quality of medical services, provided by the Emergency Clinical Hospital Timisoara, Romania, in collaboration with departments from Italian hospitals.

The Romanian partnership consist in providing health care for all patients admitted in the Emergency Clinical Hospital Timisoara, that covers basically all the geographically territory of the South-West part of Romania and the technical assistance from the “Politehnica” University of Timisoara. The Emergency County Hospital Timisoara, sustained by a team

of professional doctors is involved with three departments: cardiology, radiology and pathology. The Cardiology Department offers specific medical services: ECG (including ECG and blood pressure Holter monitoring), stress tests, pacemaker therapy, and echocardiography. The department has adequate equipment for teleconsultation: laptop and PCs, for data storage, a laptop with tele-consultation software (Clinical Image Integra<sup>®</sup>) created by the Italian partner. Also for clinical data storage it is a web camera and video grabber all this equipments ensure the mobility of cardiologists to the patient bed in a specific allocated clinical room with intranet and internet network.

The Radiology Department is a complex imagistic department. The imagistic results are stored on the server using DICOM standard and offers services to all departments. Also in this department it is a laptop for telemedicine applications with the same software as in Cardiology. In the pathology department the activity is focused on the analysis of the histological slices. The project supplied a digital camera for the microscope. Also this department as the above mentioned radiology department are connected in the intranet and internet network of the Emergency County Hospital Timisoara.

This project reflects a four years (2003 – 2006) experience in the field of telemedicine, with some particularities. Table 1 reflects the dynamics of telemedicine proceedings (n: 50).

Table 1 Telemedicine proceedings in Italian – Romanian Bilateral Project

	2003	2004	2005	2006
Telemedicine Proceedings	2	12	26	10

The main telemedicine proceedings are: clinical images transfer (n: 16, 30%), 2D-echocardiography (n: 8, 15%) transfer, video-consulting (n: 6, 11%) and unfortunately a less number of X ray, pathology images and ECG files transfer. All this results were received from both partners as a good opportunity for medical data and professional scientific information exchange. The communication between partners is achieved by a VPN network with 6 Mbps data transfer rate. The server at the University “Politehnica” in Timisoara is running on Windows 2003 Server. The software Clinical Image Integra<sup>®</sup> ensures functionalities specific to the clinical and administrative process. The next step is a challenge for us to improve the telemedicine software and to raise the number and the quality of telemedicine proceedings.

## **References**

- [1] Blobel B., Pharow P, eds. - Advanced Health Telematics and Telemedicine. IOS Press, 2003.
- [2] Comission of the European Communities COM 2004 (356) - e-Health – making healthcare better for European citizens: An action plan for a European e-Health Area, Brussels 2004.
- [3] Moga M., Mihalas Gh.I., Moga V. - Timis County Hospital Information System. MIE 2004 Special Topic Conference, München 2004.
- [4] Moga, V.D., Moga M., Stoicu-Tivadar L., Stoicu-Tivadar V., Avram R., Sicurello F. - The 8th DKMT Euroregional Conference on Environmental Medicine, Nutrition and Health, Romania 2006.
- [5] Stoicu-Tivadar L., Sicurello F., Stoicu-Tivadar V., Moga V.D., Moga M., et al - Teleconsultations as a step towards hospital interoperability. Ubiquity: Technologies for Better Health in Aging Societies, A. Hasman et al. (Eds.), IOS Press 2006, p. 455-460.

## **EFFICIENCY IN EHEALTH**

# IMPROVING EHEALTH QUALITY AND SAFETY

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## Introduction

### *A. Driving innovation*

Innovation is about the successful exploitation of new ideas. Innovation is often referred to as the process of making improvements by introducing something new. The improvements are changes that create a new dimension of performance. What is new is an unprecedented idea, method or device. Something new must be substantially different, not an insignificant change. Innovations are intended to make someone better off, and the succession of many innovations grows a whole economy [1].

The term innovation may refer to both radical or incremental changes to products, processes or services. The often unspoken goal of innovation is to solve a problem. Innovation is an important topic in the study of economics, business, technology, sociology, and engineering. Since innovation is also considered a major driver of the economy, the factors that lead to innovation are also considered to be critical to policy makers [2].

eHealth is an innovation which promises to increase quality, safety, effectiveness and also accessibility of healthcare. It comprises the application of information and communication technology in the healthcare delivery process:

*“eHealth refers to the use of modern information and communication technologies to meet needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers”* [3].

It is expected that eHealth applications will substantially increase by type, number and volume.

### *B. Market introduction*

From the point of view of market introduction, eHealth can be divided into two groups: eHealth applications which are not part of the insurance provision (either private or public insurance) and those applications which are. If the eHealth applications are not part of insurance provision, it can still be marketed if it meets the legal requirements with regard to quality

and safety. In that situation a market price is charged for the innovation, which will tax the budget of healthcare providers, healthcare institutions and/or households.

If there is a desire to include an eHealth application in insurance provision, then the application must be well-considered and it must meet minimum requirements with regard to the desired efficiency and perhaps also with regard to quality and safety.

### ***C. Research question and commentary***

The discussion of admitting an innovation contributing to quality, safety and efficiency then leads to the following key question: “*Which assessment process should be followed to admit eHealth innovation?*” The question of who determines and maintains the minimum requirements and implements them into an assessment process is a political one and is not investigated in this publication. The requirements themselves are the subject of research and also fall outside the scope of this publication.

The response to the central questions is given in five steps (Section II). Section III gives the results of each step. The publication is concluded with a discussion (Section IV).

## **Research Approach**

The solution to the question has been set in motion in five parts [4][5][6]. First, the legal and normative framework for quality and safety has been analysed. Secondly, the management of eHealth is placed in the legal and regulatory context supplemented by current ideas on market operation and supervision. Thirdly, a general model is drawn up for quality improvement in the entire innovation process of eHealth with attention to process and product specifications. Fourthly, a method is sought for making qualitative aspects measurable. Finally, all this is made operational in a test model on the basis of the so-called **TERTZ**® method. All steps have been evaluated by consulting experts.

## **Results**

### ***D. Legal and normative framework for quality and safety***

In the Medical Device Directive 93/42/EEG concerning medical devices [7] the requirements with respect to quality and safety are laid down in legislation in order to promote free trade within Europe. So, the directive refers to essential requirements with regard to quality and safety of medical devices. In this Directive a medical device is defined as follows:

(a) ‘Medical device’ means any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including

the software necessary for its proper application intended by the manufacturer to be used for human beings for the purpose of: diagnosis, prevention, monitoring, treatment or alleviation of disease, diagnosis, monitoring, treatment, alleviation of or compensation of injury or handicap, investigation, replacement or modification of the anatomy or of a physiological process, control of conception, and which does not achieve its principle intended action in or on the human body by pharmacological, immunological and metabolic means, but which may be assisted in its function by such means;

(b) ‘Accessory’ means an article which whilst not being a device is intended specifically by its manufacturer to be used together with a device to enable it to be used in accordance with the use of the device intended by the manufacturer of the device.

The essential requirements are based on a high level of protection of health and safety and assessing the utility of the device in relation to the possible risk to the patient. If there are risks involved in the use of the device for its intended purpose, the user of the device must be informed of this. The Medical Device Directive lays down strict requirements with regard to safety and quality for admittance to the market, including vigilance and post-marketing surveillance and inspection by the Health Care Inspectorate. The minimum requirements with regard to quality and safety are well summarized in various national and harmonized standards. The ISO standard 9001: *Guide for health care services* defines the requirements with regard to suitability, safety, effectiveness and efficiency, care/respect/privacy, continuity of care, patient and customer experience, availability and accessibility.

eHealth application with one or more aims as mentioned in the Medical Device Directive 93/42/EEG should be managed as a medical device. That provides a clear framework for responsibilities, choice of basic product and process standards and supplementary professional guidelines. A TNO certification comprising all these aspects for medical information [8] and medical information systems are already available [9].

#### **A. eHealth management in context**

eHealth is much more than a technical application. It is a medical service placed on the market by an organization and in which information technology (IT) and/ or medical apparatuses play an important role. An important aspect for assessment is the quality of the management of the service. In order to implement the qualitative aspects of the organization the following components should be identified, which must be assessed separately:

- The organization;
- The quality management system;
- The front office (helpdesk, for example);
- The back office (including services leased from third parties);
- The equipment used such as medical devices and ICT systems.

Assessment criteria and indicators are widely available in the literature.

### ***B. The place of testing in the innovation process***

Every product has a life cycle, in which the following stages can be identified:

- The process of technical realization: Specification, design, realization and testing;
- Purchase and implementation;
- Management, maintenance and utilization;
- Removal from use and/ or the market.

The testing has to take place in all phases of the innovation process. Here too the assessment criteria and indicators are widely and readily available. However, a number of *eHealth* products and services will make claims which can only be verified and validated in practice. It is proposed that products and services, for which admittance to the market or the insurance provision has been requested, be subject to a Quick Scan. The scan is carried out in four steps: (1) define the context in which *eHealth* is being applied; (2) analyse the maturity of application on the basis of relevant criteria and minimum scores; (3) analyse critical scores in detail, and, (4) describe the socio-technical map.

Step 2 induces a process of standardization of the qualitative aspects (see Section III.C) If the minimum scores are attained (step 2), it can be decided to proceed with a provisional or conditional admittance, whereby it becomes possible in an experimental phase to adjust the service in such a way that it meets the desired requirements. A provisional rate can then be fixed for use in this phase. If the desired effects can be realized in a demonstrable fashion within a previously agreed term, then a definitive admittance and rate can be fixed. If the desired scores are not attained, the product or service should not be admitted to the insurance provision. It will then still be possible to introduce it onto the market, as long as it meets the legal requirements. Acceptance and price of the product or service can then be determined by the market. In this way *eHealth* will get a chance to prove itself and to improve during the temporary admittance phase.

### ***C. Standardization of the qualitative aspects***

The standardization and quantification of the qualitative aspects can be done according to the QUINT method [10]. This method is based on the ISO standard 9126 [11]. The method provides the qualitative aspects of medical software and software-based services and a model for scoring those aspects. The relevant feature within the context of this publication is that five score levels are specified for each qualitative aspect:

1. **Minimum level:** In the case of a criterion reaching a lower score the product is unusable;
2. **Current level:** In general the acceptable level will not be lower than a currently accepted level;
3. **Acceptable level:** If all criteria reach a score at the acceptable level then the innovation is successful;
4. **The target level:** Each criterion can be provided with a challenging target level in pursuance of further innovation;
5. **Maximum level:** This is a theoretical level which indicates what can reasonably be taken as the maximum level which is feasible.

During the application of the Quick Scan, the relevant qualitative aspects are selected and the levels above are scored. The levels are derived from the description, context and socio-technical map. At the end of the temporary admittance phase, the target level must be reached for all criteria. During the operational phase, that level must be guaranteed. It therefore also provides a testable standard to be maintained.

### ***D. Assessment procedure in 10 steps***

An assessment system which connects the Quick Scan, improvement in the experimental phase and the final assessment for definitive admittance is the so-called **TERTZ®** method. The goal of **TERTZ®** is to enable the organization (producer, management and user organization) to make well-considered choices and implementations [12]. The method was originally developed to make an assessment and the accompanying process of improvement of quality, safety, appropriateness and cost effectiveness of specific medical technology in new healthcare models. The **TERTZ®** method has been adapted to assess and improve eHealth products and services. The adjusted version is simply called **TERTZ®** admittance and is carried out in steps.

Steps 1 through 4 comprise a Quick Scan; Steps 5 through 8 are in the Implementation phase; Step 9 is the admittance phase; Step 10 is the final part, the documentation phase.

**Step 1: Description of the context:** In this step the eHealth product is described in a standardized manner according to the components mentioned

in Section III.B. The description also includes the desired user environment, target group and the technical/ organizational/ legal context.

**Step 2: Analysis of readiness:** The analysis is carried out by determining criteria and scoring levels on the basis of the context description. The analysis provides an insight into which components of the eHealth innovation are new with regard to already existing facilities and to what extent it can fit into existing structures and infrastructures. The analysis will also provide insight into how well-considered and developed the desired context is and whether it is justified to carry out a practical test.

**Step 3: Further research of crucial aspects:** The components which still require clarification after the analysis, thereby casting doubt on the feasibility, will be further studied or discussed with experts. This can lead to supplementary criteria with which the application must comply.

**Step 4: Description of the social-technical map:** The social-technical map indicates all the parties involved with description of their roles and the influence of these parties on the success and failure of the innovation is analysed and synthesized.

**Step 5: Description of the relevant aspects to be tested:** After applying the Quick Scan it will become clear which aspects will most strongly influence the success and feasibility of the innovation and which of them require attention in this practical testing phase. This will be incorporated into the work plan for the test phase. Existing legislation, regulations, norms and standards, directives and other documents play an important role. They are often agreements on the basis of consensus which have come into practice via the legislator or the standardizing organizations.

**Step 6: Drawing up the testing and evaluation plan:** The description includes the research questions, the research plan and the overall work plan for the practical test.

**Step 7: Implementation of test and evaluation plan:** During the implementation of the test and evaluation plan the eHealth facility is both tested and improved. It is possible that in retrospect criteria will turn out not to be relevant or that criteria are lacking. It is also conceivable that the levels which the facility must meet need to be assigned a different value. Naturally, in this step adjustment of levels and criteria must be avoided as much as possible, but not ruled out.

**Step 8: Standardizing the tested results:** The findings of the practical test can be standardized and generalized for similar eHealth applications and used for future practical tests. It will be clear that the qualitative criteria developed which have been tested in practice will be valid for all comparable facilities in the future.

**Step 9: Compiling admittance recommendation:** The admittance recommendation includes specification of the new *eHealth* facility together with the accompanying qualitative criteria, scores and standard values.

**Step 10: Documentation and report:** During the entire process a product dossier will be built up and modified according to relevant ISO 9000 qualitative requirements. Finally, a management summary will be drawn up for organization which determines the admittance to the market.

### Discussion

*eHealth* promises to improve the quality, safety, efficiency and also accessibility of healthcare. Whether that is justified or not, is not the subject for discussion here. It can be stated, however, that for many reasons *eHealth* is not being implemented on a large scale and that many experimental introductions are not being sustainably implemented. The medical device regime sets strict safety and quality requirements for admittance to the market. The rules for market admittance have not been sufficiently operationalized, so that defective products are probably being brought onto the market. The regime also includes monitoring after entry to the market.

The author therefore proposes an assessment process with the aim of promoting a well-considered introduction and application of *eHealth* and to develop testable rules (criteria and standard values). So, *Which assessment process should be followed to admit eHealth innovation?* One problem in addressing this question is the very fact that *eHealth* is under development and that it can adopt many forms and sizes. It is therefore hardly possible to formulate all requirements in advance. For each service offered to the market, it is probable that different aspects will have to be assessed. A strict programme of requirements will make innovation impossible. In every case the legal requirements must be met in order not to endanger patient safety.

The **TERTZ®** admittance makes it possible to test the quality and safety of each type of *eHealth* product and service in a structured fashion during its development. The method also makes it possible to formulate testable criteria and standard values with regard to the characteristic parts of the service. On the basis of a Quick Scan it can be determined whether the *eHealth* application meets minimum requirements and which criteria are not met. On the basis of such analysis a provisional admittance must be possible with accompanying rates. During the temporary, provisional admittance the application must be adjusted so that all criteria are scored at standard level. This approach produces much information, lending a new impetus to innovation. In addition, it makes the criteria for supervision transparent.

The requirements can be maintained in two ways: 1. New products which seek entry as provided for in **TERTZ®** admittance, and; 2. Vigilance and post marketing surveillance.

Vigilance, post-marketing surveillance, incident report and research and regular inspection by the Health Care Inspectorate [13][14] are important instruments for scoring the testable standards and the degree to which they are being met. Central registration of the set of testable standards and the five quantitative levels within this provides a basis for the state of art quality, safety and efficiency of eHealth. Another condition is that a standardized nomenclature be developed and used for eHealth. [15]. A European approach is the obvious solution.

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### References

- [1] Hesselbein F., M. Goldsmith and I. Somerville (eds.), *Leading for innovation: and organizing for results*, New York: Jossey-Bass, ISBN 0-7879-5359-8, 2001
- [2] J. Ettl, *Managing innovation*, Butterworth-Heinemann, an imprint of Elsevier, 2nd edition, ISBN 0-7506-7895-X, 2006
- [3] eHealth Ministerial Declaration, 22 May 2003, eHealth Ministerial Conference [http://europa.eu.int/information\\_society/europe/health/conference/2003](http://europa.eu.int/information_society/europe/health/conference/2003)
- [4] Dumay, A.C.M. and G.Freriks, "Quality management issues for medical ICT," *The Journal on Information Technology in Healthcare* 2004; 2(4):225-235
- [5] Freriks G., M. Schoone en A.C.M. Dumay, "Aspecten van kwaliteitscriteria van eHealth zorgdiensten en zorgproducten," TNO KvL/KZ/2005.051, 16 maart 2005
- [6] Dumay, A.C.M., G.Freriks en M.Schoone, "Pakketten voor telemedicinevoorzieningen in verzekerde zorg," TNO KvL/KZ/2005.96, 2 mei 2005
- [7] Council Directive 93/42/EEC of 14 June 1993 concerning medical devices, OJ L169, 12/07/1993
- [8] T. Lopes, R.G.M. van Melick and M.W.M. Oostenbrug, "TNO QMIC® Essential Requirements for European Medical Web Applications," TNO-PG/TG/2002.101, 2002
- [9] Dumay, A.C.M., G. Freriks & M.W.M. Oostenbrug, "TNO QM-ICT Essential requirements for the electronic healthcare record and semantic system to system interoperability," TNO-PG/TG/2002.181, 2003
- [10] R.H.J. van Zeist, 1996c: "*Specifying Software Quality with the Extended ISO Model*". In: *Software Quality Journal*, part 5, number 4, pages 273 - 284, Chapman & Hall, 1996
- [11] <http://www.iso.org/>
- [12] van Boxsel, JA.M. en M. Schoone, "Nieuw zorgproduct? Toets met **TERTZ®**," TNO PG/TG/99.107 Leiden, november 1999
- [13] IGZ 04-67, 2004. "ICT in ziekenhuizen. Beveiliging van informatie nog onvoldoende voor een betrouwbare papierloze patiëntenzorg. Een inventariserend onderzoek bij twintig ziekenhuizen, uitgevoerd in najaar 2003"

[14] Dumay, A.C.M. en M.Schoone, "Assessment of a baseline of ICT related quality measures in health care institutions," ISQUA International Conference, Vancouver: Conference Proceedings, pp.7-8, 2005

[15] van Nimwegen, Chr. en A. C. M. Dumay, "Global Medical Device Nomenclature. Een nieuw classificatiesysteem voor medische hulpmiddelen," *Technologie in de Gezondheidszorg*, nummer 12, Jaargang 17, pp. 6-8, 2001

## METHOD FOR ESTIMATION OF EFFICIENCY OF TELEMEDICAL CONSULTATION

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**Abstract:** Author has propose complex method for estimation of efficiency of telemedicine consultations, which include algorithm and three groups of parameters: relevance, economic feasibility, quality indicators (A-parameter of answers, T-parameter of duration, Aq-parameter of answers' quantity, Pt-parameter of timeliness, Pq-parameter of quality, and also  $P_{tk}$  - probability of effective teleconsultation). This method had been introduced in a daily clinical practice for studying and quality assurance of telemedical consultation.

Annually in the world are spent thousands teleconsultations, new engineering decisions are developed, economic feasibility is estimated. Usually researchers consider financial benefits [2, 8], changes of clinical parameters [7, 12, 15], moral aspects [3, 11], management improvements [9,10]. In my opinion, the complex estimation of quality of telemedical consultation is extremely actual question. Such method should be reliable, simple and accessible for any researcher (scientists, medical doctor, decision maker etc.). It should be the set of objective criteria which it would be possible to use for statistical processing with the purpose of comparison, studying of different kinds of telemedical consultations etc. *Aim* of research – to develop complex method for investigation of efficiency (quality) of telemedicine consultations.

### Materials and methods

For analytical research and generalization it had been used: materials of 400 asynchronous and synchronous telemedical consultations; results of previous researches of efficiency of the telemedicine [1, 13].

I have purpose three groups of parameters: relevance, economic feasibility, quality indicators.

### **Relevance**

In some sources for the characteristic of efficiency of telemedicine the term "relevance" is used [6, 16]. In modern informatics relevance in information retrieval, measures a document's applicability to a given subject or query. For telemedicine I am offered the following formulation.

*Relevance of teleconsultation:* It is based on conformity of the distant adviser's answer to information and medical needs of the attending physician (subscriber).

There are two kinds of an estimation of relevance (Rel) [14]: subjective and objective. In the clinical practice for value judgment we are use an approximate individual estimation on 3 mark scale: discrepancy of answers to questions - 1 point; incomplete conformity of answers to questions, an illegibility of formulations and recommendations - 2 points; full conformity of answers to questions, presence of the additional confirming information (articles, links, references, similar clinical cases etc) - 3 points. By the given scale it is possible to define quantity and relative density of high, average and low relevant answers in group of homogeneous teleconsultations (by pathology, by technical system etc). For an objective estimation author has propose special questionnaire. The questionnaire for definition of relevance includes 7 questions with several variants of answers. Each answer is estimated from 1 up to 3 points. The score within the limits of 17-21 points shows on high, 12-16 - average, 7-11 - low relevance of the lead teleconsultation. Also, there is an opportunity to define relevance for telemedical system (Rel<sub>sys</sub>) for the some period of time. 
$$\text{Rel}_{\text{sys}} = \frac{\text{TK}_{\text{rel}}}{\text{TK}}$$

quantity of teleconsultations with specific relevance (high and/or average), TK - total quantity of teleconsultations. Accordingly, in ideal situation this parameter aspires to 1.

### *Economic feasibility*

Most often define the prime price (S<sub>tk</sub>) and profitability (R<sub>tk</sub>) of teleconsultations. Definition of one teleconsultation's cost can be spent proceeding according laws and instructions accepted in the given state (at the base of calculation of the cost price of medical service). For example, calculation of cost of simple medical service:

$$\mathbf{S=S1+S2=Z+H+M+I+O+P,}$$

S1 - direct charges, S2 - indirect charges, Z - salary, H - taxes, M - charges for medicines, equipment etc, I - deterioration of materials, O - deterioration of equipment, P - miscellaneous costs. Also, it is possible to use already developed methods [5].

Profitability (R<sub>tk</sub>) of telemedicine services of hospital, clinics etc is defined by the formula (where C – price of rendered services, S – prime

cost of rendered services):  $R_{tk} = \frac{C - S}{C}$ . After calculation of  $S_{tk}$  and  $R_{tk}$

researcher can compare results with other servivies. For example, there is an opportunity to economically compare telemedicine consultation and traditional consultation.

### **Quality indicators**

Quality indicators estimate for certain sample of telemedical consultations. For example, lead in the certain period of time or by specific technology. There are five quality indicators: parameter of presence/absence of the expert's answer (A); parameter of average duration (T); average quantity of the experts' answers (Aq); timeliness of teleconsultations (Pt); quality of teleconsultations (Pq). First three indicators are most simple. The A-parameter can have two values: 0 - absence of the answer, 1 - presence of the answer. It is possible to define a parity of taken place and not taken place teleconsultations by A-parameter. The T-parameter estimate for sample of teleconsultations as an arithmetical mean (in numerator - the sum of durations of all teleconsultations, in denominator - quantity of

teleconsultations):  $\bar{T} = \frac{\sum_{i=1}^n T_i}{n}$ . The Aq-parameter estimation, at the base of

[14] (in numerator - quantity of answers (experts), in denominator - quantity of teleconsultations):  $\frac{\sum_{i=1}^n Aq_i}{n}$ . Timeliness of teleconsultations (Pt)

estimate on the basis of method by [4] (in numerator - quantity of duly received teleconsultations during certain time, in denominator - total quantity of teleconsultations for the same period of time):  $P_t = \frac{m(t \leq t_{cert})}{n_t}$ .

Quality of teleconsultations (Pq) also estimate on the basis of method by [4] (m - quantity of teleconsultations of admissible quality, n - total quantity of teleconsultations):  $P_q = \frac{m}{n}$ . It is possible to understand "quality of

teleconsultation" as relevance or other certain estimation, for example, the quantity of teleconsultations with more than one answer so on. With help of two last criteria we can calculate probability of effective teleconsultation - ( $P_{tk}$ ) [4]:  $P_{tk} = P_t * P_q$ . In ideal situation this parameter aspires to 1. By  $P_{tk}$ -parameter researcher can estimate activity of telemedical system in general and, moreover, predict efficiency of teleconsultation after introduction of some technical, clinical, organizational, economical decision for telemedicine.

## Conclusion

Thus, there are three groups of parameters in complex method for investigation of efficiency (quality) of telemedicine consultations: relevance (Rel, Rel<sub>sys</sub>); economic feasibility (compare of of prime price (S<sub>tk</sub>) and profitability (R<sub>tk</sub>)); quality indicators (A-parameter of answers, T-parameter of duration, Aq-parameter of answers' quantity, Pt-parameter of timeliness, Pq-parameter of quality, and also P<sub>tk</sub> - probability of effective teleconsultation). This method had been introduced in a daily clinical practice for studying and quality assurance of telemedical consultation. Also, the method will be patented according to the international norms.

## References

- [1] Aoki N, Dunn K, Johnson-Throop KA, Turley JP. Outcomes and methods in telemedicine evaluation. *Telemed J E Health*. 2003 Winter;9(4):393-401.
- [2] Bergmo TS. An economic analysis of teleconsultation in otorhinolaryngology. *J Telemed Telecare* 1997;3: 194–199.
- [3] Chan FY, Soong B, Lessing K, et al. Clinical value of real-time tertiary fetal ultrasound consultation by telemedicine: preliminary evaluation. *Telemed J* 2000;6:237–242.
- [4] Gerasimov B, Oxijuk A, Gulak N. Estimation of efficiency systems for support of decision-making. In: *System of Support of Decision Making. Theory and Practice*. Kiev:2006:25-7.
- [5] Kamaev I, Levanov V, Sergeev D. Telemedicine: clinical, organisational, law, technological, economical aspects. N.Novgorod: NGMA,2001.
- [6] Karlsson D, Ekdahl C, Wigertz O, Shahsavari N, Gill H, Forsum U. Extended telemedical consultation using Arden Syntax based decision support, hypertext and WWW technique. *Methods Inf Med*. 1997 Feb;36(2):108-14.
- [7] Lambrecht CJ. Telemedicine in trauma care: description of 100 trauma teleconsults. *Telemed J* 1997;3:265–268.
- [8] PalaninathaRaja M., Wadhwa S., Deshmukh S.G. Cost-benefit analysis on eHealthcare services. *Ukr. z. teled. med. telemat*.2006;1(4):53-64.
- [9] Rollert MK, Strauss RA, Abubaker AO, Hampton C. Telemedicine consultations in oral and maxillofacial surgery. *J Oral Maxillofac Surg* 1999;57:136–138.
- [10] Rosser JC, Jr, Probst RL, Rodas EB, Rosser LE, Murayama M, Brem H. Evaluation of the effectiveness of portable low-bandwidth telemedical applications for postoperative followup: initial results. *J Am Coll Surg* 2000;191:196–203.
- [11] Siden HB. A qualitative approach to community and provider needs assessment in a telehealth project. *Telemed J* 1998;4:225–235.
- [12] Rendina MC, Downs SM, Carasco N, Loonsk J, Bose CL. Effect of telemedicine on health outcomes in 87 infants requiring neonatal intensive care. *Telemed J* 1998;4:345–351.
- [13] Vladzimirskyy A. Classification for methods of telemedicine efficiency investigations. In: *Med-e-Tel*, 2006:57-8.
- [14] Vladzimirskyy A, Chelnokov A. Relevance of telemedicine consultation. *Ukr.z.teled. med. telemat*.2006;1(4):99-100.
- [15] Vladzimirskyy A.V. The Use of Teleconsultations in the Treatment of Patients with Multiple Trauma. *Europ J Trauma*, 2004;6 (30):394-7.
- [16] Wiborg A, Widder B; Telemedicine in Stroke in Swabia Project. *Teleneurology to improve stroke care in rural areas: The Telemedicine in Stroke in Swabia (TESS) Project*. *Stroke*. 2003 Dec;34(12):2951-6. *Epub* 2003 Nov 20.

# **QUALITATIVE STUDY: MODEL EVOLUTION IN TELEASSISTANCE AND HEALTHCARE**

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## **Introduction**

The success of putting into practice advanced teleassistance services depends on the development and configuration of the underlying technologies, in a way that they satisfy the exact needs of all parties involved in the model, as well as being very reliable.

Therefore, the objective that is being pursued in this study is to estimate the evolution of the model in the short, medium and long term, anticipating with it the apparition and modification of parties, identifying which services will be most useful to each one of them, even in terms of payment, both in the public and private sector, all of which is focused on orientating a service model for teleassistance.

Further than simple studies to obtain opinions on these subject, multidisciplinary professionals have been consulted using an evolution of a DELPHI methodology, including brainstorming and questionnaires with the possibility of giving open answers.

## **First Questionnaire**

The objective defined in this first series of questions is to ascertain how, from the point of view of the different parties involved in the actual model, it will evolve in the short, medium and long term, in Spain, based on the circumstances that surround the teleassistance service, as we understand it today, fundamentally promoted by the Ley Organica de Dependencia (Organic Law of Dependency) recently been approved by the Spanish Government.

So, in the short term (1-2 years) it doesn't seem to be clear. The estimation is an increase in features, mainly due to the new law, but at the same time it's considered that the infrastructure is not yet implemented.

This indicates that initially what will appear will be services in person, which will not require large doses of technology behind them, but will be supported on the actual cultural barriers.

In the medium term, (3-5 years) teleassistance is seen almost as a universal service, fundamentally in the medical sector. The features will continue to increase, basically due to social demand and cultural barriers are beginning to break down. Furthermore third party suppliers appear using the emerging infrastructure to introduce their services,

However, in the long term (> 5 years) teleassistance is already completely integrated into welfare processes, both social and medical, including self-care, in the meantime the features continue to increase.

Based on this evolution, none of the current parties that are involved will disappear but new ones will appear, such as suppliers and professionals of services outside of the healthcare sector, and due to this, a third party supplier which will be the Teleassistance platform supporting these third channels.

The role that banks and insurance companies can play must be taken into account as promoter's or intermediaries in teleassistance services offering them as an added value to the rest of its products.

In terms of evolution of the parties themselves, it seems clear that the profile of the users will evolve, becoming younger and with a more proactive role in their own care, basically due to the increase in mobility and social isolation, making the self-care services take a special relevancy, mainly those based on the TV. At the same time the set of values will make them more demanding as regards to the quality of the services that they receive, as they are now being paying for them.

On the other hand, the doctors will hand over some of their tasks to the nurses, thanks to the protocol added into the processes and the help given by technology, assuming in their place, new assignments, related to analysis and consulting.

As for the service providers, they will offer what is requested of them and not what is being purchased.

Finally, the services and features that in principle seem more interesting, for the teleassisted people, their families or carers and service providers will be those, which offer information about the condition of person and therefore provide reassurance. This way, to the teleassisted person, the highlight is the possibility of an instant consultation and assessment by a qualified professional, as well as the physical monitoring and videoconference. For the carers (family or hired carers) we also have videoconference, telemonitoring of vital signs, as well as coordination and access to other medical and social elements. And for the service provider, also videoconferencing service and the vital signs case history, also emphasizing the possibility of dealing with other service providers.

## **Second Questionnaire**

In base to the responses given about which are the most interesting services for teleassisted people, carers and service providers, the responses regarding affinity with technology and language are added, then we obtain a list that can be valued by the panel of experts, in terms of how useful they are and how likely it is that they will be paid for. At first glance, it is evident they are in general, highly useful, but the interest to pay for some of these services is not so high. This point attracts our attention.

However, in more detail, and above all, analyzing the source of each of the responses, in the individual graphs, by service, two different approaches can be seen in the kind of answers, according the person responding, if they work in the public or private sector. The ones who reply in the public sector (doctors, nurses and social services) value the possibility of payment so that the service should be offered by the National Health Service as part of the obligatory social and medical services, in which case, the probability of payment by the user would be low, as it should be partly or totally funded by the government. However, those who work in the private sector (Elderly care centers and insurance companies) value the possibility of paying only when the service is important enough to be included as a feature in a teleassistance contract or policy, which would be more interesting to the general public given that the added value for that service.

With these terms, it is clear that the services are divided into 2 groups: those on the Y axis probability of payment have several zero values, and nevertheless on the X axis for usefulness, have mainly high values, higher than 7 and those which have higher values on the possibility of payment, regardless of how useful they are.

The first group corresponds to those which, from the public's point of view should be funded given the clear social and medical interest that makes them be considered as basic, whilst the second group are those services that may be paid for as an additional feature as added value incorporated in a private insurance. Those services that are highly useful (by unanimous decision amongst the public and private sectors) after classification with the possibility of payment, fall considerably, because in a large number of responses, mainly coming from the public sector, it is considered that they should be funded.

In the first group, we have mainly home rehabilitation services, both physical and psychological, also Event reminders for medical and social appointments, as well as the vital signs autotest. A possible localization service is also considered interesting. Generally, those services that generate reassurance to the teleassisted person as well as their carer (autotest and

localization) or make their lives more comfortable (home rehabilitation) avoiding expensive journeys.

In the second group, there are entertainment services and control of the home environment, which are clearly in line with the market, as well as the possibility of locating a person, both indoors and outdoors. A service that has a bigger possibility of payment, but at the same time has a low score of usefulness (indicating it's classification as a luxury type of service) is the Multi terminal Guardian, integrating different technologies such as habit control and profiling, management of sensors, control of the home environment etc...

### **Conclusions**

Generally the services in demand are those that generate reassurance, regardless to which parties the service is aimed at.

In Spain, in principle, the trigger has already appeared and it could, in the following years, cause the definitive introduction of the ICT's in the health sector: The new organic law of dependency.

This law to be fully applied will need a technological substructure, which will be made the most of by third party suppliers to provide their services and products, not necessarily health or social care, to the end users.

Lastly, the technological support offered to the teleassistance professionals, both doctors and social workers, will make possible the evolution of the role that they are carry out at the moment, from the point of view of the teleassisted person.

### **Acknowledgements**

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## **SUCCESSES IN TELECARDIOLOGY**

# **A GEO-EHEALTH SYSTEM FOR LARGE SCALE EPIDEMIOLOGIC BLOOD PRESSURE ASSESSMENT**

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**Abstract:** A web-based eHealth system has been developed. The system has been used to acquire blood pressure and related health data together with geographic data from more than 16.000 individuals. Statistical analysis indicates the well known age effects but also geographical differences. Due to its modular design this concept could be extended to other geographical regions, further health parameters, and a more sophisticated analysis. Thus, it is opening a way for epidemiological assessment of health effects which have not been investigated so far.

## **Introduction**

Although it is well known that a considerable percentage of people, in particular in developed countries, exhibit elevated or even high blood pressure, only limited information is available on the detailed geographical distribution of this and other health phenomena. The present work was carried out to assess the geographical dimension of the blood pressure situation in the Austrian province of Styria by means of a specifically developed GEO-eHealth concept.

## **Methods**

The client/server GEO-eHealth system comprised of the following 4 major components:

a) PC-based health terminals for autonomous reporting of demographic data like age, living location, gender, smoking behavior, etc. The terminals were operated by a touch-screen-based user interface. Self-measurement of the blood pressure was done using wrist blood pressure monitors (medilife BOSO, Jungingen ,Germany) which were attached to, read-out by and controlled via the PC

b) A central health server providing for storing values from the attached terminals in a database (PostgreSQL), processing the data,

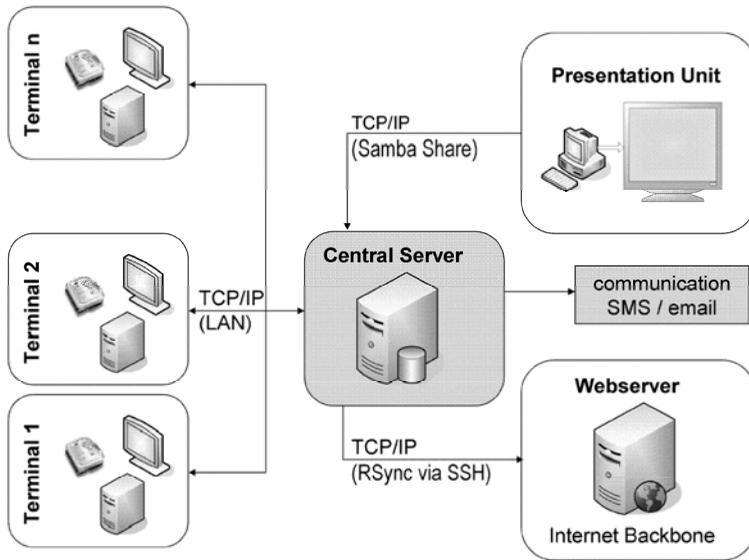


Fig. 1 Main components of the Geo-eHealth system

representing graphical data, and communicating with users by SMS and email

c) A web server with high-speed connection to the Internet to provide the public with access to the anonymized data in an easily comprehensible form

d) A presentation unit for on-site visualization of the current situation by means of a PowerPoint presentation with regularly scheduled, automated updates using data and figures as provided by the central system

Fig. 1 displays the architecture of this system.

## Results

The system has initially been used in the course of the Styrian State Exhibition “Wege zur Gesundheit” (Paths to Health) which took place between May and October 2006.

Over all, blood pressure data from 16.123 people were collected during the 6 months study period (56% male, 44% female, mean age  $42.2 \pm 18.2$  years). As expected, systolic and diastolic blood pressure of men were higher than of women ( $p < 0.0001$ ). A strong correlation in between systolic blood pressure and age could be found while the diastolic blood pressure

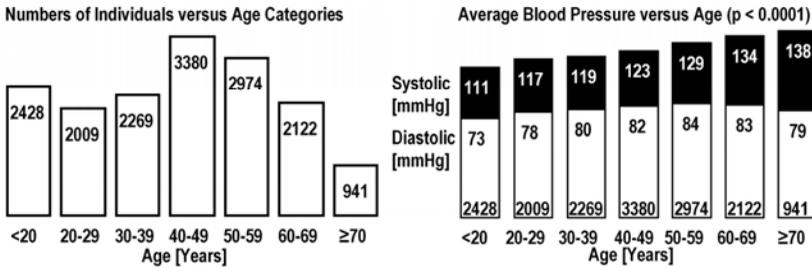


Fig. 2 Left: Distribution of the number of individuals with respect to age; Right: average blood pressure values as a function of age

increased up to an age of about 60 years and decreased for older persons (Fig. 2, right hand side).

Within Styria, regions with significantly increased blood pressure were identified. In particular, the western part of Graz, the capital of Styria, exhibited a significantly higher diastolic (81 mmHg) as well as systolic (123 mmHg) blood pressure as compared to the eastern part (79 mmHg and 120 mmHg) with  $p < 0.0005$  (systolic) and  $p < 0.001$  (diastolic). Multivariate analyses indicated that this difference was not caused by different age distributions but is supposed to be due to socio-economic factors (Fig. 3, left hand side). According to Fig. 3, right hand side, the “Mur”, i.e. the river which separates the eastern and the western part of Graz, almost perfectly separates districts within Graz where more or less than 1/3 of the people exhibit elevated blood pressure.

Further results are available online [1].

### Discussion

During the 6 months of operation, no serious technical problems occurred. Some minor events had to be handled like changing the cuff of the blood pressure devices which actually were not manufactured for such an intense use. Although in the initial deployment all three terminals were located in one place, all connections between the various components are TCP/IP based which allows for an arbitrary geographical distribution of the components as long as Internet connectivity is available.

Privacy of the subjects was maintained by avoiding collecting nay information which could potentially be used to infer the identity of the subjects.

The causes of geographical variations in blood pressure are not known in detail. However, socioeconomic factors are assumed to play a major role, as has been concluded in other studies dealing with geographical aspects [2]

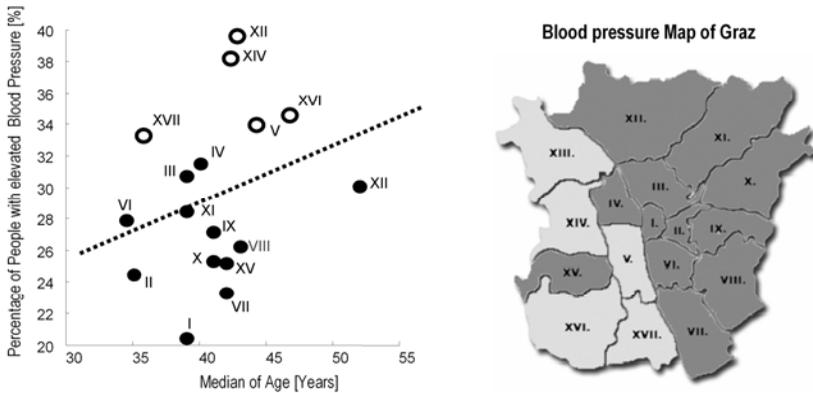


Fig. 3 Left: percentage of people with elevated blood pressure in terms of systolic pressure > 140 mmHg and/or diastolic > 90 mmHg. Main components in different districts of Graz together with age regression line; Right: map of the districts of Graz where districts in which more than 1/3 of people exhibited at least elevated blood pressure are indicated in light color

### Conclusions

The results obtained for the application of this concept in the framework of blood pressure assessment in Styria indicate that the developed system is able to provide for easy-to-use and low-cost large scale health data acquisition. Due to the modular design this concept could be extended to other geographical regions, further health parameters and a more sophisticated analysis, thus opening a way for epidemiological assessment of health effects which have not been studied so far.

### Acknowledgment

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### References

- [1] "Gesundheitslandkarte.at" [homepage on the Internet]. Graz: Austrian Research Centers GmbH – ARC; c2006 [updated 2007 Jan 16; cited 2007 Feb 21]. Available from: <http://www.gesundheitslandkarte.at>
- [2] D. A. Lawlor, C. Bedford, M. Taylor and S. Ebrahim. "Geographical variation in cardiovascular disease, risk factors, and their control in older women: British Women's Heart and Health Study," J. Epidemiol. Community Health vol. 57, pp. 134-140, 2003.

# **A TELECARDIOLOGY SERVICE QUALITY MODEL**

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***Abstract:* The generation of a National Prototype guaranteeing the quality and reliability of telecardiology in Greece is the objective of the current work.**

## **Introduction**

Any telecardiology information system should guarantee the quality of services and the possibility of collection and evaluation of telecare results. For this reason, the extensive International Standards Organization (ISO) model for Medical Informatics technology (ISO 9126) is required in the design of a Telecardiology Information System so that reliability, efficiency, functionality and maintainability of this system are ensured [1].

## **Quality assurance aspects**

There are many dimensions to exploit quality in health teleapplications. These include the following quality evaluation issues: telehealth network [2]-[4], information standards [3], medical services provision [5 -6], communications [7], interaction [8], data transmission [8], teleconsultations [9], software [10], health care [11 - 17], life [18], multimedia [19], equipment [20 - 21] and patient satisfaction [22].

The current telehealth challenges concern the determination of indicators with regard to the improvement of quality of care. The Hebert model for the quality of care in telehealth applications [2] incorporates evaluation methods of effectiveness in Telehealth Information Systems for the patients, for the health care providers as well as for the health care organizations. Questionnaires are designed to assess user, provider and organization satisfaction.

## **Classification of telecardiology services**

A telecardiology program may be classified in various phases

(pre-hospital, in-hospital and after hospital) due to the time of its application.

In the pre-hospital phase we have direct transfer of patient data (electrocardiogram) to the specialist physician or the cardiologist of the hospital on duty. With this procedure, apart from the critical decision for immediate patient transfer to the hospital we also have a prepared intensive care unit to accept the patient.

The in-hospital phase is especially useful for the communication of small hospitals or health care centers in the rural areas and of large hospitals in large urban locations. In these cases the primary care physicians have the capability to receive direct help from specialist cardiologists for the diagnosis and therapy of patients.

The after-hospital phase includes patient monitoring after the hospitalization period. The telecardiology program can be used to continuously transfer patient data to the family physician that could have contact with an expert cardiologist using videoconferencing and allow decisions for better therapeutic treatment.

### The proposed telecardiology model

In the telecardiology platform (Fig.1) the electrocardiogram is used in the form of the Standard Communication Protocol for computerized electrocardiography (SCP-ECG). The transfer from the patient home to the server is made using Web Services Technology and the W3C

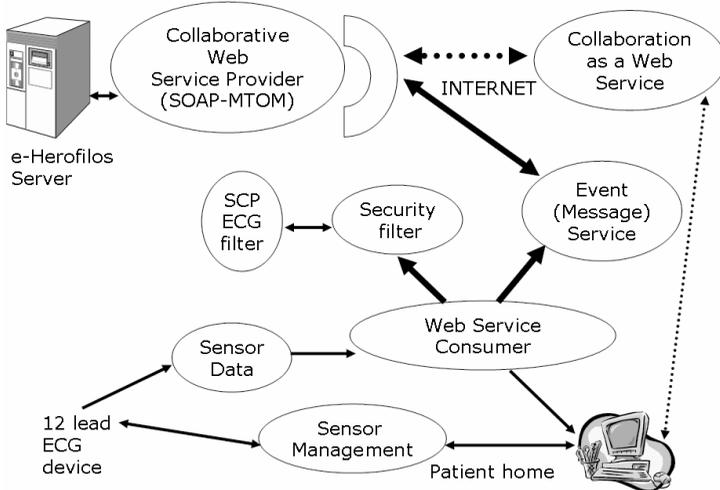


Fig. 1 The e-Herofilos model

Recommendation Simple Object Access Protocol (SOAP) Message Transmission Optimization Mechanism known as MTOM [23]. After the transfer, the Windows service on the patient Windows personal computer requests from the Web Service (in the Server) a Message Digest algorithm 5 hash that confirms that the file in the server is the same. Then an event log is created that reports the current status.

In the pilot study, for the evaluation of the telecardiology model, patients with known cardiological problem who are expected to have complications from their cardiac disease will be included. These are the patients with coronary artery disease and especially those who have been recently hospitalized due to their disease. These patients have the greatest need of such a program and the highest benefit from it. The patients will be divided into two groups: the telecardiology group and the control group. This second group will have common features as far as the age and the sex patients with coronary artery disease who will receive continuous monitoring, but they will not be included in the telecardiology program. On the basis of the groups of patients that will participate in the research criteria for inclusion and exclusion from the study have been introduced. Close collaboration with our cardiologists within the Foundation for Biomedical Research of the Academy of Athens will enable us to take care of all ethical requirements, properly select the patients, and carry out the experiments.

Every patient who will participate in the study will be monitored for three months and we estimate that we will need thirty patients in each group to proceed to statistical analysis to evaluate the service.

### **Acknowledgment**

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### **References**

- [1] ISO/IEC 9126: Information technology - Software Product Evaluation – Quality characteristics and guidelines for their use, 1991.
- [2] M. Hebert, Telehealth success: evaluation framework development, Medinfo. 10(Pt 2), pp.1145-9, 2001.
- [3] J. C. Hogenbirk, KO Telehealth Evaluation Framework, Centre for Rural and Northern Health Research, Laurentian University.
- [4] C. LeRouge, A. Hevner, R. Collins, Telemedicine Encounter Quality: Comparing Patient and Provider Perspectives of a Socio-Technical System, Proceedings of the 37th Hawaii International Conference on System Sciences, 2004.

- [5] S. E. Cross, S. M. Stevens & J. E. Bailes, A Digital Video Library Application in Health Care, in the Proceedings of the IEEE International Joint Symposia on Intelligence and Systems, pp. 254-260, 1996.
- [6] A. Tiwana & B. Ramesh, From Intuition to Institution: Supporting Collaborative Diagnoses in Telemedicine Teams, in the Proceedings of the 33<sup>rd</sup> Annual Hawaii International Conference on System Sciences, 2000.
- [7] V. Bharadwaj, R. Raman, R. Reddy & S. Reddy, Empowering Mobile Healthcare Providers via a Patient Benefits Authorization Service, in the Proceedings of the Tenth IEEE International Workshop in Enabling Technologies: Infrastructure for Collaborative Enterprises, pp. 73-78, 2001.
- [8] J. Grisby & P. L. Barton, Telecommunications Technology, Health Services & Technology Assessment, in the Proceedings of the Medical Technology Symposium, pp. 12-15, 1998.
- [9] A. W. Powell, Reengineering Health Care Delivery using Telemedicine, in the Proceedings of the Medical Technology Symposium, pp. 371-374, 1998.
- [10] G. Harris, India: Telemedicine's Great New Frontier, in *IEEE Spectrum*, April 2002, pp.16-17
- [11] A.N. Kastania, Telemedicine models for primary care, Chapter in the Book *Establishing Telemedicine in Developing Countries: from inception to implementation* (ed. R. Latifi), IOS Press, Amsterdam, 2004, pp. 89-98
- [12] R. Sacile, Telemedicine Systems for Collaborative Diagnosis over the Internet. Towards Virtual "Collaboratories", in the Proceedings of Academia/Industry Working Conference on Research Challenges, pp. 191-196, 2000.
- [13] D. L. Paul, Wicked Decision Problems in Remote Health Care: Telemedicine as a Tool for Sensemaking, in the Proceedings of the 32<sup>nd</sup> Annual Hawaii International Conference on System Sciences, 1999.
- [14] M. Gurstein Chair, Panelists: P. Day, G.J. de Vreede, M. Miller, C. T. Romm, V. Whitehead, Community Informatics: International Experiences and Case Studies, in the Proceedings of the 20<sup>th</sup> International Conference on Information Systems, pp. 578-581, 1999.
- [15] D. G. Kilman & D. W. Forslund, An International Collaboration Based on Virtual Patient Records, *Communications of the ACM*, August 1997/Vol. 40, No. 8, pp.111-117
- [16] J. C. Lowery, Getting started in Simulation in Healthcare, in the Proceedings of the 1998 Winter Simulation Conference, Vol.1, pp. 31-35, 1998.
- [17] M. A Smith, Some Social Implications of Ubiquitous Wireless Networks, *ACM SIGMOBILE Mobile Computing and Communications Review*, Volume 4, Number 2, 2000, pp.25-36
- [18] K. A. Stroetmann, M. Pieper & V. N. Stroetmann, Understanding Patients: Participatory Approaches for the User Evaluation of Vital Data Presentation, in the Proceedings of the 2003 ACM conference on Universal Usability, pp.93-97, 2002.
- [19] D. Won-Kyu Hong & C. Seon Hong, A QoS management framework for distributed multimedia systems, *International Journal of Network Management*, John Wiley & Sons, Ltd, 2003:13, pp.115-127
- [20] V. W.A. Mbarika, Is Telemedicine the Panacea for Sub-Saharan Africa's Medical Nightmare, *Communications of the ACM*, July 2004/Vol. 47, pp.21-24
- [21] W. G. Tohme & S. Olsson, Developments and Directions of Technology Assessment in Telemedicine, in the Proceedings of the Fourth International Conference on Image Management and Communications, pp. 79-85, 1995.
- [22] J. E. Bailey and S. W. Pearson, Development of a tool for measuring and analyzing user satisfaction, *Management Science*, May 1983, Vol. 29, Number 5, p530-545
- [23] Simple Object Access Protocol Message Transmission Optimization Mechanism (<http://www.w3.org/TR/soap12-mtom/>)

# APPLICABILITY OF LEAD V<sub>2</sub> ECG MEASUREMENTS IN BIOMETRICS

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**Abstract:** This paper presents statistical analysis results for lead V<sub>2</sub> ECG measurements, focusing its applicability to Human identification. We analyze the subject recognition rate provided by mean heartbeat waves, through contingency matrix analysis, and extend these results by evaluating the recognition rate using only a reduced number of mean ECG heartbeat waveforms.

## Introduction

Typically the ECG has been used for clinical diagnostics of the cardiac function [1, 2]; however, measurements are influenced by physiologic factors which include: skin conductance, genetic singularities, position, shape, and size of the heart, among others. Figure 1 illustrates a prototypical heartbeat waveform.

These singularities, which differ among individuals, make the ECG potentially interesting also for Human identification or identity verification purposes [3].

## Acquisition Setup

Previous research work studying the ECG applicability for Human identification has typically explored readings from multiple leads [4], at rest [5], and at stress potentiating

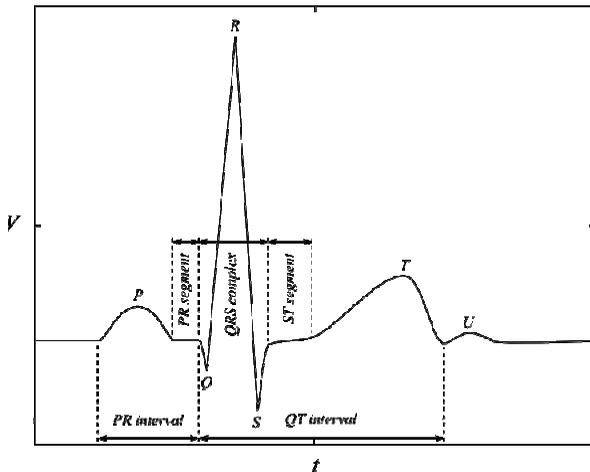


Fig. 1 Prototypical ECG heartbeat waveform

conditions [3]. Our work developed in the scope of a Human-computer interaction and multimodal electrophysiological signal acquisition setup, during the completion of a series of cognitive tasks, consisting of: an intelligence test, based on the Wisconsin sorting test, where the goal was to complete a logical sequence of four figures characterized by three properties (color, shape, and amount of symbols); a memory test, where the goal was to match hidden pairs of symbols; an association test, where the goal was to memorize a number of associations between abstract symbols and then reproduce them; a discovery test, where the goal was to identify an animal based on a singularity shown in a picture; and a concentration test inspired in a MENSA concentration test, where in two grids of 800 digits the goal was to mark every adjacent pair of digits that added 10.

A population of twenty five male and female volunteers, with a mean age of  $23.4 \pm 2.5$  years, participated in individual sessions where each was asked to complete the series of tasks, designed to take, in average, 30 minutes. The tasks were resolved using a computer, with which the subject merely interacted using the mouse as input device, and in a sitting position. ECG measurements were taken using a surface mount triode placed on the  $V_2$  pre-cordial derivation.

### Methodology

Each heartbeat waveform was sequentially segmented from the full recording, and after this, all individual waveforms were aligned by their  $R$  peaks. From the resulting collection of ECG heartbeat waveforms, the mean wave for groups of 10 heartbeat waveforms (without overlapping), was computed to minimize the effect of outliers. A labeled database was compiled, in which each pattern corresponds to a mean wave. For each mean waveform, the latency and amplitude for each of the  $P$ - $QRS$ - $T$  peaks were extracted, along with a sub-sampling of the waveform itself, providing a feature representation space of 53 features.

The ECG mean wave database is used for evaluation purposes; 50 data selection runs were performed, where in each run  $r$ , two mutually exclusive sets  $X_r$ , and  $Y_r$  are created, with respectively 10% and 90% of randomly selected patterns. For classification purposes, we use the k-NN decision rule with a Euclidean neighborhood metric [6]. A 1-NN neighborhood was adopted, since it is a particular case of the k-NN rule where the class  $w_x$  for a given pattern  $x$  is assigned as the class of the closest pattern from the training set  $X_r$ .

## Results

Under the previously described framework, we computed the recognition error over 50 classification runs, where in each run individual mean waves from each test set  $Y_r$  were classified, using  $X_r$  as training set. We obtained an average  $92 \pm 0.7\%$  subject recognition rate from a single mean wave. Figure 2 presents the contingency matrix for the subject classification error. The matrix diagonal corresponds to correct subject identification cases. As we can observe, the recognition rate is clearly above the 50% threshold for all subjects. Therefore by majority voting the contingency matrix, a 100% subject recognition rate is achieved.

To further improve the recognition rate from individual mean waves, we applied sequential classifier combination techniques to the problem. Instead of producing a decision based on a single mean wave, we consider a limited number of mean waves, classify each one of them individually using the 1-NN classifier, and apply majority voting to the group of individual decisions in order to obtain an overall subject identification decision. Figure 3 illustrates the evolution of the recognition error as the number  $h$  of individual mean waves is increased.

As we can observe, by combining the decisions of multiple mean waves, the recognition rate is highly improved. The highest recognition rate of  $99.63 \pm 0.4\%$  was obtained for a set of 9 mean waves, which according to the adopted methodology, and in which each mean wave is computed from a group of 10 heartbeat waveforms, corresponds to approximately 90s of signal acquisition (considering an average heart rate of 60bpm).

## Conclusions

In this paper we presented experimental results from a real world problem explored by our group, regarding Human identification using ECG signal. Preliminary results have shown that considering mean ECG waves corresponding to 10 heartbeat waveforms, it is possible to achieve 100% recognition rates through contingency matrix analysis.

Furthermore, we evaluated the discriminative potential of groups of mean waves, by applying sequential classifier combination methods to the problem. Using this approach it was possible to obtain recognition rates above 99%, from approximately 90s of acquired signal.

## Acknowledgments

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### **References**

- [1] E. Chung. Pocket Guide to ECG diagnostics. Blackwell Publishing Professional, 2000.
- [2] B. Lipman. ECG assessment and interpretation. F. A. Davis, 1994.
- [3] S. Israel, J. Irvine, A. Cheng, M. Wiederhold, and B. Wiederhold. "ECG to identify individuals", Pattern Recognition, vol. 38, 2005, pp. 133-142.
- [4] T. Shen, and W. Tompkins. "Biometric statistical study of one-lead ECG features and body mass index", Proceedings of the 27th Annual Conference of the IEEE Engineering in Medicine and Biology Society, 2005, pp. 1162-1165.
- [5] L. Biel, O. Petterson, L. Phillipson, and P. Wide. "ECG analysis: A new approach in Human identification", IEEE Transactions on Instrumentation and Measurement, 2001, pp. 808-812.
- [6] R. Duda, P. Hart, and D. Stork. Pattern classification 2nd ed. John Willey & Sons Inc, 2001.

# **DESIGN OF AN ONLINE ECG MEASUREMENT SYSTEM USING LAB VIEW SOFTWARE**

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**Abstract:** In this paper, an inexpensive and low cost implementation of an online ECG measurement system using LAB VIEW software is introduced. The system is capable of acquiring heart beat and Electrocardiogram (ECG) from acquisition device and transfers it to patient's personal computer by utilizing LAB VIEW software. By entering the proper IP address the same signals are available to the consultant PC for further follow-up in order to attempt the feasibility of normal cardiac electric activity of the patient. Thus, the monitoring system can allow cardiac physicians ability to easily monitor the ECG and heart rate of patients over the intranet of the hospital networks.

**Keywords:** Biosensor technology, data acquisition device, LAB VIEW software, Telemedicine technology

## **Introduction**

With rising costs and cutbacks to the healthcare system in calling physicians and connecting biomedical devices to remote regions is an inefficient way to perform Electrocardiogram (ECG) of the patient [1]. Advances in technology throughout the past decade have made it possible to resolve this problem, by rapid transmissions of the ECG to the remote locations via LAN, WAN and Internet. Using such type of monitoring system can allow cardiac physicians ability to easily monitor the ECG and heart rate of patients over the computer network of the hospital. [2]. This also provides the city cardiac specialist ability to schedule patients living in remote locations for examinations [3]. Our approach is to build "The low cost online ECG monitoring system using LAB VIEW software" for restricted and remote location of the hospitals. It can offer significant hope in reducing mortality or morbidity as well as presenting

monetary savings [4]. Electrocardiography has been in clinical use for the diagnosis and monitoring of heart abnormalities [5].

### Structure of the Project

Here, we describe the design of the research project, mainly comprises of two parts: First part is namely as, patient side for signal acquisition to get heart rate as well as to monitor the cardiac status on the desktop of the patient's computer through the LAB VIEW software and at the same time the signals are available to the consultant PC for further follow-up, are

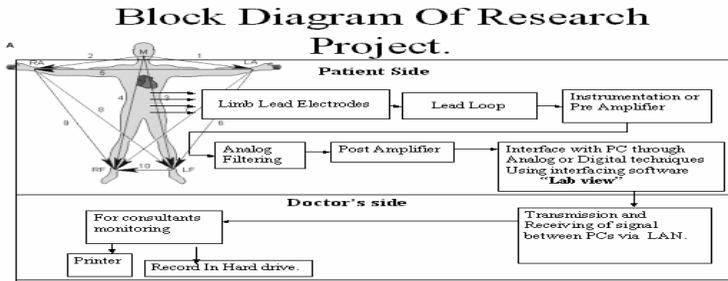


Fig. 1 Main block diagram of the project

considered to be second part of the system as, depicted in figure 1.

The overall objective of this work is to design and implement a low-cost online ECG monitoring system, which replaces conventional hospital bedside monitoring system. The system provides connection between sensor points (patient point) and central node (physician point) through Local Area Network (LAN). Successful implementation of the system seems to be of benefit to all the focused staff involved in the use of electrocardiography to provide access to the ECG of the patient via remote location. Another benefit of this project is of low cost and an ability to use in telemedicine

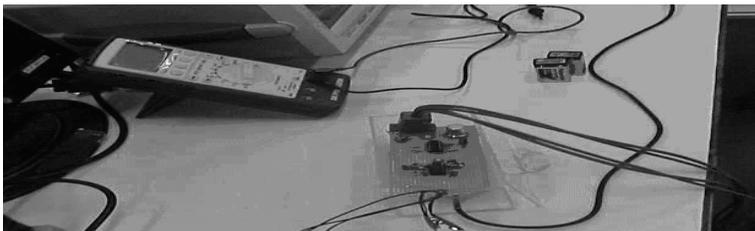


Fig. 2 Implemented Hardware

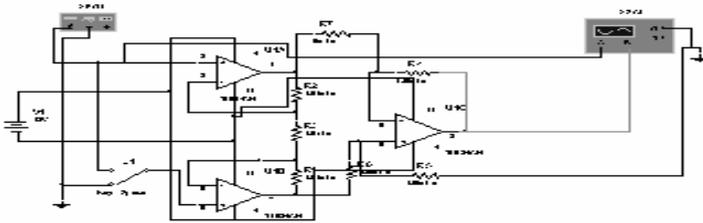


Fig. 3 Schematic diagram of amplification stage

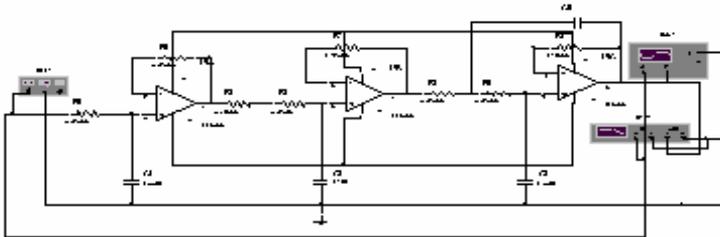


Fig. 4 Schematic diagram of low pass filtering stage

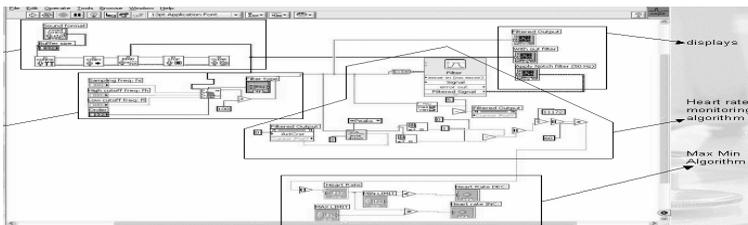


Fig. 5 Lab view ECG blocks program

point of view. This system can easily monitor the signal of ECG by just entering the proper IP address and attempts to prove the feasibility of completely online ECG.

### Hardware Implementation

Fig 2 Shows the circuit design and its implementation on a prototype based wire wrapped onto an 11.5cm by 18cm perforated board using 30AWG wire and chip holders for easy replacement of discrete components. Jumpers were wired in between stages to allow for isolation during testing and troubleshooting.

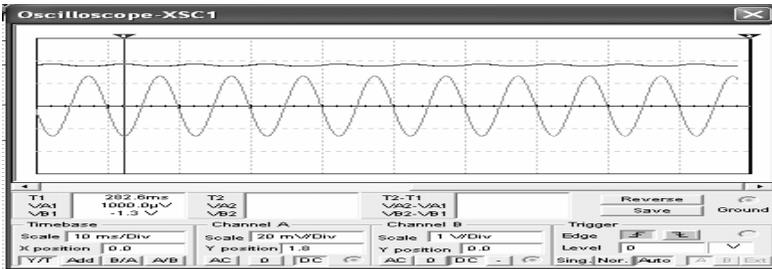


Fig. 6 Results of designed instrument amplifier

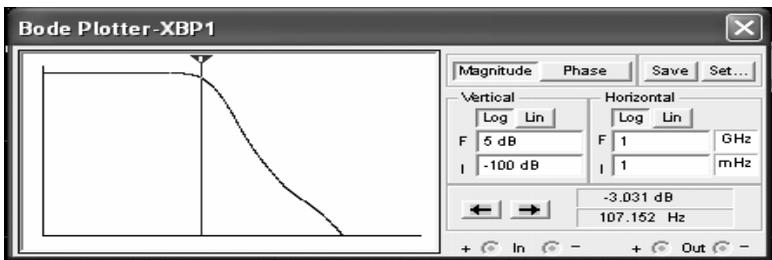


Fig. 7 An active five pole low pass filter response

Furthermore, the output of each stage was tapped and wired to output connection pins for giving the ability to test and verify each sub-circuit, as well as troubleshoot the circuit in the event of component failures in the future. The filter sections were tested using multisim2001 software, and the completed circuit overall met expectations formulated during multisim simulations. The completed differential amplifier and filter circuit is shown in the above figure. Fig.3 belongs to ECG amplifier circuit, which provides proper gain to acquire the signal.

Fig.4 is the circuit of the ECG low pass filter belongs to the ECG hardware. This circuit provides proper cut-off frequencies, which is requiring for ECG. This is about 100Hz. The simulation is performed in workbench and results are shown later.

### Software Development

The automation of ECG data collection, analysis, and display by software is a necessary element of an online ECG and heart-rate monitoring system.

LAB VIEW is a graphical development environment with built-in functionality for simulation, data acquisition, instrument control, measurement analysis, and data presentation. With Lab view, a user can

drag and drop pre-built objects to quickly and simply create user interfaces for an application, and then specify system functionality by assembling block diagrams as shown in fig 5.

### Experimental Results

Fig. 6 shows input and output signals of the amplifier circuit on oscilloscope. This simulation is performed in workbench. Fig.7 shows bode plot input and output signals of the filter circuit, belongs to ECG low pass filter. The simulation is performed in workbench. Fig.8 shows an acquired ECG signal for test purpose to view the electrical activity of the cardiac muscles.

On each part of the developed hardware carryout the patient's ECG signal to the computer. The lab view software transfers patient's ECG in real time over the internet and same time it is available to the consultant chamber for



Fig. 8 Real Electrocardiogram of the patient

interpretation of results. The low noise frequency that exists while measuring the ECG signal from human's body is greatly reduced through the low frequency filtering.

### Conclusion

This paper discusses the design and hardware implementation of low cost online ECG measurement system by entering an IP address to display the acquired heart beat on another system. During this work, we have performed various simulation based test of the physiological parameters. Further more, we have also implemented a prototype based data acquisition device for monitoring cardiac electric activity. This indigenous development of cost effective prototype monitoring system can offer significant hope in reducing mortality as well as morbidity rates and attempts to prove the feasibility of this online ECG.

### Acknowledgement

The simulation based as well as real tests were performed within the department of Biomedical Engineering. Authors greatly acknowledge the support and facilities provided by the Department of Biomedical Engineering, Mehran University of Engineering and Technology Jamshoro-Pakistan.

### **References**

- [1] C R Meyer, and H N Keiser "Electrocardiogram base line noise estimation and removal using cubic splines and state-space computation techniques," *Comp Biomed Res*, vol.10, pp .459-470, 2001.
- [2] M. Karlsson et al. "Wireless System for real time recording of heart rate variability, proc. 13<sup>th</sup> Nordic Baltic Conference on Biomedical Engineering & Physics, V. 9: 168-169, 2005.
- [3] Johnson P and Andrew. "Remote continuous physiological monitoring in the home," *J. of Telemedicine and Telecare* 2:107-113, 2003.
- [4] NP Chowdhry, A A Memon, BS Chowdhry, AQK Rajput. "Design of Bluetooth based low Cost cardiac telemonitoring system". International Conference Proceedings of the Med-e-Tel at Luxembourg, p222-224, 2006.
- [5] L. Cromwell, F.J Weibell, Erich A. Pfeiffer. "Biomedical Instrumentation and Measurements," 2nd Ed, prentice hall of India Pvt Ltd, 2002.

# MINAS TELECARDIO: TELECARDIOLOGY IN THE PUBLIC HEALTH SYSTEM OF MINAS GERAIS, BRAZIL

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**Abstract: The Minas Telecardio Project, which is coordinated by the Hospital of Federal University of Minas Gerais, develops telecardiology activities in 82 cities of the state of Minas Gerais. Its conception, implementation and first results are described in this article.**

## Introduction

Cardiovascular diseases are currently the major cause of death in Brazil [1]. Considering the acute coronary syndrome cases, the delay to identify the symptoms and to search for care is responsible for the high pre-hospital mortality rate. Almost 40% of the patients die before receiving any medical care [2].

It is supposed that the implementation of a telemedicine project focused on telecardiology can produce indicators to facilitate the organization of the care in the public health system of small villages. Furthermore, it can allow an early diagnosis and the development of a process to support patients with cardiac complains in those places.

The Minas Telecardio Project, an initiative of the State Health Department of Minas Gerais, is coordinated by the Hospital of UFMG and has the participation of four other universities in the state and their respective school-hospitals: Federal Universities of Uberlândia, Triângulo Mineiro, Juiz de Fora and State University of Montes Claros. The system links academia to primary care, through the analysis of electrocardiograms by distance, teleconsultation, second opinion and permanent education applied mainly in cardiology.

## Objective

The main objective is to implement and measure the effectiveness of telemedicine system to deliver cardiovascular care to small villages of the state of Minas Gerais.

## **Method**

For the implementation of the telecardiology system in 82 small villages along the state of Minas Gerais (MG) it was considered the following eligibility criteria: population lesser than 10.000 inhabitants; at least 70% implementation of the Family Health Program (PSF); appropriate internet connection; explicit interest of the municipal management and real necessity of the village [3]. Due to a complex logistic situation, a careful implementation methodology had to be developed concerning team formation, technological structure definition, implementation of the system itself and epidemiologic study.

### ***Formation of the teams***

The central coordination (medical, technical and research) is performed by the Hospital of UFMG, also responsible by the interconnection of the activities between the institutions involved. Each university center acts as a local coordination, supporting the systems' implementation and maintenance in the villages geographically close to it. Each village defined technical and clinic teams responsible to handle the system.

### ***Technological Structure***

The main hardware structure of the project is composed by 12 computer servers where those essential for health care deliver are arranged in clusters. The local structure in each village is formed by a high performance computer, web cam, printer and digital 12-lead electrocardiogram. Communication software permits interaction via chat, voice and image. Besides, it also allows file sharing and exchange between users in order to improve the interaction. Electrocardiogram software is also used, as well as a WEB system developed by the project team to manage online and offline teleconsultation. During project implementation, different types of telecommunication technologies were found: 44% owned satellite connections, while 41% radio, 4% dial up connections, and 11% other types of broad bands.

### ***System implementation***

The system implementation was divided in four phases: introductory meetings with the municipal management and clinical teams, tests and suitability of the Internet connections, technical visits to all the villages and training of technical and clinical local teams. Delivery of equipments was done only after the accomplishment of the four phases and signature of Compliance Terms of the Project.

The project offers duty services in telecardiology, delivered by specialists, responsible for the analysis of the electrocardiograms and online

discussions of the clinical cases. The duty service rotates along the week among the university centers and the telecardiologist on duty answers all the 82 villages enrolled in the project. Other integrated activities are teleconsultation or second opinion in other specialties and permanent education program by distance. General information about the project can be found on [www.minastelecardio.hc.ufmg.br](http://www.minastelecardio.hc.ufmg.br).

### ***Epidemiologic study***

An epidemiologic study is under development to measure the effectiveness of the telemedicine system and to compare it to the conventional cardiovascular treatments. For this assessment, the methodology proposed by Donabedian has been used: assessments of structure, process and result [4]. These evaluations are been done in 3 stages: *Establishment of a pre-implementation base line*, consisting of a health diagnosis of the 82 villages involved and an evaluation of the satisfaction level of the municipal physicians about the cardiovascular care in their village, using the CARDIOSATIS-Team scale. *Process indicators*, consisting of clinical and epidemiological data of all patients, number of examinations. *Assessment of results*: conducted by a prospective study with acute coronary syndrome patients and those with chronic cardiovascular diseases, for comparison. After a period of 60 days, information regarding to patient's history evolution and his satisfaction with the service are been evaluated through the CARDIOSATIS-User. Also, his life quality is measured through the WHOQOL-bref scale. Finally, pre and pos intervention comparative studies will be performed.

### **Partial Results**

Before project implementation, the following protocols had to be adjusted: compliance term, confidentiality term, free informed consent term, satisfaction scales (CARDIOSATIS-Team and CARDIOSATIS-User), service structure assessment protocol, patient follow up protocol and partial assessment of the project protocol. Also, seven training cycles, involving 253 professionals in technical and clinical areas, were carried out.

Table 1 shows the gradual implementation of the telecardiology system. Until December 2006, it was identified for the prospective study 510 patients (8,0% of a total of 6,402 patients) with suspicion or diagnosis of acute coronary syndrome. The scale CARDIOSATIS-Team were applied to 107 doctors direct involved. An initial evaluation of the project, consisting of its positive and negative aspects, its impact on the number of patients referred to secondary level of health system and regarding its accessibility, was conducted by 75 villages. The system was considered by 66% of the

villages as good and by 11% as excellent, 50% as easy and 20% as very easy to handle. The main positive aspects pointed out were precocious diagnosis (42%) and possibility of clinical case discussion (31%). The fact that fewer patients were referred to other towns/cities was stressed in 69% of the answers. On the other hand, the excess of workload of professionals involved in the project was considered the main difficulty (42%), followed by the technical problems of Internet connections (31%).

Table 1 – Characteristic numbers of project evolution

Month	Nº of villages using the system	Nº of ECG	Nº of different patients that received care
June	4	27	26
July	14	153	147
August	22	450	435
September	42	904	893
October	54	1611	1597
November	65	1959	1941
December	69	1503	1363
<b>Total</b>	<b>69</b>	<b>6.607</b>	<b>6.402</b>

### Discussion

The implementation of the telecardiology services in small villages of State of Minas Gerais showed satisfactory results, considering both assistive and educative aspects. The project was welcome by the municipal management, demonstrated by the investment to improve Internet connections when necessary. Another positive impact was the starting of telemedicine activities in other four universities. The virtual meeting in cardiology between the university and primary care showed to be effective, considering the high number of electrocardiograms and clinical discussions and also by the reduction of the number of patients referred to secondary health care.

### References

- [1] DATASUS/Secretaria Executiva/Ministério da Saúde. *Mortalidade Geral, anos de 1996 a 2000* (www.datasus.gov.br). Last accessed in Feb. 10, 2007
- [2] Timerman A, Timerman S. *Projeto Emerge Brasil: Síndromes Coronárias Agudas*. Sociedade Brasileira de Cardiologia/FUNCOR 2001. (in portuguese)
- [3] M.B.Alkmim et al. “A Telemedicina na Atenção Primária” in *Telessaude Um Instrumento de Suporte Assistencial e Educação Permanente*, Editora UFMG, Belo Horizonte, Brasil, pp. 129-145, (in portuguese)
- [4] Donabedian A. The definition of quality and approach to its assessments. Ann Harbor Health Administration Press. 1980. vol.1

# TELECARDIOLOGY FOR DEVELOPING COUNTRY

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***Abstract:* The Republic of Maldives is an ideal country for the introduction of eHealth services because this country consists of 199 islands spread over long distance. Using the classical approach to health care structure, it is not easy to offer medical services to the population of the whole country. Based on the introduction of telecardiology services, the evaluation of social-economic benefit is presented.**

## Introduction

eHealth is a potential solution on how to improve health care in developing countries. It was officially recognized by the World Health Organization in its Resolution on eHealth approved by the Fifty-eighth World Health Assembly in May 2005. This Resolution stated that “eHealth is the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research.” eHealth has the potential to extend medical care efficiently to nearly 40% of the population of developing world, where healthcare is almost non-existent.

Based on several successfully implemented eHealth pilot projects in both developed and developing countries, it is clear, that eHealth is a powerful tool for a big variety of practical applications. We are still in the very beginning of introduction of eHealth services into medical practice. The interest to eHealth is growing much faster in developing countries than in developed countries. Taking into account the different situation in health care sector for these two groups of countries, the application areas and priorities are also different. The introduction of eHealth services requires some investment and training. Because the healthcare budget is very limited in all developing countries, it is important for administration to understand the benefit which the introduction of eHealth services brings to a country. Dealing with healthcare, we need to speak about social-economic benefit. It is one of the main government obligations to organize and manage healthcare services for the population.

eHealth can improve the access to and/or quality of some of medical services for people living in rural and remote areas of a country. Because of the important social benefit of eHealth and just for this reason any government has to support the introduction of eHealth services. How can we justify the introduction of eHealth services economically? Those benefits must be identified, not only in monetary terms but also considered improvements in access, quality of care, better return of resource utilization, better clinical end results, user satisfaction, and improvement of the overall community health status.

### **Telecardiology in the Republic of Maldives**

As an example, let us consider the introduction of telecardiological service in Maldives. The Republic of Maldives consists of 1,190 coral islands and only 199 islands are inhabited. Administratively the Maldives is divided into 20 atolls. The country is small with the population about 284,000.

The health care services are provided at the main hospital in Male, the capital, and there are six regional hospitals and four atoll hospitals. In addition, every atoll has at least one health centre. The health care services on other islands are provided through health posts. The heart disease is the single most fatal disease of our society. It is responsible for more death than any other disease. Many of these deaths are the result of the time elapsed between the cardiac event and the medical assistance provided to the patient. One of the leading factors in the diagnosis of a person's heart condition is his/her electro-cardiogram (ECG) data.

Traditionally, ECG diagnostics were carried out at hospitals or clinics where the patient would be physically attached to an ECG machine and the doctor would simultaneously diagnose his/her condition. Today with the development of advanced microprocessors, computing and transmission technologies, remote transmission and acquisition of ECG via the telephone line became possible, presenting new possibilities for a wide range of applications ranging from home care to preventive diagnosis and emergency services. There are only a few cardiologists in Maldives. The Indira Gandhi Memorial Hospital (IGMH) is the main hospital in Male and there is one cardiologist there. It is difficult to organize the appointment with a cardiologist because it is long and expensive trip by boat or even by plane from far remote islands. Moreover, for patient with myocardial infarctions, it is not recommended any travel because it is dangerous for life. Who could help them? If a patient lives at island where regional or atoll hospital is located, he or she can get at least cardiac service provided by general practitioner. But in another case, it is not easy to get a medical service.

It is possible to introduce the service of telecardiology in Maldives. Actually, there are two types of services which have a clinically proven. One is the provision of diagnostic services and professional counseling to patients with suspected cardiac symptoms. The second is the provision of emergency-type services, primarily to patients with heart condition who would subscribe to a service center for monitoring and emergency assistance. Both types of services are based on telephone transmission of ECG by the patient/subscriber to a computerized ECG receiving station at the service center, which could be located at Indira Gandhi Memorial Hospital in Male. It is also possible to organize 24 hours emergency service if doctors on duty working in the shift in the hospital's ward will be trained cardiology and how operate telecardiology receiving station.

The beauty of eHealth cardiology service is that this service is not required expensive set up. As a rule, it is PC with specialized software. In addition, each health posts, health centers and each hospital have to be equipped with ECG machine. There are already several ECG machine available in Maldives. It will be only necessary to provide for these ECG machine a simple interface in order to send ECG via telephone line to receiving station at IGMH.

### **Cost-Benefit Analysis**

What is the benefit coming from the introduction of telecardiology services?

First of all it is a big social benefit. Much more people would get access to cardiology service and even in emergency situation they would receive some help. It will result in the reduction of the number of death. It is not possible to set up the cardiology service for the whole country in a classical way by increasing the number of cardiologists and putting them in all hospitals and health centers. It will be too expensive and it is not a solution because patients living at islands without health center would have the same difficulties as before with regard to access to cardiology service. eHealth is the only way to increase access to medical services.

Secondly, the limited medical professional resources would be used more efficiently helping at a distance island and atoll health centers to provide better treatment. The telecardiology system provides useful support to GPs in disease management in real time. The medical services in Maldives are not free. The cost of consultation at the government hospital is Rf 25.00 (USD 1.95). Private clinics charge Rf 100 (USD 7.8) per consultation.

Let's assume that private sector is going to introduce telecardiology service in Maldives. How business plan would look like? As usual, there are two main categories of cost: investment cost and costs of running

telecardiology service. Operational costs include mainly staff cost, for professionals and support staff, and related other process costs. Without going into details, investment and running costs together will roughly need, for three years operation time, between USD 30,000 – 35,000.

Let's also assume that the cost for one cardiology consultation is the same as already introduced in private clinics – Rf 100 (USD 7.8). If each year there is only 1,500 consultations, then for three years it will be USD 35,100. This simple analysis indicates that there is a potential positive economic impact. The Republic of Maldives is becoming popular tourist destination. By the year 2002, tourism made up 30% of GDP and the number of tourists had grown to 485,000. If only 0.5% of tourist asks for ECG measurement, it would contribute 2,425 additional cardiology consultations. To get such consultation for USD 10, it is very cheap and it is not necessary to keep at each resort an expensive cardiologist. It has also to be taken into consideration that travel cost by boat or by plane is much more expensive than Rf 100. Sometimes due to the bad weather condition, it is not possible to travel at all. But time is the critical factor for patients with heart disease.

### **Conclusion**

It is not possible to provide cardiology service for the whole country without eHealth.

The strengthening of health systems through eHealth may contribute to the enjoyment of fundamental human rights by improving equity, solidarity, quality of life and quality of care.

The introduction of telecardiology services in Maldives will make a significant social impact by contributing to one of the main Government goal – “Provision of quality health services that are accessible and affordable to all citizens.”

The simple cost-benefit analysis indicates also that telecardiology service in Maldives will be cost effective and could be even run by private sector. Further study can evaluate the sustainability issues, which include ongoing upgrades, training, and maintenance of the system.

Telecardiology is only one of many eHealth services, which could be useful for Maldives.

Absence of a national policy framework about eHealth is an obstacle to achieving the successful introduction of eHealth into medical practice in Maldives. This policy must be in agreement with any overall informatics policies in force in a country as well as with its overall health sector policy. It is useful to develop so called “eHealth Master Plan”, which must be implemented step-by-step in a coordinated manner. The main goal of “eHealth Master Plan” is to provide a coherent national arrangement

directed the implementation of different eHealth projects, eliminating interoperability problems, maximizing the benefits for invested financial resources, and enabling people to function more effectively.

So far in Maldives, there is no telemedicine infrastructure to enable transfers of information between hospitals and other health care institutions. On the other side, the existing telecommunication infrastructure is ready today to support many of eHealth services.

### **References**

[1] Health Master Plan, [www.health.gov.mv](http://www.health.gov.mv)

[2] Making Better Access to Health Care, Report on Question 14-1/2, International Telecommunication Union, 2005.

# TELEMONITORING BY CONGESTIVE HEART FAILURE: PREDICTIVE VALUE OF BLOOD PRESSURE AND WEIGHT INSTABILITY IN THE EARLY DETECTION OF PENDING CARDIAC DECOMPENSATION

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**Abstract:** Heart failure constitutes a relevant clinical and health economic problem that calls for new strategic options. Telemedicine lends itself as a central service and information instrument that guarantees optimized therapy management through the consistent monitoring of the chronically ill patient. Predetermined vital parameters are automatically transmitted to the telemedicine center; in the event that predefined threshold values are exceeded, therapeutic measures are initiated immediately. The center can be reached by the patient experiencing cardiopulmonary symptoms 24 hours a day, 365 days a year. Results show that for CHF patients (NYHA III-IV) transmission of vital parameters within a medical care program prevents hospitalization. A decompensation can be detected in an early stage and can be prevented by family physicians and specialists with the support of a telemedicine centre.

## Problem constellation and formulation

The current rise in health care costs is primarily the expression of the capping of resources. In this context, the expansion of medical possibilities, new needs connected to them, the consequential (over-)aging of the population, and the resulting increase of chronic and multiple diseases play a decisive causal role. For health care, this is becoming a growing logistic problem as well, one that will not be manageable without the use of information and communication technologies. From the health care perspective, telemedicine offers the decisive advantage that two of its essential mechanisms have an effect on the improvement of the cost-benefit ratio: 1. the concentration of resources – the patient under telemedical care receives the diagnosis and possibly even treatment without direct contact with a physician, within a short period of time and even at great distances; 2. the use of alternative technologies – the computerized processing of patient data is faster, more efficient, and prevents unnecessary duplicate tests. Thus, under present constraints such as the lack of physicians and the

demographic changes of the population structure, telemedicine presents itself as a trend-setting form of support that will gain considerable importance in the care of patients. Specific approaches arise particularly in economically significant diseases such as heart failure, hypertension, diabetes, asthma, and chronic obstructive lung diseases which urgently necessitate a new patient care system. A clinical example with which the developments in a health care system of the future can be described – representative of and exemplary for a series of other chronic clinical pictures – is heart failure. Chronic heart failure is the only heart disorder of increasing incidence; approximately 200 000 new cases are anticipated annually in the Federal Republic of Germany alone. The patient's lack of knowledge about the disease, lack of compliance and insufficient medicinal substitution in context with an inadequate and sketchy record of health-relevant, physiological measurement parameters result in an above-average re-hospitalization of such patients with an average stay of 18 days and estimated annual hospital costs of 1.5 billion Euros.

This situation can and must be improved through appropriate managed care programs, where a coordinated, multidisciplinary approach that takes the hospital, the specialist in private practice and the general practitioner into account may prove to be especially promising. At the same time, telemedicine will be assigned the vital function as a central service and information instrument that guides and optimizes the flow of information and data between patient, hospital, and the doctor in private practice. International literature justifies this assumption; further more a synoptic evaluation of selected international studies on the effectivity of telemonitoring under clinical and economic aspects convincingly shows that the frequency of repeated decompensations requiring intensive care and the rehospitalization rate especially for patients who are often hospitalized drops significantly. Moreover the length of hospital stays is reduced. This implies considerable cost reduction for hospital and intensive care unit stays [1-6].

Main objective of the study was to evidence whether patients with impending decompensation can be authentically identified with the help of a telemedicine healthcare program to avoid cardiac decompensations with subsequent clinical admission by early intervention.

### **Methodical approach and patient care program**

The development of a cardiological telemonitoring program by Personal HealthCare Telemedicine Services formed the basis of this controlled, prospective study (see reference [7] for an overview). This program guarantees a constant monitoring of the patient in stages II-IV according to

NYHA (New York Heart Association) and facilitates optimized therapy management and control by means of a closely monitored and complete collection of health-pertinent data. Via telephone, the patient automatically transmits his or her given vital parameters (e.g., weight, blood pressure, oxygen saturation) to the Telemedicine Center. If these values fall below or exceed individually predetermined threshold values, an alarm is triggered so that therapeutic measures can be initiated immediately. Independent of the center’s reaction to alarms, the patients are also contacted at least twice per month, and questioned in a standardized way. The objective of these surveys is to foster the patient’s medical compliance and to recognize indicative changes in the patient’s health as early as possible. Educational measures with respect to diet, exercise and pharmacotherapy round out the program and strengthen the patient in dealing with disease. This benefits a trend that is currently termed “empowerment.” More and more, patients are asserting the claim to have a say and be involved in the respective processes. The internet offers them the opportunity to obtain the necessary health information and creates the preconditions for a physician-patient relationship with no a hierarchical information gap. This promotes the development of a professional partnership with patients who take responsibility for themselves.

### Results

450 patients (362 male, 88 female, age  $66 \pm 10.4$  years, ejection fraction (EF)  $40 \pm 17.2$ ) with congestive heart failure (NYHA level III and IV) were included in the study according to predefined protocol criteria. An electronic health record that comprised all relevant medical data was

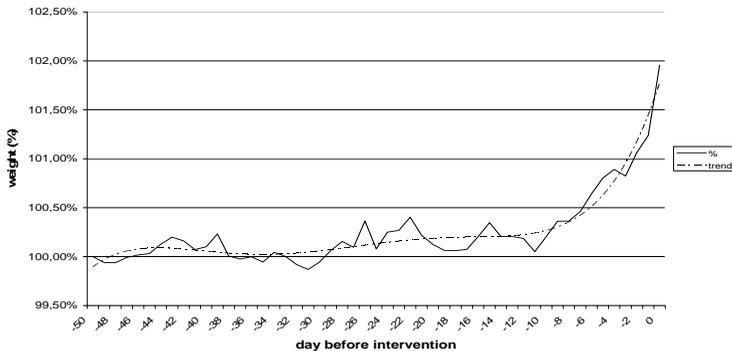
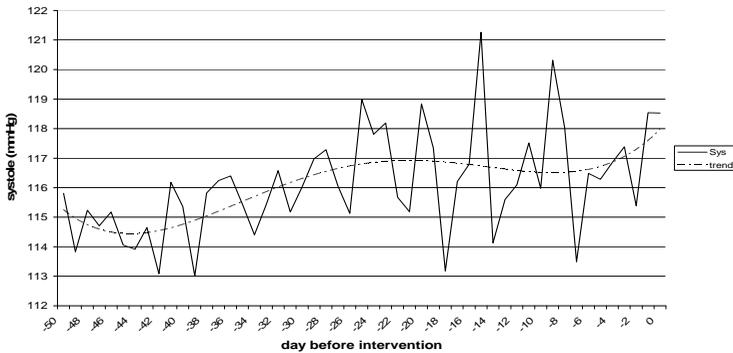


Fig. 1 Increasing weight in percentage 50 days before intervention



*Fig. 2 Systolic variability 50 days before intervention*

generated for each patient. All patients were equipped with an electronic scale and blood pressure device. All measurements were transmitted automatically and the patients were contacted in case of alerts and in addition according to the protocol criteria as described above. By given indications a visit to the physician was recommended or necessary emergency activities were initiated.

Additionally all patients were contacted in a period of 14 days by the telemedicine centre to evaluate clinical symptoms, medication and quality of life.

Within a range of more than one year ( $460 \pm 205$  days) 77 patients (62 male, 15 female, EF  $36 \pm 18$ ) with 182 events that caused an intervention by the telemedicine centre were documented. During the examined 50 days before intervention the weight accrued in average for 1.96%. From day 8 pre-event an increasing weight about +0.36 % in comparison with the base weight (50 days pre-event) can be observed. It grows nearly exponential from +0.89%, +1.07% and +1.24% related to the base weight at days 4, 2 and 1 pre-intervention and manifested at the day of intervention at +1.96% (Fig. 1).

The weight gain is accompanied by instability of the haemodynamic situation, which can be found especially in the systolic values (Fig. 2).

In 2.7% of the cases an emergency ambulance was indicated, clinical admission was necessary in 13.5%. In 83.8% a clinical admission could be prevented by adaptation and improvement of the family physicians or specialists medical treatment.

## **Conclusion**

The result of this evolution illustrates that for CHF patients (NYHA III-IV) the transmission of vital parameters within a medical care program prevents hospitalizations. A decompensation can be detected in an early stage and can be prevented by family physicians and specialists with the support of a telemedicine centre.

In general the introduction of telemedicine in the care of and the management and regulation of therapy in chronically ill patients is still regarded as pioneering work in Germany – in spite of the intense support given by health care policy and health economics.

The system's central component is the complete on-line documentation of various physiological measurement parameters relevant to the specific disease, thereby covering a considerable part of the often complex, primary health care of the chronically ill by means of home-care devices.

The use of patient-oriented technology will not replace patient contact, but instead improve it and enhance the patient's participation and his/her self-management; the physician-patient relationship is intensified through the use of modern working instruments and by a new understanding of the roles of all those involved in health care and puts the patient in the center of a reformed relationship management.

## **References**

- [1] Stewart S et al. An economic analysis of specialist heart failure nurse management in the U.K. *Europ Heart J* 2002; 23: 1369-78.
- [2] Riegel B et al. Effect of a standardized nurse case-management telephone intervention on resource use in pts with CHF. *Arch Intern Med* 2002; 162: 705-12.
- [3] Vaccaro J et al. Utilization reduction, cost savings, and return on investment for the PacifiCare CHF Program. *Disease Management* 2001; 4(3): 131-42.
- [4] De Lusignan et al. Compliance and effectiveness of 1 year's home telemonitoring. The report of a pilot study of patients with chronic heart failure. *Eur J Heart Fail* 2001; 3(6): 723-30.
- [5] Jerant AF et al. Reducing the cost of frequent hospital admissions for CHF: a randomized trial of a home telecare intervention. *Med Care* 2001; 39(11): 1234-45.
- [6] Cordisco ME et al. Use of telemonitoring to decrease the rate of hospitalization in patients with severe CHF. *Am J Cardiol* 1999; 84(1): 860-62.
- [7] Korb H. Integrierte Versorgung bei chronischer Herzinsuffizienz: Optionen für die Gesundheitsversorgung von morgen durch die Möglichkeiten der Telemedizin. In: Jäckel A, editor. *Telemedizinführer Deutschland*. Edition 2005. Ober-Mörlen: Medizin Forum AG; 2004.

**BEST PRACTICES OF EUROPEAN EHEALTH  
EXPERTISE**

## ACUBASE – ON-LINE SYSTEM FOR HIGH QUALITY ACUTE TOXICITY DATA ACQUISITION AND MANAGEMENT

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**Abstract:** One central part of ACuteTox – FP6 EU Research Project to optimize and pre-validate a testing strategy for predicting acute toxicity – is AcuBase, an on-line system for effective data management and high quality data acquisition. 37 partners from 13 countries involved in ACuteTox needed to have a user friendly system to store the *in vitro* data generated during the project and *in vivo* toxicity data collected from literature. Acubase is written as a multi-layered and multi-module web-hosted application and database that facilitates storage and retrieval of data collected from human poisoning cases, animal studies and *in vitro/in silico* testing. Acubase works on client-server architecture and any modern web browser on client-side is needed to get access. The database is at the moment available on Internet <<https://acubase.amwaw.edu.pl>> for partners of the Consortium and contains data on ninety seven reference chemicals. Due to the large number of participating centers, the diversity of experimental designs and type of generated data, the creation of one template for entering data from the *in vitro* experiments was a very demanding task. In the future that *in vitro* template could be used for other similar multi-center projects producing *in vitro* data.

**In summary AcuBase serves as a central element of the ACuteTox project and is an example of toxicological on-line service which will be available for the broad circles of toxicologists and physicians in the near future.**

### **Introduction**

Acubase is an innovative on-line system which integrates comprehensive data sets on acute toxicity of chemicals assessed using *in vitro*, *in silico* and *in vivo* methods. It serves as a central element of the ACuteTox FP6 Integrated Project (<http://www.acutetox.org/>), which aims to optimize and pre-validate an *in vitro* testing strategy for predicting human acute toxicity.

The scope of our system allows for collection and management of data from research laboratories involved in the project located in various countries.

In the course of the project, data on the toxicity of a selected 97 reference chemicals, from animal studies, human poisoning cases, *in vitro* experiments and *in silico* modeling, are collected and analysed in Acubase. To date the results from 3077 *in vitro* tests, 2206 animal studies and 2902 human cases have been collected.

### **Structure**

Acubase is a web-hosted multi-layered application and database typical of internet installations : Postgresql + PHP4 + Apache 1.3. AcuBase is located on the server in the Department of Medical Informatics and Telemedicine of the Medical University of Warsaw (URL: <https://acubase.amwaw.edu.pl>).

The choice of client-server architecture facilitates access via regular web-browsers. The Acubase application consists of four layers: database, code, logic, presentation. The internal structure of the data is based on six principal objects which are linked by the chemical object. The six basic objects functioning in parallel in the database are: *in vitro* experiment, kinetic experiment, *in silico* experiment, animal *in vivo* experiment, human poisoning case, chemical.

The chemical object is described in the database as a separate structure linking the other objects. This structure will allow the statistical analysis and the comparison of any experiments performed with the same chemical. Therefore, in our system it is easy to select and report all *in vivo*, *in vitro* and *in silico* data belonging to one chemical.

Users can define an experiment using only the chemicals that have already been stored in the database. This implies that the first step when working with Acubase is to enter the chemical names. This enables in the second step entering and storage of the results from experiments performed

on these chemicals. At present Acubase contains information on 97 ACuteTox reference compounds and only for these chemicals the experimental data can be introduced.

### **Functionality**

The functionality requirements for the database were formulated jointly by the Department of Medical Informatics and Telemedicine of the Medical University of Warsaw and ECVAM. In its current form the database enables entering, storage and viewing of new experimental data from in vitro and in silico experiments and literature data from in vivo animal experiments and human poisoning cases, as well as information about the tested chemicals (e.g. physicochemical properties). The data can be entered and accessed on-line by all 36 institutions participating in the project and located in Europe. To facilitate working with the data a reports section was implemented providing scientists a tool for exporting the results into an Excel format.

### **Security**

The security of Acubase is achieved through authorization of the users by passwords and use of an https (secure) communication protocol. The connections are encrypted on a www server layer in which secure socket layer (SSL) libraries were compiled. The database layer of our application is not accessible via Internet (e.g. no access to database passwords) and is resistant to common SQL Attacks (e.g. an SQL injection attack that "injects" or manipulates SQL code by adding unexpected SQL to a regular query).

### **Summary**

In the future AcuBase will provide a toxicological on-line service which will be available for broad circles of toxicologists and physicians. One of our aims is to provide toxicologists with a profound knowledge on acute toxicity, using both raw and analyzed data. Our second aim is to make this toxicological on-line service useful for physicians all over the world. Future plans involve the development of a server that will make a part of the stored toxicological data publicly available e.g. using an external search tool for human poisoning cases.

## **CONNECTED HEALTH: DELIVERING SAFE, AFFORDABLE AND ACCESSIBLE HEALTHCARE**

T. Stroemsnes  
*Cisco Europe*

Controlling cost and complexity and improving the way healthcare is delivered remains top of mind for most healthcare executives. In any business, service disruptions are frustrating inconveniences that often result in unnecessary expenses and lower workforce productivity. But for the healthcare industry, in particular, such delays can be the difference between life and death. However, meeting these objectives requires an approach that securely connects the entire spectrum of health systems, processes, devices, and data.

Connected Health is an holistic vision of healthcare focused on the sharing of information across the healthcare continuum from general practice surgeries to hospitals – such as patient demographics and clinical data, best practice protocols and critical public health information – over a common information and communications infrastructure.

Various best practices will outline during this session how the Cisco Medical-Grade Network – a secure, resilient infrastructure that integrates all technologies across the healthcare environment – creates a foundation for Connected Health. It enables caregivers and patients to connect and communicate as they give or receive treatment in hospitals, offices, at home or on the road.

The presentation will touch on some of the following examples of information communications technology in use in healthcare and will include some specific, named examples of institutions using technology in this way:

### **Improving delivery of Healthcare services**

When Sweden's leading hospital - Karolinska University Hospital – deployed a Cisco Medical-Grade Internet Protocol Network it found it could improve the delivery of healthcare services by helping hospital doctors and home-based medical specialists share patient information quickly and securely, making diagnosis and treatment faster and more efficient.

### **Patient centric Healthcare**

Four years ago, Arras Hospital, in northern France, was among the lowest-performing five percent of all French public hospitals. Through a sustained commitment to innovate, it has become a European leader in connected healthcare. Arras is now achieving major efficiencies built on integrated digital technology – and pointing the way to a truly patient-centred system of care, extending far beyond traditional physical boundaries.

## **FINANCING OPPORTUNITIES AVAILABLE AT EU AND NATIONAL LEVEL TO SUPPORT AND BOOST INVESTMENT IN EHEALTH**

L. Botifoll

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### **Econet**

Econet delivers advisory and consulting services in the public funding consultancy sector. Internationally experienced professionals strive to deliver seamless, consistent services wherever our clients operate. Econet wishes to cooperate with Med-e-Tel in the assessment of financing opportunities available to companies at EU and national level to support and boost investment in e-Health.

Our long-term experience in the European grants consultancy sector, combined with proved and recognised competence collaborating with the main European players and Institutions, creates a solid foundation to provide the services required in a professional, efficient, and high-quality manner.

Part of the social object of Econet is the carrying out of market studies and specifically the studies about public financing in the shape of economics aids and grants. Econet is particularly concerned with supporting the public interest. On behalf of the grant awarding community, Econet assists in the development of grant programmes from the local to the international level. Programme development typically starts with the current situation, the aims and a description of the target group. Various priorities and measures then guide how the grant will be allocated and implementation begins. Services can cover such aspects as the setting up of an executive organization, providing advisory staff or IT management tools. Econet can supervise executive organisation, financial-administrative progress and evaluation of programme effectiveness.

The recent background and statistics of Econet's performance are:

- Company founded in 1991, in Spain
- 3 excellence centres (Madrid, Brussels, Vienna)
- 30 working places across Europe
- More than 600 clients in the Private, Public and NGO sectors
- Projects realized (1991-2005) total €6.5 billion.

- Listed in the 500 European fastest growing companies (2006)
- 83 employees in 19 EU countries.

Econet was the first grants consultancy company certified with ISO 9001 which recognises its know-how in the grant advisory field and related processes. It has developed many ICT support tools and two partner networks (M€rit and Guide) across Europe.

Furthermore, Econet runs a network of EU Grant Advisors (EUGA) in 19 EU Member States and leading consortiums of public and private organisations involved in ICT development. Both international leaders and local specialized providers participate, creating a network of more the 200 member organisations. The aim of the EU Grant Advisor Programme is to help SMEs to obtain public funding resources through knowledge of the principles and orientation guidelines of ICT programmes. Furthermore, Econet actively participates not only in grant consultancy but also in programme definition, technical assistance to awarding bodies, international consortium building and programme deployment.

### **Purpose of the Session**

The overall aim of the session will be shedding light and providing an identification of solutions to common challenges faced by the EU and its Member States in terms of leveraging investments in eHealth. The session will undertake an assessment of the financing opportunities available to the EU-27 to support and boost investment in eHealth (covering the element of implementation, exploitation, and deployment) in their own regions, nations, and also include cross-border elements. Also, a treatment of the extent to European Economic Area countries and the accession countries will be comprised.

The session will touch on coverage, availability, sums of financing, conditions, and opportunities for partnerships from both European (e.g., Directorate-General Regional Policy; the European Investment Bank) but also internationally (the World Health Organisation, the United Nations, the World Bank). The results of the session will be included in a report that will be available publicly through the Med-e-Tel website and a CD-Rom.

### **Thematic aspects of the Session**

The specific objectives of the session are to provide participants with well researched and informative background materials in response to:

- 1) Their individual challenges in terms of supporting and boosting investment in eHealth;
- 2) The identification of ways in which a collaborative approach to investment in eHealth could be undertaken.

Hence, the session will:

3) Describe the wider context of healthcare investment in Europe currently and prospectively, 2007-2013. Main aspects to be presented:

- Political commitment at the different policy levels
- Regulatory framework in force and foreseen for the next period
- Financial perspectives for the medium-term period (2010) and comparison of it with the recent past.
- Technological environment, trends, attention paid to innovative eHealth products/services and business and care models

4) Assess current and potential future sources of investment in eHealth, 2007-2013. Thematic priorities financed under national, European and international instruments will be analysed. Transversal aspects will be also considered:

- Rules for participation (co-financing, beneficiaries, countries participating, Project phases funded)
- Business models behind the projects and programmes
- Budgets foreseen in the programmes
- Evaluation of the impact of the programmes

The assessment will include an overview of the different methods of financing; different time-periods possible; cross-border elements and considerations, where relevant; and the different disbursement mechanisms.

5) Analyse possible sources of funding will be analysed including, among others:

- Institutional (e.g., hospital) level
- Regional funds
- National funds
- European Commission funds: the European Social Fund and the European Regional Development Fund in particular. But also, the range of other Directorates-General programmes with their various programmes including but not limited to the Public Health Programme and the Information and Communications Technologies Policy Support Programme (ICT PSP) of the Competitiveness and Innovation Programme (CIP)
- Research and development funding opportunities that will also support eHealth deployment and implementation
- European institutions, such as the European Investment Group (Bank and Fund)
- International institutions, such as the World Health Organization and the World Bank.

6) Undertake a treatment of the extent to which European Economic Area countries and the accession countries, whether due to accede imminently or in the mid-term future, have access to similar funding.

7) Assess alternative healthcare funding and support affecting eHealth.

Main aspects to be presented:

- Current and alternative healthcare financing mechanisms
- Best practice financing schemes in the EU and worldwide
- Analysis of the methodology used in the best practices
- Assessment of the scaling up of alternative schemes
- Analysis of the leverage effect of the different alternative instruments.

Examples of coverage of such alternative schemes will include:

- Public-private partnerships;
- Industry-health authority relationships and networking;
- Private (commercial) sources of financing and/or charitable donations;
- Public procurement and pre-procurement;
- Reimbursement schemes;
- Equipment leasing schemes; and
- Individual citizens' willingness and capacity to invest more in their own personal healthcare.

8) Investigate useful ways of obtaining value-added in eHealth among Member States. Possible ideas or schemes will be presented, e.g., consortia or coalitions of Member States – in which case, the investigation should cover criteria such as similar and complementary healthcare systems; financing mechanisms; reimbursement mechanisms; populations, dimensions, and geographic locations.

9) Indicate effective and efficient healthcare management support. A brief overview will be included of those crucial organisational, management, and resourcing issues which are likely to impact on the EU Member States once initial, or one-off funding for eHealth has been located and successfully obtained, e.g., leadership, planning and preparation, programming, change management, assessment of return-on-investment and cost-effectiveness, and ongoing financial support.

10) Identify possible approaches to the European Commission initiatives in eHealth in general. Main aspects to be presented:

- Identification of new priorities under existing programmes
- Feasibility analysis of the launch of new eHealth-oriented programmes

- Simulate the different scenarios of the i2010 Action Plan implementation according to the investment and instruments planned.

### **Methodology**

The presentation will be divided into two phases. The purpose of the first phase will be to identify, analyse, and prioritise the various eHealth sources of investment from an EU and national level policy perspectives. Thus, first the existing knowledge of the field will be examined and assessed, which will assist in identifying major opportunities and challenges in the most relevant areas identified. In the second phase, the results and insights developed in the first phase will be validated, the policy implications evaluated, and the relative strengths, weaknesses, opportunities and risks of European eHealth methods of financing assessed.

## SNOMED CT STANDARD IN E-HEALTH: IS IT REALLY NEEDED?

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**Abstract:** Systematized Nomenclature of Medicine Clinical Terminology (SNOMED CT) has been in use since 2002 and its predecessor Systematized Nomenclature of Pathology (SNOP) since 1964. The demand for standardized clinical terminology is growing with the introduction of national healthcare IT systems. In the paper the reasons justifying the use of SNOMED CT are given. They are as follows: providing the foundation for electronic health records (EHR), making healthcare knowledge more usable and accessible on national and international level, and improving patient safety. How to disseminate SNOMED CT most effectively is an important question. The creation of SNOMED CT Standards Development Organization (SDO) seems to be the best way of doing it. The role of other institutions in dissemination such as WHO, ASEM, Commonwealth and ISfTeH is also important. The foreseen advantages of SNOMED CT use are decreasing the health care costs and increasing the patient safety.

### Introduction

Systematized Nomenclature of Medicine Clinical Terminology (SNOMED CT) has been in use since 2002 following the introduction of Systematized Nomenclature of Pathology (SNOP) in 1964. English, German, Spanish and Danish language editions are available up to now. As more and more countries are introducing the national healthcare IT systems the demand for standardized clinical terminology will be growing [1]. SNOMED CT can be used for coding, retrieving and analyzing data about health and health care. It is comprised of codes, terms and relationships, for use in precisely recording and representing clinical information across the scope of health care. Each code represents a single meaning/concept and can have multiple descriptions/terms.

### **Reasons for using SNOMED CT**

There are several reasons justifying the use of SNOMED CT. Among them are: providing the foundation for electronic health records (EHR), making healthcare knowledge more usable and accessible on national and international level and ensuring systems interoperability. It is estimated that full systems interoperability can bring up to 5% savings of the total healthcare costs [2]. The question of technical and semantic interoperability is relevant. The technical interoperability means that systems can exchange and use the data while semantic interoperability means that systems interpret the data with the same meaning. The use of SNOMED CT can improve the healthcare of persons traveling or working in another country (e.g. Poland – ca 1 mln citizens working abroad) by the possibility of translating EHR to the language of the foreign country. Also patient safety (estimated 44 000 – 98 000 patients dying in the US hospitals each year as the result of medical errors that could have been prevented) can be improved [3]. The significant parts of errors are medication prescribing errors. In American study of University of Massachusetts 1200 errors were found in 27 000 medical records – 4.5%. As much as 30% of errors could have been detected at the stage of prescribing if electronic alerting system based on coding system was used [4]. Pharmaceutical products are one of the top-level SNOMED concepts. Also health benefits such as clinical decision support are enabled via use of SNOMED CT.

### **Ways of SNOMED CT dissemination**

How to disseminate SNOMED CT most effectively? There was a plan to form SNOMED Standards Development Organization SNOMED SDO by 31 December 2006 but it has not been achieved yet. Nine countries (Australia, Denmark, Lithuania, New Zealand, U.K., Canada, USA, The Netherlands, Sweden) potential charter members expressed their interest to become members of SNOMED SDO when it is formed. Its goal is to offer countries the opportunity to take a leading role in the development, ownership and maintenance of SNOMED CT [5]. Nations participating in SDO will have the right to use SNOMED CT in their system at an affordable price. The College of American Pathologists (CAP) will transfer SNOMED CT intellectual property rights to the SDO after its creation.

Also the role of such institutions and organizations as World Health Organization (WHO), Asia Europe Meeting (ASEM), Commonwealth and International Society for Telemedicine and eHealth (ISfTeH) is important in dissemination. The participation of WHO in SNOMED SDO is under consideration.

### **Conclusions**

- Implementation of SNOMED CT standard in e-health has several advantages: decreasing the cost of health care, increasing patient safety, improving the health care of citizens traveling or working abroad.
- Multinational and multi-institutional support is needed for SNOMED CT
- Dissemination

### **Acknowledgement**

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### **References**

- [1] K. Donnelly. SNOMED-CT: The advantages of Coding System for eHealth. Medical and Care Compunetics 3, L. Bos et al. (Eds) IOS Press 2006, pp. 279-290.
- [2] J. Walker., E.Pan, D. Johnston, J. Adler-Milddteton. The Value of Health Care Information Exchange and Interoperability. Market Watch 19.01.2005, pp. 10-18
- [3] K. Ho. Achieving Patient Safety Through Information Technology – An Emerging Frontier Becoming Mainstream. E-health & medical IT Solutions 2006. Touchbriefings, pp. 42-43.
- [4] <http://www.usp.org> U.S. Pharmacopeia's Center for Advancement of Patient Safety (2002)
- [5] R. Rudowski , M.Nerlich., R. Richardson, J. O'D Mc Gee, F. Lievens., M. Noga et al. SNOMED - a tool for achieving semantic interoperability in e-health systems. 11th ISTeH International Conference "E-health for All Developed and Developing Countries, Common Issues, Universal Solutions", 26-29. 11. 2006, Cape Town, South Africa, p.76

# **STUDY OF THE EXPEDIENCY OF IMPLANTATION OF NATIONAL SYSTEMS OF MEDICAL AND PHARMACEUTICAL INFORMATION VIA INTERNET IN UKRAINE AND RUSSIA (DOCTOR.UA PROJECT)**

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***Abstract:* Nowadays appears the necessity of modernizations in systems of medical and pharmaceutical information of Ukraine and Russia because of the wide range of diseases, methodic of treatment and quantity of available drugs on the markets. The work shows that Internet-systems of medical and pharmaceutical information proved their practicability of using in post-USSR countries.**

## **Introduction**

Today can be noticed the rash development of medicine and pharmacy. Nowadays appears the necessity of modernizations in systems of medical and pharmaceutical information of Ukraine because of the wide range of diseases, methodic of treatment and quantity of available drugs on the markets. Existing systems in modern circumstances, in conditions of limited labor and financial resources, and large implantation of evidence-base medicine, often can't effectively satisfy the requirements of population and health professionals in medical and pharmaceutical information [1]. The objective of this work was to determine the efficiency, performance requirements and financial practicability of using new for Ukraine systems of medical and pharmaceutical information, which are based on the data communications via Internet.

## **Material and methods**

The work was based on the study of Ukrainian project Doctor.UA (non-commercial project which provides health professionals and citizens by quality medical and pharmaceutical information through the Internet, project is launching by JSC "Apteka Doctor"). For deciding given tasks were applied following methods: statistical analyses, usability-testing, interviewing the visitors.

## **Results**

Introducing of Doctor.UA is scheduled in several stages. First of all in January, 2003 was opened four-years test project, which was the part of corporative site of the company (<http://apteka-doctor.com>). It was named Pre-Doctor.UA and it in simplified form modeled Doctor.UA.

Pre-Doctor.UA has realized following functional units (some units – partially):

- Reference information for visitors in different directions of medicine;
- Information about drugs which are available on the market (incl. instructions for using);
- Teleconsultations;
- Information about healthy lifestyle and role of preventive maintenance;
- News of medicine and pharmacy;

During first decade of January, 2007 the results of activity of Pre-Doctor.UA were drew up. Statistical data of attendances of the whole project and separate it services was explored. The results from three different statistics servers were studied and the index of average attendance of the project was determined: it forms 406 persons daily, the growth was rather essential from at average 27 visitors/daily in 2003, then 244 – in 2004 and 650 – in 2005, to 704 visitors daily – in 2006. During that time system has processed 33584 inquiries for granting the instructions for using determined drug. Qualified specialists have given 1038 consultations in 12 fields of medicine and pharmacy. Technically the service has been functioning with the usage of personal software “Pre-Doctor.UA – Consult”. This software solution allows organizing asynchronous text consultations in the mode “patient’s question-doctor’s answer” [2]. Asking a question the user gets a unique password of it, which allows updating the question, if necessary. It provides the possibility to have a dialogue between a doctor and a patient. As for doctors` answers there is a system of step licensing of medical consultants. Each question is directed to a certain theme (which subsequently can be changed by the administration or a doctor). And only doctors, who have the right (license) for answering in the given subject, see this question on their consultant administration interface and can answer it. Besides, each doctor is given a certain qualification (category). According to it the answer can be updated by the doctor who has given it or by the doctor of higher qualification. If the answer is updated by the doctor of the same or low category, this answer passes the stage of an

expert judgment. If the expert finds the answer being correct, then it will be added.

Software capabilities also allow carrying out the following operations:

- Using of emergency modes of communication with a medical consultant (triggering of automatic question-notification function on a doctor's mobile phone);
- Gathering of answers statistics (including average answering time per year/month; average time necessary for the doctor to answer and absolute answers quantity);
- Drawing up of doctors ratings on the basis of statistics;
- Filing of consultations, ample opportunities of search in archives (by number of the question, keyword);
- Highly probable prevention of spam occurrence in questions.

On the basis of Pre-Doctor.UA activity and the analysis of the Ukrainian part of the Internet, it is possible to formulate the basic problems of medical-pharmaceutical Internet-systems in post-Soviet countries in comparison with alternative information systems, and also the ways to solve these problems (typical for all projects or by the example of Pre-Doctor.UA and Doctor.UA):

1. Number of Internet-users. The global network does not cover the majority of the Ukrainian and Russian population. In Ukraine, for example, the quantity of Internet-users in 2003 was 3,8mln people [3]. Regrettably there wasn't published other official information about the quantity of Internet-users in Ukraine after 2003, but prevalence of the Internet in post-Soviet countries tends to powerful growth, and today the Internet-audience is a significant part of the population. Moreover, it is important, that the majority of the audiences, which are characterized by such parameters as active living position, solvency, striving for extracting information, are already Internet-users [4].

2. Confidence in medical-pharmaceutical Internet. Unfortunately, no significant studies of this problem were arranged in post-Soviet countries, but it is necessary to present the analysis data of the company "Datamonitor". In 2002 the company experts have interrogated over 4.5 thousand people in France, Germany, Italy, Spain, Great Britain and the USA and have found out, that 57% of those who was in search for medical information for last 12 months used the Internet. For comparison, 76 % of the interrogated confided in personal doctor, in books, magazines and TV – 73% of them, and in friends and family – only 53% [5]. Undoubtedly, a similar Ukrainian research should be carried out, but it is possible to draw preliminary conclusions that the level of trust is sufficiently high.

3. Financing of projects. At the stage of large-scale implementation, such projects require rather massive financing. For the projects Pre-Doctor.UA and Doctor.UA this problem was solved owing to the fact that at the given stage financing of projects is carried out exclusively out of funds provided by the owner company. Though the project Doctor.UA has good independent financial prospects, and in future it is planned to involve funds of grants, advertisers and probably investments of other companies with preservation of a controlling interest so as to achieve self-repayment.

In 2006, 97% of the interrogated visitors (n=300) have positively appreciated the idea of Doctor.UA launch. The information structure Doctor.UA has been designed in view of the analysis of Pre-Doctor.UA activity as well as the analysis of market needs in the sphere of medical and pharmaceutical information.

### **Conclusions**

1. As a result of the carried out analysis of Pre-Doctor.UA activity, it has been established that there is a necessity of large-scale implementation of Doctor.UA, what is planned to be done during the years 2007-2009 (in three stages). 2. The medical-pharmaceutical Internet systems have proved their practicability of using in post-USSR countries. Such systems effectively solve primary problems, satisfy visitors` needs and have significant popularity. Today realization of such projects requires investment; nevertheless they have good independent financial prospects in the future.

### **Acknowledgment**

A. A. Lendyak thanks to Professor Parnovskiy B. L. and Professor Yagensky A. V. for their advices. The author also thanks to the team of Ukrainian national Internet-project Doctor.UA

### **References**

- [1] Lendyak A. A. Internet-pharmacy– Lutsk: Volyn regional publishing, 2006.– 150p.
- [2] Vladzimirsky A. V. Clinical teleconsulting. The reference for the doctors. Second edition.– Donetsk: Nord LTD, 2005.– 107p.
- [3] State committee of the communication and informatization of Ukraine.–2004.– <http://www.stc.gov.ua/>
- [4] The level of using of the Internet in Ukraine.-2006.-Socialological report of Kyiv international institute of sociology– <http://www.regnum.ru/news/744809.html>
- [5] Health websites gaining popularity.–2002.–<http://news.bbc.co.uk/2/hi/health/2249606.stm>

## TELEMEDICINE AT SEA: COMMUNICATIONAL CHALLENGES

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**Abstract:** This paper discusses human as well as technological challenges related to the provision of medical advice to seafarers. We discuss the possibility of introducing global Seafarers Medical Card.

### Introduction

When a person is injured or ill at sea, there may be a need to seek medical advice from land. For more than 50 years, several radio medical services has been operational, starting by using radio signals and Morse code, evolving through telephones to full blown telemedicine solutions. In addition to all the challenges facing telemedicine users and providers on land, there are several to be met at sea. Technological limitations and organisational challenges are abundant, but we also have significant medical challenges. The doctor has never seen the patient, and most probably never will. Normally he will not even speak to the patient, but to the officer in charge of the treatment. On the other hand, telemedicine in some form is the only means by which you can get expert advice while on sea, and there is decades of experience in its advantages as well as its limitations.

A number of international regulatory conventions govern the provision of medical advice to seafarers. The most explicit is ILO Convention 164 [1]:

#### *Article 4*

*Each Member shall ensure that measures providing for health protection and medical care for seafarers on board ship are adopted which- ---*

*(b) Aim at providing seafarers with health protection and medical care as comparable as possible to that which is generally available to workers ashore.*

On land, there has been a significant development of e-health systems that benefits patients in remote areas. The provision and sharing of information within and between the health care systems has also been vastly improved

in the last decades. On sea, however, we do not see the same development. We examine some of the challenges to maritime telemedicine in this paper.

### **Technical and organisational challenges**

A ship at sea is an isolated place, and the only means of communication to shore is satellite and radio. Thus telemedicine solutions for ships must be able to use satellite communication, with the limits to message size and real time applications that this introduces. Flexible solutions are developed that are able to use several communication carriers depending on what is available at any time. For instance, video communication may be used when within VSAT coverage, while message based communication could be used in other situations. Research carried out at the Norwegian Centre for Telemedicine [2] indicates that video conferencing is of limited importance, but images, text and ECG are more important.

In order to prevent sensitive information from falling into the wrong hands, most countries have strict rules for handling medical information that can be connected to a person. This involves encryption, rules about who may or may not receive copies of the information and rules about how to store the collected information. All these challenges must find technical solutions. Most commercially available solutions today are proprietary, requiring the same software in both ends. For maritime medical aid, this is a particular problem, as the Radio Medical services in place hardly can handle an abundance of receiving systems. Thus, to get an effective telemedicine service, standards must be in place for the message exchange, and this must be compliant with the data security standards that should be adhered to by the medical centres. Ships that would like to use electronic communication with the medical centres should subscribe to this service, getting the proper access codes and information security in place before using the service.

The technical and medical skills of the medical officers on ships vary considerably. The need to seek medical advice does not occur very often on each ship, so any system developed for maritime telemedicine purposes must be easy to use. Still, the systems must preserve the security and integrity of patient data, as well as help document the information exchange that has taken place between the doctor and the medical officer.

Another point to be taken into account is the telecommunication system used by the ship for requiring medical advice. Based on C.I.R.M. statistics (see Figure I), the e-mail is becoming the system most used for medical assistance of patients on board ships. This represents an advantage, being this system the most suitable for transmitting by store-and-forward images of affected areas and several biomedical data.

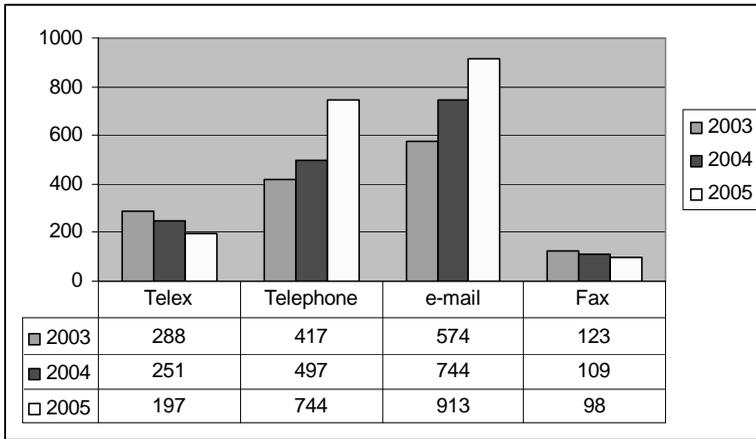


Fig. 1

The receiving centre must also be available for training and testing purposes, this should be scheduled at regular intervals. All medical systems require regular training, in particular when they are rarely used. Obvious as this is, it is nevertheless often neglected.

### Medical challenges

The doctors working for the Radio Medical services rarely have any prior knowledge of the patients' medical condition. We propose to introduce such an electronic medical card in the Radio Medical services for sailors. This could serve as a large scale pilot project for the proposed European general medical card, and would provide immediate benefits to the sailors as well as the radio medical services. The officer with medical duties on board is the person in charge of the patient. Normally, this is the first mate and, the medical advice given is requested by the medical officer, and most times, the communication is between the doctor on land and the medical officer. The telemedicine advice is thus given as second opinion or expert advice, rather than treatment advice.

Analysis of C.I.R.M. data of patients assisted in the years 2004-2006, shows that amongst the 4,684 patients the centre has treated, the number of cases with objective medical data has increased from 4% of the patients in 2004 to 12.3% of patients in 2006. Dynamic images (ECG or ultrasonography) were transmitted only in a few cases from cruise and passenger ships. Static images were the type of telemedical data most often sent from ships to C.I.R.M. Pictures sent as attached files to e-mail



Fig. 2

messages included views of traumatized areas (25 % of cases), of skin lesions of dermatological interest (23% of cases) , ocular lesions (15 % of cases) and burns (8 % of cases). Sometimes, pictures were used to guide local treatment of lesions (Figure 2).

A major problem for the radio medical service doctor is that he or she has virtually no knowledge of the patient, save from the description that is received from the ship. In many cases, it would have been valuable to have a general description of the medical status of the patient prior to the incident that causes the call for help. Introducing a maritime medical card will be a help in this situation. The content of the medical card should be identical for all sailors, and be supported by all the Radio Medical services in place in accordance with ILO 164 and IMO 960.

### Conclusions

Recent developments in telemedicine have to a small extent benefited sailors, but the potential is substantial. The major limitations are organisational and medical, not technical. Introducing a medical card with patient information will help the doctor on land to better understand the condition of the patient. In particular, information about earlier medical conditions and allergies will be helpful. We want to try out this idea in a pilot project, starting with a few ship owners that subscribe to the service for their crew.

### References

- [1] <http://www.ilo.org/ilolex/cgi-lex/convde.pl?R164>
- [2] Moksness SG, Larsen E, Norum J. M@ritim - medisinsk assistanse og rådgivning via telemedisin i maritime miljø - en kartlegging av behov. NST-rapport 03-2002, februar 2002 (Norwegian only)

## **TELEPSYCHIATRY IN DENMARK**

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**Abstract:** "Telepsychiatry" refers to use of telecommunication technologies in order to provide mental health care from distance. Mental health care system in Denmark faces significant barriers in providing psychiatric care towards refugees/migrants on their mother tongue. Furthermore, difficulties with recruiting specialists to outlying areas results in long waiting lists for both refugees/migrants but also indigenous population. 4 telepsychiatry sites have been established in period since July 2004. 45 participants have been involved in the project until January 2007. All participants reported a high level of acceptance and satisfaction with telepsychiatry.

**Keywords:** telepsychiatry, mother tongue, refugees/migrants.

### **Introduction**

"Telepsychiatry" refers to the use of telecommunication technologies with the aim of providing psychiatric services from a distance [1]. Several studies demonstrated high reliability- and patient's acceptance of telepsychiatry [2,3,4,5,6,7]. It is no secret that mental health system in Denmark did face (and still does) significant barriers in providing appropriate psychiatric care towards refugees/migrants on their own language. Psychiatric treatment of refugees/migrants in Denmark is concentrated to several centers around the country where the treatment provides mostly via translators. There are only few "ethnic psychiatrists" in a country where 8,2 % of population consists of refugees/migrants [8]. Limited access to clinicians that speak their language and have similar cultural and ethnic background can have an influence on speed and accuracy of diagnosis and treatment. Furthermore, shortage of resources especially in outlying areas affects access to mental health for Danish patient population as well. One solution to these problems is to increase access to psychiatric expertise by using telepsychiatry (videoconference in real time). Psychiatric Centre Little Prince in Copenhagen employs clinicians that aside from Danish speak their patients' respective languages (see [www.denlilleprins.org](http://www.denlilleprins.org)). This paper describes recent telepsychiatry project started in the summer 2004. **The key aim** of the project is to provide

psychiatric service on patients' mother tongue. The project period is 3 years (July 2004- July 2007).

### **Materials and methods**

The main part of the work in this project is providing diagnostic assessment with subsequent treatment suggestions. In some cases continuously psychotherapeutically treatment via telepsychiatry supported by relevant medication was established.

Participants involved in the project are mentally ill refugees/migrants. Only one Danish patient has been involved in the project so far. Furthermore, staff involved in patient contact contributed in coordination of professional efforts within the project. Total number of participants involved in the survey until January 2007. was 45 (14 women and 31 men). Mean age for males were 41,6 years and 46,4 years for females. Countries of participants' origin are: Ex-Yugoslavia, Iraq, Somalia, Lebanon, Syria, Poland, Iran, Morocco and Denmark.

Duration of participants' education was as followed: 0-4 years (18%); 5-8 years (27 %); 9-12 years (39 %) and over 12 years (16 %). Most of participants (82%) did not have any contact to mental health system before arrival to Denmark. 61% of participants were in contact either with psychiatrist and/or psychologist in Denmark before being involved in the project. The mean number of sessions (by 45-60 min) completed for all 45 subjects was six. Five participants had at least one face-to face contact. The rest of the sample received only remote service. All participants in the project received written information about telepsychiatry. They all undersigned consent before or after the first telepsychiatry session. They were asked to complete the 10-items questionnaire after end of the telepsychiatry-contact in order to determine satisfactory level, advantages and disadvantages by using telepsychiatry (Table I). There were 5 possible ways to answer: "Yes, in high degree", "Yes, in some degree", "No, only in less degree", "Not at all" and "Don't know". The last two questions needed descriptive answers.

### **Technical set-up**

The videoconferencing system links Psychiatric Centre Little Prince in Copenhagen with 4 sites around the country (two Psychiatric departments; one activity centre and one asylum-seeker centre). These 4 sites are aprox. 150-200 km away from Copenhagen. Videoconferencing is via broadband sHDSL by 2Mb/s, using Polycom VX7000 equipment.

Table 1 Questionnaire

- |     |  |
|-----|--|
| 1.  | Did you get enough information about telepsychiatry?                                     |
| 2.  | Do you perceive "contact via TV" as uncomfortable?                                       |
| 3.  | Did you feel safe under telepsychiatry contact?  |
| 4.  | Have you been satisfied with sound quality?  |
| 5.  | Have you been satisfied with picture quality?  |
| 6.  | Did you achieve your goal via telepsychiatry/could you express everything you wanted to? |
| 7.  | Would you recommend telepsychiatry to others?  |
| 8.  | Would you prefer contact via translator in future?                                       |
| 9.  | What were you most satisfied with during the telepsychiatry contact?                     |
| 10. | What were you most unsatisfied with during the telepsychiatry contact?                   |

**Results**

Diagnostic assessments disclosed wide range of psychiatric disturbances (Fig.1). Participants reported a high level of acceptance and overall satisfaction with telepsychiatry regardless their ethnicity, educational level or previous experiences within mental health system (Fig. 2). There were no difference in satisfaction rates between patients that received subsequent

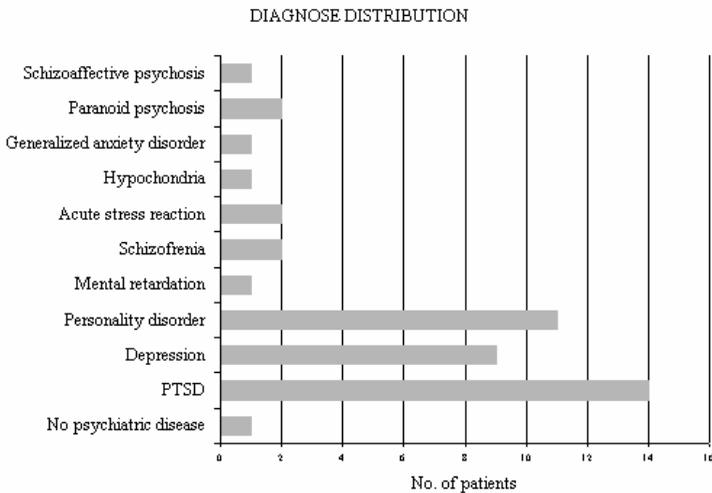


Fig. 1

face-to-face consultations and the rest of the sample. Participants

appreciated possibility to express their intimately emotional and existential problems on their mother tongue. Furthermore, they mentioned reduced need for travel. The most of participants reported willingness to use telepsychiatry again as well as they would prefer help by telepsychiatry on own language rather than face- to-face contact with the doctor via translator (Fig.3).

**Discussion**

The project presented both assessment and treatment via telepsychiatry. Key predictor of satisfaction with telepsychiatry in this survey was possibility to communicate on mother tongue. Participants` willingness to receive psychiatric service on

mother tongue via telepsychiatry rather than usual contact via translator can be understood as a natural need of confidential relation with the therapist and/or consequence of possible bad experiences with translators. According to our results, there are no difference in satisfaction level between participants who got subsequent face-to-face consultations and those who didn't. Of course, it is good idea to introduce the patient under face-to-face contact and possibly diminish eventual reluctance against new and unknown technology.

Our results also indicate that participants` ethnicity, educational level and degree of illness had no influence in order to choose telepsychiatry versus psychiatric help provided via translator. This is in discrepancy with an earlier published survey, which indicates that individuals with better

DID YOU ACHIEVE YOUR GOAL / COULD YOU EXPRESS EVERYTHING YOU WANTED TO ?

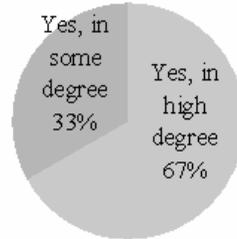


Fig. 2

WOULD YOU PREFER CONTACT VIA TRANSLATOR IN FUTURE ?

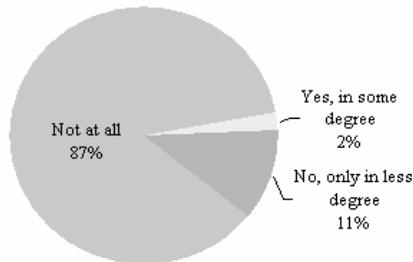


Fig. 3

physical health and higher adaptive coping scores tended to be more willing to participate in telepsychiatry [9]. Only one Danish participant has been involved in the project. The participant expressed high level of satisfaction with the method because of no need for transportation and no waiting time. This participant lives in outlying area where shortage of resources results in long waiting lists.

### **Conclusion**

Telepsychiatry, as suggested by large number of original surveys through last four decades, is a growing field with the potential to deliver high quality; much needed assistance in a variety of settings to persons in need of mental health services [10]. In a field such as assessment and treatment of refugees/migrants, often torture survivors, who are significantly underserved on their mother tongue, telepsychiatry enables access to appropriate speciality service. Used as a supplement to existing mental health system, telepsychiatry brings professional psychiatric expertise to outlying areas with resource shortage. Consequently, it is able to serve not only refugees/migrants but also wide range of Danish patient population.

### **Acknowledgement**

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### **References**

- [1] Brown FW.(1998).Rural telepsychiatry. *Psychiatr Serv*; 49:963-964.
- [2] Hawker F, Kavanagh S, Yellowlees P, Kalucy RS. (1998).Telepsychiatry in South Australia. *J Telemed Telecare*; 4:187-194.
- [3] Baigent MF, Lloyd CJ, Kavanagh SJ, et al.(1997) Telepsychiatry: 'tele' yes, but what about the 'psychiatry'? *J Telemed Telecare* ; 3(Suppl 1):12-14.
- [4] Simpson J, Doze S, Urness D, Hailey D, Jacobs P.(2001).Telepsychiatry as a routine service -the perspective of the patient. *J Telemed Telecare*; 7: 155-60.
- [5] Kopel H, Nunn K, Dossetor D.(2001). Evaluating satisfaction with a child and adolescent psychological telemedicine outreach service. *Journal of Telemedicine and Telecare* 7 (suppl 2):35-40.
- [6] Bose U, McLaren P, Riley A, et al.(2001). The use of telepsychiatry in the brief counseling of non-psychotic patients from an inner-London general practice. *Journal of Telemedicine and Telecare* 7(suppl. 1):8-10.
- [7] Bishop JE, O'Reilly RL, Maddox K, et al.(2002). Client satisfaction in a feasibility study comparing face-to-face interviews with telepsychiatry. *Journal of Telemedicine and Telecare* 8:217-221.
- [8] Udlaendingestyrelsen (2004). Nøgletal på udlaendingeområdet.
- [9] Rohland B.M., Saleh S.S., Rohrer J.E. and Romitti, P. A. (2000). Acceptability of Telepsychiatry to a Rural Population. *Psychiatr Serv* 51:672-674.
- [10] Monnier J.,Knapp R.G. and Frueh B.C. (2003).Recent Advances in Telepsychiatry: An Updated Review. *Psychiatr Serv* 54:1604-1609.

**INTERNATIONAL TELEMEDICINE AND  
EHEALTH INITIATIVES AND  
DEVELOPMENTS**

# **A NEED FOR INTERNATIONAL ETHICAL AND MEDICO-LEGAL GUIDELINES FOR TELEMEDICINE IN AFRICA**

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***Abstract:* Telemedicine offers a means of overcoming the shortage of doctors in Africa. For international telemedicine services to be effective and assist Africa, ethical and medico-legal issues relating to international practice of telemedicine need to be resolved, as do issues of standards.**

## **Introduction**

The recent WHO World Health Report summarises the inequity of health provision in Africa; “the African Region has 24% of the burden but only 3% of health workers commanding less than 1% of world health expenditure. The exodus of skilled professionals in the midst of so much unmet health need places Africa at the epicentre of the global health workforce crisis.”[1]. In addition, the United Nations Population Division, predicts that the population of Africa will double, to 1.94 billion people, by 2050 [2]. This will place further pressure on healthcare resources. It is not surprising that the World Health Assembly and the WHO proposed telemedicine as a potential solution to the shortage of healthcare professionals in developing countries and more specifically in their rural areas [3]. As a result, many African countries have now included telemedicine as a means of achieving their Millennium Goals

The use of telemedicine to improve the access of rural patients to sparse specialist skills within a country does, however, add to the workload of already overworked doctors. For telemedicine to actually improve Africa’s access to healthcare professionals there must be access to an international pool of doctors. This raises the vexed legal and ethical issues of international practice of medicine, and telemedicine?

The WHO resolution of 2005 alludes to ethical matters by acknowledging the need to respect the principle of equality and differences in, culture, education, language, physical and mental ability and geographic location [3]. It does not, however, address specific ethical questions related to telemedicine, nor does it address the question of vulnerability of people in

disadvantaged countries [4]. Is there a possible need for different ethical and clinical guidelines and standards for telemedicine in developing countries? One argument revolves around the concept of an appropriate standard of care. Should a patient in a developing country be deprived of a telemedicine consultation with a specialist because the equipment and techniques used may not meet the stringent standards set in the developed world, where the standards are influenced by fear of litigation? Is there a need to develop alternative standards, which serve as guidelines for those who are not able to meet the developed world standards? Is some service better than no service and could a service that does not meet developed world standards constitute an appropriate standard of care in the developing world?

There is a paucity of existing ethical and clinical guidelines. Extensive review of several databases and Google Scholar identified 21 telemedicine guidelines. Only four countries and one international association have developed ethical guidelines for the practice of telemedicine in their countries. Common ethical issues identified include; the doctor – patient relationship, informed consent, confidentiality, data security, adequacy of records, data standards and quality, clinical competence, licensure and medical responsibility.

### **Ethical Issues**

The use of telemedicine challenges the traditional perception of the patient - physician relationship [5]. Not only is the patient no longer involved in a face to face consultation in the same room as the physician, but the management of their problem may be directed by someone with whom they may never communicate. This in turn raises issues of informed consent, confidentiality, data security and medical responsibility.

Should a patient be required to provide informed consent to participate in a telemedicine consultation? Opinions differ. Some say that informed consent is not required as there is implied or tacit consent to participate in a consultation [6]. Others submit that implied consent should not be extended to telemedicine and contend that written informed consent should be a prerequisite, as telemedicine is not yet a routine service [6].

What constitutes truly informed consent? For consent to be valid, it has to be based on substantial knowledge of the act consented to by the patient, with the patient having the right to withhold consent [7] Obtaining informed consent becomes more difficult when the patient has had limited exposure to, and knowledge of, information communication technology (ICT). There is an obligation to explain that the consultation will not be with a physician in the same room, but that sophisticated ICTs will be used, and a requirement to explain how the patient's data will remain secure and how

confidentiality will be maintained. This is a difficult task, even for a computer and technology literate doctor dealing with a computer literate patient. For the computer illiterate or semi-literate it poses a challenge which may be exacerbated by language differences [8].

Consent has always been intrinsically linked with the issue of confidentiality, which in the electronic environment can be compromised. The World Medical Association has recommended the following; "Because of the risks of information leakage inherent to some types of electronic communication, the physician has an active obligation to ensure that all established standards of security measures have been followed to protect the patient's confidentiality." [9]. Is this a reasonable expectation in a rural setting in a developing country, where all that may be available for a doctor to perform a telemedicine consultation with a specialist is a telephone and modem, with an e-mail link, using a commercial service provider? When does the patient's right to health supersede their right to privacy? In this less than ideal situation, can e-mail encryption available in commercial communication software be considered to be sufficient security? What level of security is required on the hard drives of computers of doctors who participate in store and forward e-mail based telemedicine?

Allied to this is the responsibility of maintaining adequate records. There is a degree of consensus that both the referring health practitioner and the person consulted should keep adequate records of all aspects of the case and the findings and recommendations of a telemedicine consultation [10]. The matter of responsibility for the prescription of drugs requires further consideration as does the issue of electronic signature.

Does telemedicine allow for the same standard of care that exists in a traditional consultation [11]? The test for the standard of care expected of medical practitioners is: how would a reasonably competent practitioner in that branch of medicine have acted in a similar situation [12]? Telemedicine may enhance that standard of care by providing access to specialized care in the resource poor setting. The assumption is made that the data transmitted for a telemedicine consultation is of an appropriate quality, quantity and relevance for a medical opinion or decision to be made. There is also the obligation to ensure that the technology used for telemedicine is reliable, of sufficient quality, is correctly calibrated and will not fail and or compromise the patient [13]. Vagaries in power supply and telephone communication links in rural areas make reliability and equipment failure, issues that need specific consideration when producing guidelines for developing countries.

There is also the expectation that the practitioner offering a telemedicine opinion is competent in the field and will be available for additional follow-

up consultation if required [14]. Several web-based international consultation services exist, with little obligation to offer follow-up and no certainty that the advice given comes from a practitioner well versed in the field within the context of the developing world.

### Conclusion

For Africa to derive the expected benefits of telemedicine, the questions raised need to be addressed internationally and resolved in a pragmatic way, as a matter of urgency.

### References

- [1] World Health Organization. "World Health Report 2006. Working Together for Health," World Health Organization, xviii-xix, 2006.
- [2] United Nations Development Program. "Human Development Report 2005. International Cooperation at a Crossroads: Aid, Trade and Security in an Unequal World," United Nations Development Program, pp. 236-239, 2005.
- [3] Committee A. "World Health Assembly EHealth Resolution (WHA 58/28)," vol. A58/62, pp. 4-6, 2005.
- [4] S. Edworthy. "Telemedicine in Developing Countries," *Br Med J*, vol. 8, pp. 557-560, 2001
- [5] B. Stanberry. "Legal Ethical and Risk Issues in Telemedicine," *Comput Methods Programs Biomed*, vol. 64, pp. 225-233, 2001.
- [6] "National Initiative for Telehealth Framework of Guidelines," (NIFTE), 2003. [www.cstsc.org/resources/frameworkofGuidelines2003eng.pdf](http://www.cstsc.org/resources/frameworkofGuidelines2003eng.pdf)
- [7] B. Stanberry. "The Legal and Ethical Aspects of Telemedicine. 3: Telemedicine and Malpractice," *J Telemed Telecare*, vol. 4, pp. 72-79, 1998.
- [8] A.A. Stulting. "Ethics in South Africa: New Challenges," *Med Law*, vol. 19, pp. 397-401, 2000.
- [9] "WMA Statement on Accountability, Responsibilities and Ethical Practice of Telemedicine," World Medical Assembly, 1999 [www.wma.net/e/press/1999\\_5.htm](http://www.wma.net/e/press/1999_5.htm)
- [10] R.J. Rodrigues. "Ethical and Legal Issues in Interactive Health Communications: a Call for International Cooperation," *J Med Internet Res*, vol. 2, pp. 8-10, 2000.
- [11] K. Bottles. "The Information Revolution: Opportunities and Pitfalls for Patients and Providers," *Physician Exec*, vol. 26, pp. 20-27, 2000.
- [12] Dada M, and D. McQuoid-Mason. Eds. *Introduction to Medico-legal Practice*. Durban: Butterworth, pp. 1-27, 2001.
- [13] J. Car, and A. Sheikh. "Email Consultations in Health Care: 2--Acceptability and Safe Application," *BMJ*, vol. 329, pp. 439-442, 2004.
- [14] R.D. Silverman. "Current Legal and Ethical Concerns in Telemedicine and E-Medicine," *J Telemed Telecare*, vol. 9 Suppl 1, pp. 67-69, 2003.

# APPLICATIONS OF INFORMATION TECHNOLOGIES FOR RESEARCH IN CLINICAL OPHTHALMOLOGY

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Lithuania is implementing the eHealth strategy by the pilot national projects creating the common structure and R&D components of the integrated national eHealth system [2].

Combination of information technologies and signal processing techniques into Web based services for health system can help with better diagnosis and even acquire new clinical knowledge. Web based tools give more flexibility for developers and for medical practitioners: compatibility for different computer platforms, better service and response to needs, better access using available internet connection. Web based tools can be used in effective way combining them with signal and data processing tools such as Matlab (*the Mathworks, Inc*). This synthesis can give a flexible result, especially in system development phase.

Ophthalmoscopic evaluation of eye fundus changes still remains one of the main diagnostic methods in ophthalmology. Photography of the eye fundus helps in documentation and follows up of the development of the eye diseases. Tools and services for eye fundus image analysis have been developed. Evaluation of the eye fundus images is complicated because of variety of anatomical structures and possible changes in case of eye diseases and requires a proper experience from the expert. One of the ways in which modern information technologies can help is the eye fundus processing with parameterization of the main anatomical structures.

In this research ophthalmologic data acquired from eye fundus images, digitalized and analyzed visually by integrated combination of the self organizing neural network (SOM) [5] with the Sammon's – type multidimensional scaling.

The main targets of applications of information technologies for research in clinical ophthalmology are images (optical and ultrasound data) and

signals (ultrasound data) - the most informative sources for differential diagnosis [1, 3 - 4].

The main activities:

- Registration and parametrization of diagnostic signals and images, selection of most informative parameters, creation of databases and interfaces;
- Data mining in data bases and clinical decision support using learning algorithms, remote access to services and expertise of physicians.
- Development of prognostic, diagnostic and treatment recommendations using the knowledge portals created.

### **Materials and Methods**

Eye fundus images of 19 healthy (22-23 years old) voluntaries, and 138 patients with glaucoma and myopia.

Automatic and interactive image processing algorithms developed for analysis of digital images of the eye fundus. Framework of the eye fundus image analysis consists of:

- Estimation of the eye fundus image quality;
- Localization of the main landmarks in the eye fundus;
- Segmentation of the optic nerve head and vessels;
- Calculation of quantitative parameters of segmented objects

Analysis and parametrization of image was done by combining both automatic and interactive tools. The correlation matrix of 27 parameters was calculated. 27-dimensional vectors obtained: one vector corresponds to one parameter. These vectors visualized and decisions made on a basis of the visualization results.

The integrated combination of SOM and Sammons mapping [6] is used. It is quite a common tool for the multi-dimensional data visualization.

### **Results**

Methods and software for eye fundus images parametrization – including automatic recognition of optical nerve region, automatic outlining of this region and calculation of geometric parameters of the optical nerve, excavation and retinal vessels created. The set of parameters reflecting the diagnostically important eye fundus features calculated. The method of excluding of the network of blood vessels from fundus image was developed enabling to improve diagnosis of retinal damages. Calculation of the normal parameters and determination of normal relationship between the main structures in emmetropic eye fundus performed. Complete

framework for eye fundus image processing was implemented in eHealth diagnostic system using Web technologies, Web server, PHP, Java applets and Com objects compiles from Matlab image processing scripts.

The distribution of parameters on the Som table and on the plane (Sammon mapping) indicates that the parameters form some clusters: parameters of excavation, optic nerve disk and excavation ellipse eccentricity form separate cluster. Here were also some subclusters. The results can not serve directly for assistance in clinical decisions. However it will be used in developing a computerized tool for eye disease diagnosis.

### **References**

- [1] Paunksnis A. et al. Teleophthalmology in Lithuania: chapter 22, Teleophthalmology. Ed: Kanagasigam Yogesan et al. Berlin: Springer, 167-177. 2006.
- [2] Lithuanian eHealth strategy 2005-2010. <http://www.sam.lt>
- [3] Paunksnis A. et al. Information technologies for human health – clinical decision support project. eHealth and Telemedicine. Proceedings of the 6<sup>th</sup> Nordic Conference, 63-64. 2006
- [4] Kurapkiene S. et al. Ultrasonic diagnostic applications for ophthalmological eHealth subsystem. eHealth and Telemedicine. Proceedings of the 6<sup>th</sup> Nordic Conference, 217-218. 2006
- [5] Kohonen T. Self-organizing Maps, 3<sup>rd</sup> ed. Springer series in Information Sciences, 30. Springer-verlag. 2001.
- [6] Dzemyda G. et. al. Heuristic approach for minimizing the projection error in the integrated mapping. European Journal of Operational Research, 171: 859-878. 2006

# **E-HEALTH IN POLISH LOCAL HOSPITALS: PRESENT STATE, REQUIREMENTS AND POSSIBILITIES**

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**Abstract:** Application of e-Health, which ensures effective communication among health care units with different diagnostic equipment and referential level, enables a significant improvement in the quality of medical service. The aim of the study was to evaluate present state, requirements and possibilities of further development of e-Health in Polish local hospitals. 346 local hospitals were invited to take part in the main study. Detailed data from 96 (27.7%) local hospitals were obtained and subsequently analyzed. It may be assumed that e-Health in Poland is limited mostly by the technical (number of available devices with digital output), economic and infrastructural reasons. However, the majority of hospitals declare will to enhance consultation effectiveness as well as the quality of their digital resources.

## **Introduction**

The hospital service in Poland is in practice categorized by the reference level. The first level hospitals, providing the least specialized care, are established by county self-government. The second level units are mostly founded by voivodship self-government. Finally the third, mostly clinical, university or ministerial hospitals provide highly specialized medical care. Therefore, the quality of medical service at local hospitals can be significantly improved by application of e-Health, which ensures effective communication among health care units with different diagnostic equipment and referential level.

## **Material and methods**

The selection of evaluated hospitals was made on a basis of data derived from the national register of health care units. Hospitals established by county self-government, city counties, voivodship, and companies were initially involved. Subsequently hospices, nursing homes, health-resorts and sanatoria, detoxification centers, out-patient clinics, chronic medical care

homes, rehabilitation centers, psychiatric hospitals, and certain types of specialist hospitals (i.e. mother and child care, infectious diseases, tuberculosis and lung diseases) were excluded. Selection was performed according to the hospital name, number of beds (over 30) and prevailing character of health activity. Such analysis allowed limiting our interest to 346 county self-government hospitals, candidates for investigation, providing in-patient service for the inhabitants of towns and villages.

The main study was preceded by a pilot performed in 97.0% of Mazovia District local hospitals in cooperation with Marshal Voivodship Office, which allowed certain methodological adjustments. Afterwards, a questionnaire designed to collect detailed data on information and telemedical resources, e-Health development plans etc., has been sent to the founding bodies of the hospitals and directly to the hospitals via ZOZMAIL (healthcare institutions mailing system) in order to maximize the response rate. Data from 96 (27.7%) hospitals were obtained, with the response rate ranging from 55.6% (Malopolskie Voivodship) to 5.6% (Zachodniopomorskie Voivodship). Ward allocation in the investigated group (96) and in the candidates group (346) according to specialization is presented in Fig.1. Therefore, it may be assumed that the following wards are located in a typical county hospital: internal medicine, surgery, obstetrics and gynecology, pediatric, and other non-operative specializations. The departments of ophthalmology, urology and psychiatry proved to be the least common.

Emergency Department was present in approximately 43% of hospitals from the candidates group and in 59% from the investigated group. The allocation of imaging diagnostic equipment in the candidates group (97%) and in investigated group (98%) proved to be similar. Such observations were also made for USG (42% and 39%, respectively), CT (14% and 13%), endoscopic laboratories (60% and 64%). As a consequence the assumption that the investigated group is representative seems to be justified.

## **Results**

Initial analysis shows that the mean number of computer terminals amounts to 74 per hospital, ranging from 6 to 219. Access to the Internet is available in all questioned hospitals. Bandwidth of <512 KB/s was reported in 7% and >1 MB/s in 40% of cases. Although the great majority owns websites containing general information, on-line services for patients were reported only by 2.0% of respondents. Computer network in the administration was reported by approximately 95% of hospitals, while network in wards and diagnostic laboratories respectively by 78% and 67%. Plans for creating or enhancing the network were reported in 77% of cases.

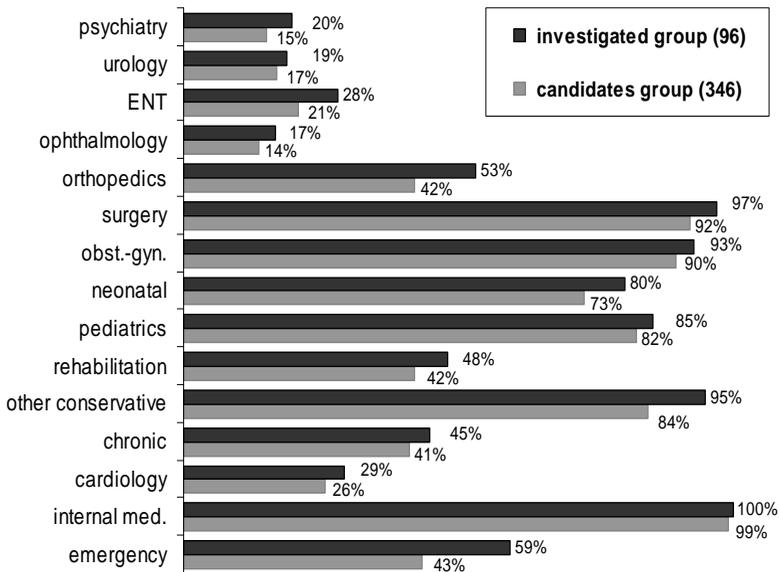


Fig. 1 Ward allocation in the hospitals – candidates group and investigated group

Diagnostic equipment with digital output (DICOM standard compatible) was reported by 26.0% of the hospitals regarding CT, 14.6% - x-ray, 26.0% - USG, 13% - endoscopy, and 8% - electrophysiology. The majority intends to purchase such equipment. There were 22 ambulances capable of data transfer, operated by 17% of questioned hospitals. Specialist consultations were conducted in great majority by traditional means (including phone and mail). However, the need for improvement of effectiveness in this matter was reported by 65% of respondents (Fig. 2). Plans for introduction of electronic teleconsultations were made by 30% of hospitals. The most frequently mentioned barriers for e-Health development were: lack of DICOM compatible equipment (88.0%), economic reasons (83.0%), problems with data transmission (47.0%), and data security (30.0%).

### Conclusions

It might be assumed that e-Health in Poland is limited mostly by the technical (number of available devices with digital output), economic and infrastructural reasons. The need for application of telemedicine solutions is reported by the majority of questioned hospitals as well as a will to enhance

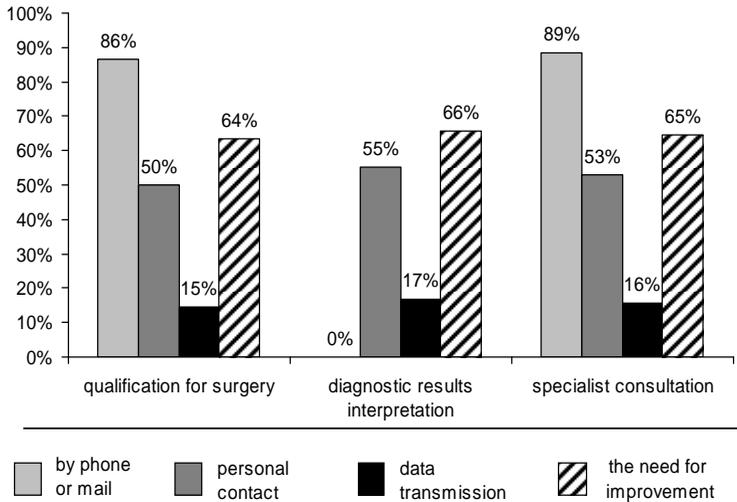


Fig. 2. Consultations of local hospitals with other health care units

consultation effectiveness and the quality of digital resources. Further analysis extended with statistical data from the State Statistical System in order to finally evaluate actual demand for e-Health services in Poland need to be performed.

## EPATHOLOGY – VIRTUAL PATHOLOGY CENTER IN GEORGIA

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**Abstract:** The main goal of “ePathology – Virtual Pathology Center in Georgia” project is to develop a new model of application of information and communication technologies (ICT) to implement and promote second opinion consultations and education in the medical field of pathology (telepathology). The project proposes to create a unified, resilient and transparent infrastructure, available on demand, in order to expedite pathology consultations between rural pathology laboratories and specialized medical centers. Special emphasize will be placed on: (1) distribution on computational resources; (2) development of image processing algorithms; (3) combination of image data with patient’s medical data; (4) interoperability of databases of heterogeneous content for medical and research purposes. This model should assure a timely and secure access of medical data, as well as combine a wide variety of distributing resources, which should work under a single and unified environment.

### Introduction

The term globalization involves a complex series of economic, social, technological and political changes seen as increasing interdependence and interaction between people and companies in disparate locations. The phenomenon of globalization has already reached the medical field, most importantly in the areas of knowledge, diagnosis and therapy. The access of as many people as possible to these areas should be guaranteed by a technically efficient man-machine interacting system and by an effective organization of specialists around the world. An efficiently operational and organized exchange of medical information increases the quality of diagnosis and therapy, and assures the continuous education of the medical personnel.

The main task of a medical informatics system is to enable medical non-experts to gather exchange and discuss relevant data at any time with experts in any place on the world. A wise conception of such a structured dialogue for consultations and continuing medical education is based on a user-friendly, fast, simple, efficient and sustainable system for the exchange of medical information.

Countries with middle and low incomes are often affected by severe limitations in the practice of Pathology. The result of this inefficiency often translates in inappropriate treatment of patients due to inaccurate diagnosis. The rapidly expanding Information and Communication Technology (ICT) allows that day after day we are near to closing this gap.

### **Objectives**

Telemedicine and eHealth can be designated as a special form of ICT; as a method of delivering medical services by electronic means of communication, with the provider and the recipient of these services being at different places. Applied to the field of pathology (telepathology), telemedicine can help:

- To assure accurate anatomic-pathological diagnosis in rural regions, and
- To assure or increase the quality of an existing pathology services.

In the first situation telemedicine supports local doctors and healthcare workers by giving them the opportunity to consult specialists abroad, by offering interdisciplinary local or national boards of specialists (e.g. tumor boards, clinical pathological conferences), by allowing a simple and continuous access to the literature or to publications, and by presenting lectures and teaching courses using the same instruments offered for teleconsultations.

The general objectives of telemedicine are:

- To reduce direct costs to the healthcare sector and to the patients;
- To reduce indirect costs (loss of production);
- To enhance citizen's quality in the availability of specialized medical services (e.g. surgical pathology) in remote areas and by providing them the same or similar level of medical care as provided by conventional technology;
- To improve cooperation between specialized and primary care centers;
- To promote the proficiency of physicians and other healthcare personnel by means of teleconsultation, and continuing eTraining, eLearning and eMonitoring;
- To reduce waiting lists for specialized healthcare by providing consultations to remote health centers in the most usual procedures in a specialty (e.g. cytology and pathology);
- To improve and expedite consultations among different healthcare units in special cases (e.g. tumor boards and clinical pathological conferences);

- To increase delivery of primary and secondary health services to the patient's home and to increase access to healthcare information directly (e.g. virtual libraries and international publications).

The introduction of telemedicine applications often result in substantial changes in healthcare practices. Investments in telemedicine are usually accompanied by improvement in the quality of care and services, shorter turnaround times and more availability of information. As a consequence there are significant changes in health outcomes and patient satisfaction.

A continuous assessment is required to appreciate and respond to changes after the introduction of telemedicine in a healthcare system. A proper evaluation should include: assessment of advantages, disadvantages, costs (transaction and incremental costs), investment schedules, fluency and quality of communication, needs of and access to different services, changes in work processes, and the division of work evoked by the new "instrument". Since telemedicine can also influence the conventional decision making of clinicians, the legal and ethical consequences of telemedicine and eHealth should also be assessed.

Technological changes have specific implications for economic research in social welfare and health services. Organizational effectiveness is measured by the momentum of the service system, businesses, and research institutions in regional, national and international cooperative networks. Effects should be assessed on the bases of the functionality (changes in processes), fluency (saving time, speed of diagnosis, quality of diagnosis and treatment), and efficiency (cost-effectiveness) of the new technology.

Telemedicine applications may be difficult to evaluate, since study designs usually feasible for some operators may not achieve proper scientific standards. Randomization and double blinding may not be possible. However, controlled trials can be made in nearly all telemedicine applications. In the present project, a prospective assessment of every medical case and of the quality of teaching sequences is proposed.

### **Goals**

Efficient, effective and reliable systems for remote consultations and distance education are the top requirements for eHealth organizations, as in telepathology. However, solutions have so far proved elusive and the deployment of ICT in many health sectors has required major transformational changes. One of the major problems for a full potential delivery of telepathology is to provide the tools for the world-wide access of this critical eHealth service. Thus, it is necessary to make radical improvements in service productivity, access to medical services, and improved quality of diagnostic with acceptable levels of patient safety. A

well developed ICT could serve to breakdown many of the existing barriers to the access of eHealth in the world. The overall technological background of the present project, which centers on the creation of a unified, effective and resilient ePathology system, will serve to transcend the state of the art in eHealth and telepathology.

The “ePathology – Virtual Pathology Center in Georgia” project aims to provide a world-wide infrastructure for telepathology environments by using: teleconferencing and digital imaging. With this project the attempt to get remote access to patient record databases for improved clinical diagnosis will be done. The goals of the proposed project are:

- Creation of a unique, centralized Pathology Virtual Center (PVC) – this will avoid the duplication of efforts and will promote a more systematic and coordinated approach to pathology diagnosis, education and training.
- Collaboration with global partners – this goal extends the reach of pathology education and training efforts worldwide.
- Development and improvement in the access to pathology information and maintenance of pathology resources. This will be achieved by eLearning and Internet-based courses, which are likely to increase in significance and impact. They do not only require the development of suitable material geared to such delivery systems, but also demand that users have access to the necessary technology. This can present a barrier to agencies and organizations that are smaller in size or have limited financial means. The goal is to ensure that current resources remain available, that users can obtain them readily and that new resources are developed or improved to address gaps in information and audiences.

In the frames of present project application of the following tools is proposed:

- eClinic – telediagnosis, teleconsultation and telepathology activities;
- eLearning – telementoring, teleinstruction and teleeducation;
- eImaging – videoconferencing to support multidisciplinary (i.e. tumor boards) team meetings and diagnosis across distances.

The project envisages the deployment of ICT to enable: secure remote patient diagnosis, follow up and monitoring; enhanced and ready access to educational materials on pathology topics in the form of lectures, clinical cases and downloadable pathology slides; increase the understanding of cancer screenings in the non-medical community and for patients with

cancer by answering frequently asked questions and making available a community bulletin board.

The main goal of the proposed project has been to overcome the time and distance barriers that separate caregiver from the patient. Widespread adoption of the technology has been hampered by a number of technological, regulatory and other barriers. Innovations such as ICT-based patient records, remote consultations, hospital information systems, ICT-based decision support tools, community health information networks, and new ways of distributing health information to professionals and consumers are supported by, and in some cases reliant on, the widespread use of networked eHealth technologies. The proposed project will transcend the existing state-of-the-art in ICT by the creation of a system which supports both point-to-point and multi-point communication in a fully meshed topology and which will create a test bed to provide support for sophisticated authorization, workflow, security, error detection and recovery.

The present project is a new initiative, which will be based upon the existing experience of the members of this project and will be carried in the conditions of close collaboration. The aims are:

- To increase knowledge and proficiency in pathology education and training;
- To increase efficiency of traditional basic and continuous medical education in the field of pathology;
- To increase availability and accessibility of databases and computing tools.

### **Expected Results**

The implementation of the present project can effectively:

- Reduce medical errors;
- Help manage the knowledge and information in pathology, and support the decisions making process based on evidence based practice guidelines;
- Ensure better communication between healthcare providers and patient;
- Advance the goals of redesigning the healthcare system;
- Develop and improve eHealth technologies.

There are important issues that have led to medical errors, poor quality of care, and dissatisfaction among patients and healthcare providers. In this environment of technological advances, ICT has the potential for transformation of the education process and healthcare too. However, the

integration of more recent advances and visions with goals of the institutions, nations and more broadly of the world is the main challenge.

Overall methodology that will be used during the project implementation is dissemination of information, exchange of experience, education/training, demonstration and practical implementation of work. As a result of the present project we will gather and prepare all relevant information, disseminate materials, create web-pages, update web-page information, host project gathering, provide eHealth, Telepathology, eLearning service, virtual conferences, seminars and webinars (seminar in the web), etc.

# THE EVOLUTION OF TELEMEDICINE IN INDIA

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## Introduction

With every sixth individual on the planet living in India, the Indian healthcare industry is one of the biggest. [1] In the last six years, thanks to the relentless work done by several groups of committed champions of telemedicine including Apollo Hospitals, The Indian Space Research Organization (ISRO), SGPGI in Lucknow, SRMC in Chennai, AIMS in Kochi, and Narayana Hrudayalaya in Bangalore telemedicine in India has come of age. That the next conference of the International Society for eHealth and Telemedicine is to be held in Chennai in November 2007 speaks for itself. The three hundred and fifty, telemedicine units located in suburban and rural India, and the thirty-telemedicine units functioning in tertiary care hospitals, is just the beginning.

625 million Indians living in rural areas have access to less than 20% of the available doctors which itself is only 1:2000. India spends only 0.9 per cent of GDP on health, of which only 0.09 per cent reaches rural India. [2] However in the last decade there has been an unprecedented growth and development in Information and Communication Technology. The teledensity of India is now 22% with an expected almost four fold increase of mobile phones over land lines. Satellite transmission, fiber optic cables, increasing band width, fall in computer prices, licensing of private internet service providers, internet thro' cable etc have become the buzz words even in suburban and rural India. India no longer has to *follow* the advanced countries, they do not even have to *piggy back*, they can *leap frog* ! It is easier to set up an excellent telecommunication infrastructure, than to place thousands of unavailable medical specialists in suburban and rural India.[3] According to a recent Frost & Sullivan survey (January 2007) 12% of household expenditure in India is on health . 82% of expenditure on healthcare is directly borne by the people. In 2012, the annual expenditure on healthcare in India is expected to be about 208 billion Euros.

India has joined the band of nations who have recognized the potential of telemedicine. The National Task Force on Telemedicine, a Planning Commission working group on Telemedicine, The Telemedicine Society of India and a National Institute of Medical. Informatics and Telemedicine, a

possible Telehealth Act for India speak for themselves [4]. Apollo Telemedicine Networking Foundation and Anna University are now jointly conducting formal courses on Telehealth Technology. Aravind Eye Hospitals [5] and Sankara Nethralaya are doing yeoman service in Teleophthalmology using VSAT enabled fully equipped mobile vans. Pilot studies with hospitals on wheels with telemedicine facilities are being carried out. ISDN lines, broadband high speed Internet and VSAT's are used for connectivity. The Government of India is embarking on a major e-governance project with 110,000 multi- purpose Internet kiosks in villages. Plans are afoot to provide basic health care using these kiosks.

Tele education for medical personnel has taken off in a big way. The Ministry of Health, Govt of India, has initiated a major Pan India programme of Tele-medical education. Doctors all over India, having access to two-way audio-video lectures, interact with eminent professors. The Ministry of Information Technology has drawn up standards on telemedicine and these will eventually be implemented. Preliminary information is being gathered regarding the feasibility of launching a HEALTHSAT [6] – a satellite exclusively for providing health care. India will soon reach that critical mass essential for a successful take off in telemedicine. The future promises to be exciting.

Providing healthcare services via telemedicine can make specialty care available in rural and suburban areas, several pilot projects are now in place in various parts of India. In far flung areas of Uttaranchal,[7] where existing medical facilities are very poor, a joint effort of TIFAC (Technology Information, Forecasting & Assessment Council) and government of Uttaranchal focuses at providing healthcare facilities. A mobile hospital, equipped with diagnostic facilities is visiting different towns on different days. Remote consultation takes place through a VSAT on board the van.

### **Standards**

The effective delivery of telehealth services will require establishment of standards in clinical practice, privacy, confidentiality, telecommunications, record keeping and ethical behavior. Interoperability of systems, compatibility and scalability are an absolute must. All equipment should meet international DICOM standards. Privacy, authentication, authorization, certification digital signature standardization, equipment liability, digital compression and constant benchmarking is required. It is a matter of justifiable pride that methods to achieve uniformity and standardization in the delivery of Telemedicine have been initiated. A Technical Working Group was set up in the Department of Information Technology, Government of India in 2002 ([www.mit.gov.in/telemedicine/home](http://www.mit.gov.in/telemedicine/home))

involving experts from the fields of IT and health, practicing doctors & academicians. Enhancing interoperability amongst various Telemedicine systems was a primary objective. The Department of Telemedicine Apollo Specialty Hospitals was the first telemedicine unit in South Asia to obtain an ISO 9002 accreditation.

### **Why outreach through telemedicine?**

The health scenario in India reveals that 620 million live in rural India. The bed population ratio is 1:1033 (2001) vs. ideal of 1:500. Two million beds are required against 0.8 million now available. To achieve this target, at least 700 hospitals of 250 beds each, are needed annually with a recurring expenditure of 6 billion Euros per year. 80% of specialists in India live in metros and urban areas catering to only 20% of the population [8]. They are unwilling to relocate to sub-urban or rural areas. Telemedicine in conjunction with insurance, serving as an outreach to reach the masses is therefore the only solution.

### **Mobile telemedicine – a reality in India [9]**

There are about fifteen active mobile telemedicine units in India today that go to different villages every day. A villager gets into an air-conditioned mobile truck with ultrasound, X-ray, echocardiogram, ECG, biochemistry laboratory, ophthalmic equipment etc. A paramedical technician focuses the ophthalmoscope into the eyes of the patient, and a tele ophthalmologist in a tertiary care center evaluates the fundus. A VSAT on the truck transmits the images through satellite technology. Though many of the existing vans are dedicated to ophthalmology, multi purpose vans are also available now. Emergency technicians in ambulances will in the future, use digital cameras and cellular telephones to transmit pictures of accident scenes to the local emergency departments. Real-time monitoring of patients in ambulances will reduce the time to initiate treatment and allows the emergency crew to be better prepared. Pre hospital management will eventually be of the highest standard.

Telemedicine can bridge the gap only when tele diagnosis is followed up by appropriate referrals for investigations and subsequent management. To achieve this, universal insurance is an absolute necessity. Through telemedicine, patients can ensure that the care they get is the care they want [10] Empowered patients will embrace location independent care, imposing global standards. Issues in implementing telemedicine include acceptance of this modality by society, patients, family physicians, specialists, administrators and the government: designing cost effective appropriate technology, connectivity, hardware and software, standardizing, certifying,

authenticating and registering telemedicine units so that minimum safe standards are uniformly adopted : running short term courses to train the trainers and the users, passing a Telehealth act for India, payment to teleconsultants to make the scheme attractive and viable: getting grants, subsidies and waivers to introduce telemedicine in suburban and rural areas, getting Indian telemedicine units recognized by other countries so that we can provide overseas teleconsults for revenue generation which can be used to subsidize rural telemedicine; and introducing telemedicine in the medical/IT curriculum.

### **The Indian Space Research Organization's Telemedicine initiatives [11]**

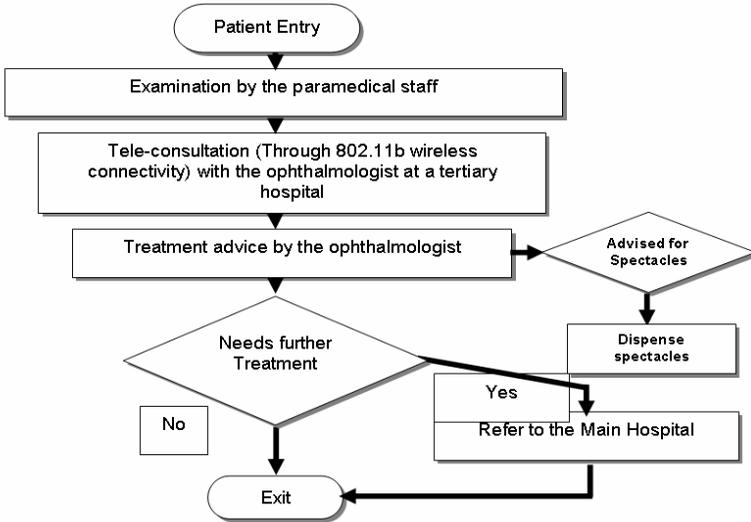
They include providing telemedicine technology and connectivity between remote/rural hospitals and super specialty hospitals for teleconsultation, treatment and training of doctors and paramedics; providing connectivity for Continuing Medical Education (CME) between medical colleges and post graduate medical institutions and hospitals : providing connectivity for Mobile Telemedicine units for rural health camps especially in the areas of ophthalmology and community health and providing connectivity for Disaster Management Support and Relief. The healthcare data has also been standardized through use of DICOM and HL7 standards. Shortly ISRO's Telemedicine Network will be reaching the mark of 200 Hospitals – 165 Remote/Rural/District Hospital/Health Centre connected to 35 Super Speciality Hospitals located in the major cities including 5 to 8 Mobile Telemedicine units for tele-ophthalmology and community health. More than 1,50,000 patients have been provided with Teleconsultation & treatment in the network so far.

### **Formation of National Task Force (NTF)**

A National Task Force has been constituted by the Ministry of Health Government of India to work out various aspects of implementing Telemedicine in the country's Healthcare system. This includes a draft national policy on "Telemedicine and Tele medical education" and preparing a central scheme for the 11th Five Year Plan. A National Telemedicine Grid (NTG) for a nation wide connectivity and an e-health web portal as a national repository of health/medical information generally not available in the Internet is also envisaged. The proposed Constituents of the National Telemedicine Grid are connectivity for Telemedicine, Medical Education and Medical Training and (b) Health care information service for the administrators/decision makers.

### Academic Telemedicine

SGPGIMS a tertiary level national medical institute in Lucknow has been



*Fig. 1 Flow chart showing - Tele-ophthalmology in Mobile Van.*

*Ref: Kim CSI, 30: 11, 13-16 2007*

involved in tele-education, pre-referral screening, tele conferencing, tele-surgical conferences and workshops, tele follow up and telementoring [12] since 1999. **Teleophthalmology**: Blindness is a major public health problem in India [13]. During the last three years Aravind Eye Hospital and Sankara Nethralaya have been doing yeoman service in the state of Tamil Nadu using VSAT enabled Teleophthalmology vans. 120,000 patients have been screened and provided treatment in the vans, which go to different villages. 18,000 patients have been referred to the parent tertiary hospital for world-class, state of the art, free treatment. The algorithm used by Aravind Eye Hospital is shown below.

### India's role in Global Telemedicine

The Government of India has embarked on a mega project which would eventually provide eight hours of real time teleconsultation to 53 countries of the African Union. 12 super-specialty hospitals in India have been identified to offer this service. In addition formal educational programmes covering all aspects of health care including medical and surgical

disciplines will be beamed from these centers to Africa. The Ministry of External Affairs Government of India has also taken the initiative to provide telemedicine to the neighbouring SAARC countries. The working group constituted for this purpose is in the process of working out the modus operandi.

### **Acknowledgments**

We are thankful to the founder chairman Dr. Prathap Reddy, Mrs. Preetha Reddy Managing Director and Mrs. Sangita Reddy Executive Director of the Apollo group for providing the encouragement and the necessary infrastructure, which enabled the kick starting of telemedicine in India

### **References**

- [1] Ganapathy K. Guest Editorial. Computer Society India Communications. Vol 30: p4, February 2007.
- [2] Ganapathy K. Telehealth: Yesterday, Today and Tomorrow. Computer Society India Communications. Vol 30: 5-12, February 2007.
- [3] Ganapathy K - Telemedicine in India. *Asia Pacific Biotech News*. Vol 10, No 19, 15 October 2006.
- [4] Ganapathy K - Telemedicine: Express Health Care Management Vol6, No 3, 16-28 February 2005.
- [5] R. Kim. Creating Affordable, Accessible Eye Care Services through Tele-Ophthalmology. Computer Society India Communications. Vol 30: 13- 16, February 2007.
- [6] Ganapathy K - Telemedicine in the Indian context. An overview p 178 – 181 in “Establishing telemedicine in developing countries: from inception to implementation. Editor Rifat Latifi. Studies in health technology and Informatics. Vol 104. IOS Press, 2004.
- [7] Durgesh Pant, Mahesh Sharma. “Doctors are getting wired in novel ways to benefit Uttaranchal Citizen using Telemedicine Services”. Computer Society India Communications. Vol 30: 40-42, February 2007.
- [8] Ganapathy K – Medical Informatics around the world Universal Publishers: Barnes & Noble. Editor A. Steele, Chapter on India 2002.
- [9] Ganapathy K.. Articles on telemedicine: Express Health Care Management Vol6, No 3, 16-28 February 2005.
- [10] Ganapathy K.- Health technology as a fulcrum of development for the nation- The road ahead. 171-173. National Institute Communication & Information Resources. Selected Proceedings the 89th Indian Science Congress. ISBN: 81-7236-232-3 New Delhi 2005.
- [11] Satyamurthy LS, Murthy RLN, ISRO’s Telemedicine Program- an innovative application for delivering Healthcare to the Rural Population. Computer Society India Communications. Vol 30: 31-32, February 2007.
- [12] Pradeep PV, Mishra SK, Vaidyanathan S, Nair CG, Ramalingam K, Basnet R (2006). Telementoring in endocrine surgery: preliminary Indian experience. *Telemed J E Health* 12(1), 73-77.
- [13] Nirmalan PK, Katz J, Robin AL, et al., Utilization of eye care services in rural South India: the Aravind Comprehensive Eye Survey, *Br J Ophthalmol*. 2004; 88:1237-1241.

**HOMECARE APPLICATIONS: MAINTAINING  
QUALITY OF LIFE FOR ELDERLY,  
DISABLED AND PEOPLE WITH SPECIAL  
NEEDS (BUSINESS MODELS, EXPERIENCES,  
AND SOLUTIONS)**

# AMBIENT ASSISTED LIVING: PREPARATION OF A NEW EUROPEAN FUNDING PROGRAMME

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**Abstract:** Since September 2004, a group of representatives of European countries is preparing a new European funding programme called “Ambient Assisted Living”. This new funding programme will be based on the funding instrument “article 169” as offered in the context of the 7th European Framework Programme for Research and Technological Development.

The demographic change provokes a new society. A decreasing number of young people are confronted with an increasing number of older workers, retirees and very elderly people. Not only new forms of solidarity between the generations have to be developed but behaviors and attitudes have to be changed as well. Ageing in Europe has not only an effect on society but also enormous economic and social implications in a number of areas, e. g. in employment and labor markets, in pension systems and in healthcare systems.

Governments will not only be forced to establish innovative mechanisms to deal with issues arising from an ageing population but also for undertaking market reforms and policy co-ordination to ensure long-term viability of social welfare programs, while minimizing the negative effects on the economy. New ways in assisting an ageing population are also necessary: the majority of elderly people will be able to live an independent and relatively healthy life but the risk of becoming impaired remains high and the



[www.aal169.org](http://www.aal169.org)

prevalence of chronic diseases generally increases with growing age. This situation offers opportunities for innovative technologies, products and services, addressing explicitly the particular needs and user requirements of the elderly.

Consequently, governments from all over Europe prepare a new way of co-operation, specifically addressing these issues in the new Ambient Assisted Living programme, with the following specific aims:

- Create a critical mass of research and technological development (RTD) based on common strategies for applied Research & Development in independent living across Europe and Member States, including establishment of a favourable environment for the participation of SMEs.
- Fostering the emergence of systemic innovations for independent living of elderly people, thus increasing their quality of life and autonomy and reducing the costs of their care. The systemic innovations can be based e.g. on innovative utilization of technology, new ways of customer interaction or new type of networks and value chains. This results in new innovative products and services that utilize ICT.
- Support industry by providing a coherent European approach for developing common approaches, while facilitating the need for localisation and adaptation of possible solutions to be compatible with varying social preferences and regulatory aspects on the

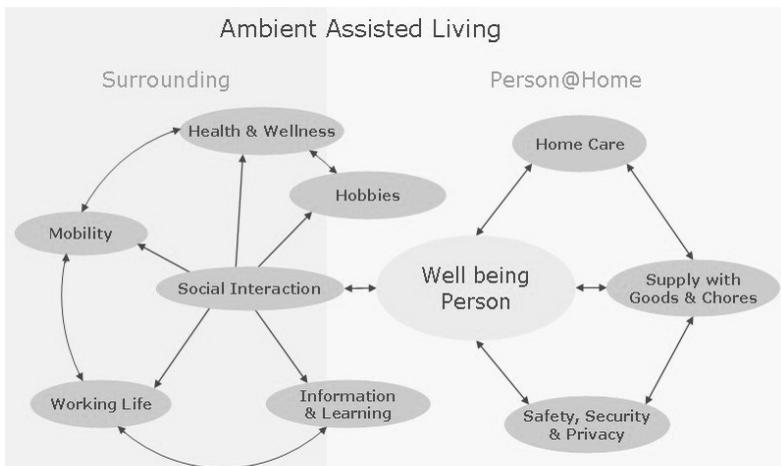


Fig. 2 Demands and needs of persons – potential topics for calls for

national or regional level across Europe, as an important prerequisite for commercial exploitation and market development.

The AAL Programme shall be implemented on the basis of work programmes identifying topics for calls for proposals to be agreed with the Commission as basis for the financial contribution by the Community.

The understanding of “Ambient Assisted Living” is that it aims

- To extend the time people can live in a decent way in their preferred environment by increasing their autonomy, self-confidence and mobility,
- To support maintaining health and functional capability of the individuals, especially the elderly or persons with chronic illnesses or disabilities,
- To promote the eventual risk profile individuals to better and healthier lifestyle
- To enhance the security, to prevent social isolation and to support maintaining the multifunctional network around the individual
- To support carers, families and care organizations
- To increase the efficiency and productivity of used resources in the ageing societies
- To improve equal access to services.

Therefore AAL promotes systemic innovation that includes adoption of new or improved technologies in combination with innovations in the customer interface, organizational-institutional level and introduction of new business models, networks and value chains. New technologies - especially in combination with new services and caring organizations - offer enormous opportunities for improving the living standard at home.

Current research mostly focuses on ICT-usage, but as the definition above shows - AAL is more than that and focuses on the support that technology and innovation in general can offer for the individual, for the service system and for the ageing societies.

Through applied research and innovation projects, with emphasis on integration of the required technologies and exploring new ways for the inclusion of user needs into relevant products and services, AAL169 aims to reinforce a consolidated European market for AAL products, environments and services by addressing multinational consortia that consist of organizations from the AAL169 partner states.

The AAL projects will be funded on a cost shared principle. As national project partners within AAL projects will be administratively handled by their national programme managing agency, also the national funding principles will be applied.

Being subject of a co-decision procedure of the European Parliament and the Council, the Ambient Assisted Living programme shall be ready to start in early 2008 in case of a positive opinion of these two bodies. With an annual programme budget of about 50 M € equally contributed by the participating states and the European Commission, the programme marks a considerable effort in accompanying the demographic ageing challenge.

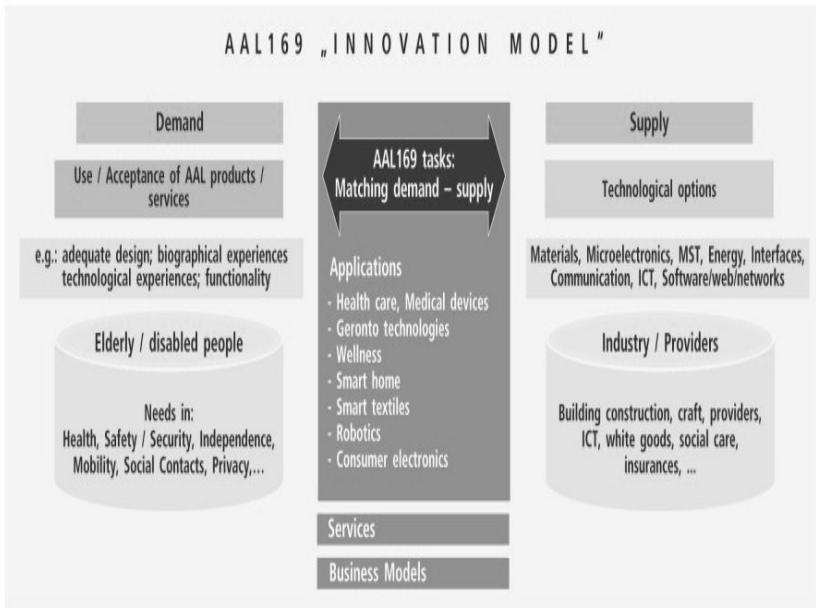


Fig. 3 The AAL innovation model

### Acknowledgment

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# **FORECASTS FOR CONSUMERS' PURCHASE OF INTEGRATED HOME HEALTHCARE SYSTEMS IN THE U.S. - A HEALTHY APPROACH FOR THE CE (CONSUMER ELECTRONICS) BUSINESS**

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You sit down with the client, discuss available features and components, and design a system that blends the latest technology with the desires and lifestyle of the resident. You select various hardware devices, program gateways and controllers, place environmental sensors, optimize communications platforms, and pull these disparate elements together into a home system that improves the quality of life for your customer and their family.

Integrated home automation system? Multi-room A/V experience? No. For an emerging group of integrators, it is the design, installation and management of personal health and wellness systems that enable their clients to care for an aging parent and the healthcare needs of their family. As baby boomers take on the responsibilities of monitoring the well-being of their parents *and* children, they are turning to their CE professional to integrate healthcare applications into security and home automation systems. The end result is the truest form of safety and peace of mind technology can deliver.

A growing number of manufacturers and services providers are making advanced home healthcare components and solutions commercially available to the market today, with many more on horizon from some of the biggest names in consumer electronics, computing and healthcare. In fact, for most of this decade, consumers have been purchasing and installing resident monitoring, medication reminders and “tele-health” products and services in the US and internationally. The most basic of home healthcare products, the personal emergency response system, or PERS, has been around for more than 20 years and are currently fixtures in more than one million US homes. Developed as prototypes within leading academic and corporate research labs, innovative products and features are being enhanced and brought to market by influential companies such as Philips, Intel, Motorola, QUALCOMM and others.

Of greater importance to integrators, however, is the relative simplicity of these devices to install and use, thereby, reducing crew requirements and investment. Additionally, the vast majority of these home-based, technology-enabled healthcare products and services utilize existing technologies and standards, further lowering the technical training and learning curve required to deliver solutions into customers' homes.

For these reasons, manufacturers and integrator alike see home healthcare services as the next major growth opportunity for the electronic house.

### **Healthcare delivery into the home is lucrative, inevitable**

Consumers spend more than \$7 billion annually out of their own pockets on home healthcare products and services (Centers for Medicare and Medicaid, Office of the Actuary, National Healthcare Expenditures, 2004). As our population ages, baby boomers are becoming increasingly responsible for caring for their elderly parents while managing the healthcare needs of themselves and their children. In fact, 45% of all US households have at least one member managing a chronic disease (2004 Care giving in the US Survey, AARP, National Alliance for Care giving), and according to AARP, a staggering 44.4 million individuals care for a family member or loved over the age of 18. A study done by MetLife and ADT Security found that 7 million Americans are responsible for the care of an elder who lives on average 300 miles away, and 50% of all caregivers spend 46 hours per week on average to care for family members. There are 35 million Americans over the age of 65 today, and with that figure expected to top 70 million by 2030, it the fastest growing age demography in the US today (US Census Bureau, Centers for Medicare and Medicaid). Of this group, only 4% reside somewhere other than their own home (Family Caregivers Association Fact Sheet - [www.hfcacares.org](http://www.hfcacares.org)).

Universally, people prefer to remain in their own homes and maintain their independence, yet while 96% of older American's are fortunate to be able to do, it is quickly becoming a *requirement*. Current hospitals and nursing homes do not have the capacity to handle the coming "age wave" of a larger, sicker population. When combined with the severe doctor and nursing shortage expected in the next 10 years, the delivery of healthcare into the home becomes a local, state and national necessity.

Significant financial incentives further drive this category. The average visit from a certified home health aid was \$109 in 2005. The typical monthly cost for a nursing home or assisted living facility ranges from \$3,000 - \$8,000 per month or the equivalent of \$40,000 - \$80,000 annually. It is not, therefore, much of a stretch to image affluent consumers being willing to accept the price tag on today's home healthcare systems as they

enter the market at prices of \$2,500 - \$10,000 per year, and providing a staggering return on investment for consumers of 60 – 90 days!

Research firms Forrester Research and Parks Associates estimate that approximately \$500 million was spent in 2005 on advanced home healthcare products and services, but their views of future growth differ. Forrester projects revenues of \$2 billion by the end of 2008, while Parks Associates projects a more moderate demand for digital home health services in the near term. They forecast that plateau will take an additional 24 months to reach, or by the year 2010 (Forrester Research “Who Pays for Healthcare Unbound”, July 2004; Parks Associates “Digital Home Health – A Primer” 2006). In the longer term, the market is expected to explode to nearly \$30 billion by 2012, when many believe that federal and state governments (via the Medicare and Medicaid programs, respectively), followed by private insurance companies, will begin to reimburse for these products as part of their health insurance coverage plans. Clearly, as greater cost and decision-making responsibility fall upon all of us as consumers, the demand for technology solutions that assist in caring for ourselves, and our families, grows exponentially.

### **Solutions suited for integrators**

Advanced home healthcare systems are comprised of hardware, software and platform components. When integrated together or purchased as a complete solution set, they range in application from patient monitoring (activity or inactivity, behavior patterns, vital sign collection), to medication adherence (reminders, education, reaction tracking, drug infusion), telehealth systems (vital sign analysis and treatment instructions, education, doctor/nurse/patient collaboration, integrated care) to A/V communications tools (connecting family, friends, doctors, nurses, social workers), and electronic medical records, self-management tools (testing, nutrition/fitness tracking), online health portals, and condition-specific services.

A survey of CE Pro readers initiated by EH Publishing and independent research firm, Intuitive Care Advisors, found that integrators are fielding an increasing number of inquiries from their customers for healthcare-related applications, with the number one reason being to “keep an eye on” an aging parent (Intuitive Care Advisors 2005 Channel Report, March 2006). As a follow-up to that effort, ICA conducted a series of phone and online interviews with baby boomers around the country to gauge their interest in home healthcare products and services. Findings overwhelmingly (80%) indicated that consumers want integrated solutions for them and their parents to use, not multiple devices. Additionally, boomers placed a specific priority on the integration of healthcare applications with security systems,

appliances and phone systems (Intuitive Care Advisors 2006 Baby Boomer Home Healthcare Technology Report, June 2006).

Early models for these integrated home healthcare systems have emerged and can best be categorized into “base” or “universal” systems, and “clinical” systems. Base systems include activity and environment monitoring integrated with the home security, lighting and HVAC system. “Clinical” systems are designed with the individual resident’s medical needs in mind, and include medication management and telehealth systems integrated with healthcare provider monitoring.

The market foundation for selling these feature-rich, home healthcare systems is already in place. There are currently more than 1 million US homes with a PERS unit, and industry followers estimate that an additional 4 million households could use the device.

### **Business model, competitive advantage attracting the CE professional**

Most of today’s home healthcare systems and components are being offered to customers on a monthly subscription basis. This presents the CE professional with the opportunity to generate recurring revenues every month, in addition to the initial design and install of the system. And, unlike install - and hardware-driven services, profit margins for current home healthcare services can reach as high as 70% - 75%.

Additionally, until insurance companies pay for these products, consumers are left to pay for them out of their own pockets. Integrator customers are typically, affluent baby boomers who have the discretionary income to purchase these systems and demand technology solutions to meet their caregiver responsibilities while improving the quality of life from the comforts of home.

The custom electronics channel is particularly well-suited for home healthcare system design and installation. The selling process of engaging the family decision-makers in designing a system that meets their needs and restrictions of the home environment parallel that of creating a home healthcare system. Integrators’ technical expertise in pulling together disparate components into a cohesive, single system to learn and use are perfectly matched with the desires of baby boomers who appreciate the limitations and apprehensions of their parents, and are involved in the purchasing decision. Perhaps mostly importantly, the CE pro’s passion and desire to be the “Technology” expert, positions them well for partnerships with home healthcare agencies, nursing homes and healthcare providers who have a sizeable installed base of clients in need of home-based solutions.

“The importance of this service and specialized know-how translates itself into higher perceived value and level of professional services – therein, more customer loyalty. I don’t envision our clients running down to Best Buy for a healthcare system”, states Richard Ward, President of Richmond, VA-based, Integrated Healthcare Technologies, “The sheer market size of this opportunity dwarfs the current integrator business”.

### **Growing number of suppliers**

Until recently, advanced home healthcare product and service suppliers were predominantly innovative, yet undercapitalized, start-ups with the desire to commercialize their offerings and the agility to do so faster than the larger, more established manufacturers. This, however, is changing. Some of the leading consumer electronic, IT and medical device manufacturers are moving aggressively into this market. Three events that took place in 2006 embody this trend.

Early in the year, Royal Philips Electronics purchased Lifeline Systems, Inc. the leading personal emergency response system services provider, for \$750 million, looking to build upon its base of 500,000 subscribers. Later in the year, in a move to encourage manufacturers to make devices interoperable according to recognizable standards, the Continua Health Alliance was launched in June 2006 ([www.continuaaalliance.org](http://www.continuaaalliance.org)). Continua brings together an impressive, and growing, list of OEMs’, service providers, insurance payers, and others joined together in the drive towards plug-and-play compatibility for consumers and installers. Most recently, to help manufacturers and service providers capitalize on this emerging market, EH Publishing, publishers of *CE Pro* Magazine and producers of the *Electronic House Expo* series of events, announced the launch of the Consumer HealthTech Summit, taking place September 24 – 26, 2007 in San Francisco. With a market driven by consumers purchasing these products and systems out of their own pockets, suppliers are looking for distribution channels and partners with the kind of access and influence CE professional own to motivate early adoption.

“GrandCare Systems is very excited at the prospect of working with the integrator channel. We find them to be technically astute, entrepreneurial, and in touch with the community they serve”, stated Charlie Hillman, CEO of West Bend, WI-based, monitoring and communication system supplier GrandCare System “I am confident they will see the enormous potential in the home health market.”

### **What's ahead?**

As with any rising market, innovations and players will emerge and are transformed. Business models will be tested, tweaked and copied. However, macroeconomic drivers are inevitably forcing the convergence of healthcare, home technologies and baby boomer influence. As prospects for home healthcare systems increase, so too will the options. Communication service providers will leverage their infrastructure to bundle healthcare-related monitoring and IPTV services. Security dealers will up sell value-added services as add-ons to their installed PERS customer base. Home automation controllers and servers will add home healthcare modules to deliver ease of use for consumers and efficient installation for integrators. Most of all, larger players will tap into their marketing and distribution resources to raise awareness and drive demand for home healthcare systems and services among consumers.

# MEDICAL MONITORING FOR INDEPENDENT LIVING: USER-CENTERED DESIGN OF SMART HOME TECHNOLOGIES FOR OLDER ADULTS

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**Abstract:** Formally involving users in the design of eHealth solutions can be beneficial. However, within the eHealth domain, the design process is often technology driven. In contrast, we present the need for and benefits of a user-centered approach to technology development. In addition, we argue that smart home environments, such as Georgia Tech's Aware Home, Philips' Home & CareLab and TNO/DUT's Experience Labs, facilitate this approach. In this article, we describe two studies that were recently conducted in the Aware Home to examine monitoring in a home environment. One project involved a formative evaluation of the perceived needs and perceived benefits of using visual sensing systems within the homes of older adults. The other involved the usability evaluation of a computer assistant for the supervision of older diabetics' self-care. Both evaluations suggested that older adults recognized the potential benefits of having these types of monitoring technologies in home environment.

## Introduction

Many Information and Communication Technology (ICT) solutions in the form of eHealth technologies are developed to support older adults in maintaining independence [1]. These technologies have the potential to help older adults perform activities required to live independently or, when unassisted independent living is no longer possible, to assist care takers in providing care at a distance. Because older adults are a segment of the population increasingly interested in using computers [2], and because of their unique health needs, the implementation of eHealth technologies to support older adults seems a logical and useful plan that should be pursued.

However, there has not been widespread deployment of eHealth solutions among older adults. One of the main reasons for the delay in adoption is the lack of the acknowledgement of the projected users and their personal and

cognitive requirements [3]. If designers of eHealth technology apply a predominantly innovation driven approach without the appropriate regard for usability, these technologies are less likely to be adopted. User-driven design and user evaluation during the development of new eHealth technologies is critical for successful adoption of such technologies [4] and thus critical for the adoption of eHealth solutions among older adults.

Those interested in designing user-centered eHealth solutions for older adults may question how best to study technologies, which are designed to be used at home, in a lab environment. We propose the use of smart home laboratories as an alternative to a traditional laboratory approach. A smart home laboratory facilitates testing prototypes by offering a comfortable domestic atmosphere and encourages natural behavior in an experimental setting. A research initiative that fulfills this description is Georgia Tech's Aware Home ([www.awarehome.gatech.edu](http://www.awarehome.gatech.edu)). Other examples of smart home laboratory environments are the Philips' Home&CareLab ([www.research.philips.com/technologies/misc/homelab](http://www.research.philips.com/technologies/misc/homelab)), and TNO/Delft University of Technology's (DUT) Experience Labs (<http://www.usabilitytesting.nl>).

### **Smart home laboratories**

Georgia Tech's Aware Home, was built in 1998, is approximately 5000 square feet, and has two identical floors. It contains the functional and design requirements of a normal home, as well as additional sensing and display capabilities to support ubiquitous computing interventions for residents of the house. The Aware Home has a number of advantages over other laboratory environments, including contextualizing technologies under study. Because activities and goals within the home environment differ from those in office environments, traditional usability testing laboratories (which are often designed to look like offices) may be inappropriate [5]. One key difference is that in the home environment a person is free to choose how space and time are structured, what activities are undertaken, and who is involved [6]. This environment can facilitate understanding of older adults as a whole person including sensory, motor, and cognitive capabilities and the interactions of age related changes in these areas; in a broad context of a larger social unit, and in relation to their physical environment [7].

Studying older adults' perception of Georgia Tech's Aware Home reveals opinions, considerations, and ideas about introducing newly developing technology in the home as it might become available in the coming decades [8]. In addition, early and iterative evaluation of new technology may increase the probability of acceptance, by ensuring that it is both useful and

usable [9]. Finally, the Aware Home facilitates the bringing together of researchers from different disciplines, whose disparate knowledge and experience is beneficial in the design of technology. Other examples of smart home laboratories that promote this user-centered design approach are Philips Home&CareLab and TNO/DUT's Experience Labs.

The CareLab was developed at the Philips High Tech Campus in the Netherlands. At the CareLab special attention is paid to the study and design of technologies termed "Ambient Assisted Living" technologies which consist of technologies that address user needs by focusing on the safety and protection of the personal environment and the stimulation and enabling of older adults to maintain an active lifestyle. One example of this type of technology is the Intelligent Life Style Assistant which utilizes a remote monitoring service to provide safety and protection while also offering an interactive IP-TV platform that stimulates cognitive activities and enables continued participation in society.

TNO Human Factors division and Delft University of Technology both have experience laboratories to accommodate research that samples the experiences of home occupants who use of technologies and services which are still under development. An important focus of both of these laboratories is to develop personalized environments in such a way that a broad range of occupants, including older adults, can easily access the services that might be of interest for them [10]. User, activity, and context profiling technologies are included in the environment to allow the home's system to adapt to the occupant's task performance and well-being. The infrastructure of the laboratories is flexible to enable research with users who move between home and other locations (e.g., office, hospital or gallery), and those who communicate with persons from other locations using personalized information technology (e.g., tele-conference or chat [11]).

### **Recent aware home studies**

To illustrate the potential for technology designed in contextualized laboratories, we will provide two recent examples of studies conducted in the Georgia Tech Aware Home. The focus of the first study was on technology to support older diabetics. Many older adults suffer from type II diabetes and often require support to successfully cope with their disease. There are two types of solutions which have successfully provided support for diabetics in the past. First, educating patients and raising their level of commitment to manage their diabetes can help them take better care of themselves [12]. This sort of self-care, defined by Bhuyan [13] as activities individuals, families, and communities undertake with the intention of

enhancing health, preventing disease, limiting illness, and restoring health, can improve a patient's lifestyle, medical adherence, and future health outcome. Second, to provide patients with hands-on care, lower expenses, and meet with staff shortages, health care is increasingly beginning to rely on Telecare, which is the provision of remote care to people at home by means of information and communication technology (ICT).

One way to address both of these solutions is through the use of a computer application that supervises the patient by monitoring their personal characteristics including personality traits and cognitive abilities, as well as the person's environment. Based on these data, the assistant supports self-care, maintains medical instruments, co-manages the Electronic Patient Record (EPR), and mediates communication with (remote) medical specialists. In the study conducted in the Aware Home, participants were asked to use the computer assistant to complete sample tasks. The older adults made very few errors using the computer assistant which suggests that the technology was usable for the sample tasks. In addition, participants were interested in a mobile version of the computer assistant, reporting that many of the features of the system would be useful outside of the home environment. This experiment is part of the SuperAssist project that comprises complementary empirical investigations in all three laboratories mentioned above [14].

The second example study addressed the ideas of monitoring and privacy more in depth. It may be particularly important for users to understand the benefits of monitoring technology because they may have concerns (e.g., privacy) that need to be weighed against potential benefits. Some benefits of monitoring technology include the ability to raise an alarm in response to concerning situations such as changes in activity levels of the residents or unusual events occurring within the house, such as doors being left open over extended periods of time. Additional monitoring options include well-being monitoring, physiological monitoring, monitoring of chronic diseases [15], and monitoring cognitive functions. The idea of being monitored may even alleviate a sense of social isolation [16]. However, monitoring may provide a sense of false confidence for both users and caregivers [15]. One study of monitoring technology in the Aware Home included a formative evaluation of the perceived needs, concerns, and benefits of using visual sensing systems in the home environment.

In this study participants were given a tour of the Aware Home and introduced to three different types of visual sensing devices: a video camera, a point-light camera and a blob tracker. Each device captures and transmits a different level of information about the person being monitored. A video camera for example, transmits images similar to those found on

TV; a point light camera transmits images where the activity of a person being monitored may be distinguished, but not the identity; and the blob tracker shows only location information. After being introduced to each device participants completed a 2-part structured interview. They were first asked about their general opinions of monitoring technologies and how they imagined them being used within a home they might live in. Next, they were presented with different scenarios and asked about privacy concerns as well as potential benefits each device might provide in that situation.

Results from the first section of the interview suggested that privacy was an important design consideration for older adults. Participants mentioned a number of ways privacy could be achieved or maintained through design details. Results from the scenario based portion of the structured interview suggested that although participants had more privacy concerns about devices which captured detailed information, like the video camera, they also perceived the video camera as more beneficial [17].

### **Conclusion**

Both evaluations presented here suggest that older adults perceived the potential benefits of having monitoring technologies in home environments designed to support independent living. Because the studies were conducted in a smart home environment, participants may have been more able to imagine themselves using monitoring technologies in their own home. The rich environment can enable potential users to consider the technologies in context and therefore provide richer input which in turn can be used throughout the design process. Smart home laboratory environments, like Georgia Tech's Aware Home, Philips' Home&Care Lab and TNO/DUT's Experience Labs, are important for representative user-centered evaluation of eHealth monitoring technologies.

### **References**

- [1] Curry, R. G., Tinoco, M. T., & Wardle (2002). The Use of Information and Communication (ICT) to Support Independent Living for Older and Disabled People. Retrieved January, 2007 from <http://www.rehabtool.com/forum/discussions/ictuk02.pdf>.
- [2] Goodman, J., Syme, A., & Eisma, R. Older Adults' Use of Computers: A Survey. HCI 2003, Bath, UK, Sep 2003.
- [3] Kaufman et al. (2003). A Cognitive Framework for Understanding Barriers to the Productive Use of a Diabetes Home Telemedicine System. Proceedings of the AMIA.
- [4] Niman, B. v., Sund, T., Rodriguez-Ascaso, A., Brown, S., & Garner, P. (2006). User Experience Design Guidelines for Telecare Services. Proceedings of the 8th conference on Human-computer interaction with mobile devices and services.
- [5] Hindus, D. (1999). The Importance of Homes in Technology Research. In Streitz, N., Siegel, J. Hartkopf, V., Konomi, S. (Eds.), Cooperative Buildings – Integrating Information, Organizations, and Architecture. Proc CoBuild'99, October, 1999.

- [6] Kidd, C.D., et al. The Aware Home: A Living Laboratory for Ubiquitous Computing Research. In Streitz, N., Siegel, J., Hartkopf, V., Konomi, S. (Eds.), *Cooperative Buildings – Integrating Information, Organizations, and Architecture*. Proc CoBuild'99, October, 1999.
- [7] Mynatt, E. D., & Rogers, W. A. (2002). Developing Technology to Support the Functional Independence of Older Adults. *Ageing International*, 27, 24-41.
- [8] Sarkisian, G. P., Melenhorst, A. S., Rogers, W. A., & Fisk, A. D. (2003). Older Adults' Opinions of a Technology-Rich Home Environment: Conditional and Unconditional Device Acceptance. *Proc Human Factors & Ergonomics Soc.*
- [9] Caine, K. E., O'Brien, M. A., Park, S., Rogers, W. A., Fisk, A. D., Van Ittersum, K., Capar, M. & Parsons, L. J. (2006). Understanding acceptance of high technology products: 50 years of research. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.
- [10] Neerincx, M.A., Lindenberg, J. & Grootjen, M. (2005). Accessibility on the Job: Cognitive Capacity Driven Personalization. *HCI 2005*, St. Louis, Missouri: MIRA Digital Publishing.
- [11] Lindenberg, J. Pasman, W., Kranenborg, K., Stegeman, J. & Neerincx, M.A. (2007). Improving service matching and selection in ubiquitous computing environments: a user study. *Personal and Ubiquitous Computing*, 11, 59-68.
- [12] Golin, C.E., DiMatteo, M.R., Leake, B., Duan, N., & Gelberg, L. (2001). A diabetes-specific measure of patient desire to participate in medical decision making. *Diabetes Education* 27(6), 875-86.
- [13] Bhuyan, K.K. (2004). Health promotion through self-care and community participation: Elements of a proposed programme in the developing countries. *BMC Public Health* 4(11).
- [14] Blanson Henkemans, O.A., Neerincx, M.A., Lindenberg, J. & van der Mast C.A.P.G. (2006). SuperAssist: A User-Assistant Collaborative Environment for the supervision of medical instrument use at home. *First Int Conf on Pervasive Comp Tech for Healthcare 2006*, Innsbruck, Austria, 29 Nov-1 Dec, 2006.
- [15] Reeves, A. A., Ng, J. W. P, Brown, S. J. & Barnes, N. M. (2006). Remotely supporting care provision for older adults. In *Proceedings of the International Workshop on Wearable and Implantable Body Sensor Networks*.
- [16] Rowan, J. & Mynatt, E. D. (2005). Digital family portrait field trial: Support for aging in place. In *Proc SIGCHI*.
- [17] Caine, K. E., Fisk, A. D., & Rogers, W. A., (2006). Benefits and privacy concerns of a home equipped with a visual sensing system: A perspective from older adults. *Proc Human Factors & Ergonomics Soc.*

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# **THE PATIENT HOME ASSISTANCE APPLICATION BASED ON TELEMEDICINE SERVICE**

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**Abstract: The presented application is focused on the particular homecare services that facilitate adaptive care including drug administration and new regime of therapy working as a closed-loop system. The system allows multi-parametric monitoring providing expert feedback based on the multimedia content bringing and maintaining the doctor and patient virtually closely 24 hours a day.**

## **Introduction**

One of the topical interests of medical care is to develop a sustainable and personalised healthcare at affordable cost for as many as citizens. A special attention is given to personalise monitoring of elderly peoples and chronic patients in order to provide an efficient chronic disease management as in [1]. The high-tech methods can cut the medical costs in different ways including wireless electronic monitoring and diagnosis at home as is discussed in [3].

Going on the idea to implement the enhanced telemedicine services in benefit of both patient and doctor, we paid a special attention to the home remote assistance and control of chronic and aged persons. In the previously reported research [4], we have defined the concept of Programmable Multimedia Homecare Assistant (PMHcA) and we have described its integration in current medical routine. Based on the preliminary evaluation we prototyped an application for patient assistance, including several facilities: 24-hour assisting, telemonitoring and alerting, e-prescribing and adapting the therapy. This solution is to extend the support of telemedicine beyond of its traditional facilities like telemonitoring and telediagnosis by improving the integration of e-health and telemedicine into routine medical practice.

## System description

### The patient terminal

For the required equipment of patient terminal was decided a commercial hand held device (PDA). This is because of the expectation this kind of devices will have an affordable cost for more and more citizens. The hardware supports the ad-hoc wireless connections towards a large-scale communication network. It also provides the friendly-user interface with the patient including multimedia messaging and graphical touch-screen interaction. A specific on-line adaptive multimedia context is provided to the patient in order to assist and control his or her therapy, to recommend the appropriate life style and to signal other meaningful events. The doctor provides the entire personalised information content of the application and the therapy schema is also under the doctor's full control. The schema with

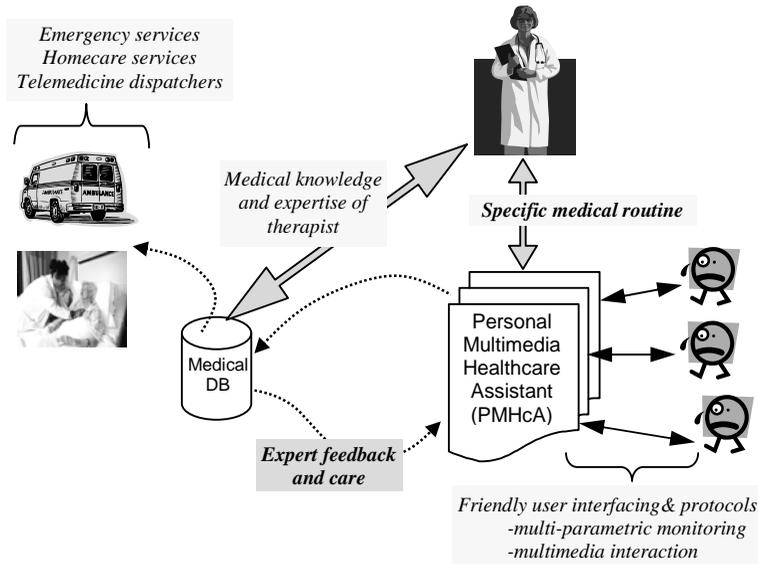


Fig. 1 Basic architecture and relationships of the application

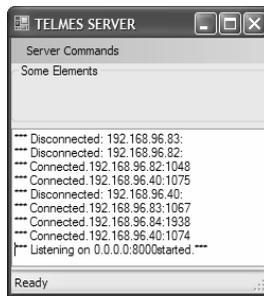
the working tasks, the relationships and responsibilities of the entities in the system are depicted in Fig. 1.

**Software implementation**

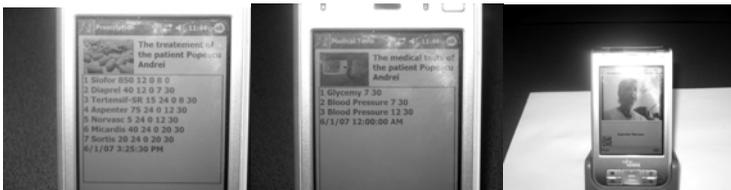
Current technologies in software development targeted on the mobile devices were used. The software application includes two main modules. First is a specific database that contains medical records as drugs prescription, multi-parametric health tests as well as life style prescriptions, regimes. Second is a programme that runs on the mobile device performing the following tasks: the client-server communication, that means the patient terminal is capable to initiate a connection to up-load and down-load interested data at the prescribed time. This programme also manages the user interface and runs the multimedia content. The programme runs on the patient terminal for 24 hours under the control of his or her personalised therapy which is hosted on the medical DB server and just in time adapted if need. It is currently displayed on the terminal screen when the patient should self administrate



*Fig.2 The patient terminal logging on*



*Fig.3 Users status report*



*Fig.4 Different running instances including multimedia delivery*

the drugs and periodically self made health tests A special routine for data transmission securing based on additive hybrid cellular automata was also implemented [2]. Fig. 2 shows the terminal patient at login stage and Fig.3 shows a server report example of different patients' status in service. Different working instances of the application referring on drug schema and health monitoring tests are depicted in Fig.4. The patient is remotely monitored based on the records depicted in Fig. 5.

idRezultate2	idTesteMedicale	Data	Observatii	id_pacient	ValMin	ValMax
25	1	2007-02-15 07:31:15	PERFORMED!	1	NULL	105
26	2	2007-02-15 07:32:49	PERFORMED!	1	95	148
27	3	2007-02-15 12:50:00	NOT PERFORMED!	1	NULL	NULL
28	1	2007-02-16 07:31:25	PERFORMED!	1	NULL	110
29	2	2007-02-16 07:32:57	PERFORMED!	1	85	155
30	3	2007-02-16 12:31:33	PERFORMED!	1	80	160

idRezultate1	idMedicament	Data	Observatii	id_pacient
45	2	2007-02-15 07:30:09	TAKED!	1
46	1	2007-02-15 08:00:22	TAKED!	1
47	3	2007-02-15 08:31:03	TAKED!	1
48	4	2007-02-15 12:40:00	NOT TAKED!	1
49	5	2007-02-15 12:40:00	NOT TAKED!	1
50	2	2007-02-15 19:30:26	TAKED!	1
51	1	2007-02-15 20:00:18	TAKED!	1
52	6	2007-02-15 20:40:00	NOT TAKED!	1
53	7	2007-02-15 20:40:00	NOT TAKED!	1
54	2	2007-02-16 07:30:15	TAKED!	1
55	1	2007-02-16 08:00:10	TAKED!	1
56	3	2007-02-16 08:30:23	TAKED!	1
57	4	2007-02-16 12:30:11	TAKED!	1
58	5	2007-02-16 12:30:13	TAKED!	1

Fig. 5 The server hosted records of the patient actions and parameters

### Conclusions

The application for patient home assistance is focused on a particular homecare service, which creates the possibility to bring and maintain the doctor and chronic patient closely between the regular consultations by continuous assisting and controlling. The patient is virtually assisted by doctor's telepresence via a special designed software and hardware support.

In addition to the previously mentioned purpose, this project also contributes on the sensitive issues like ehealth/telecare for independent or assisted living in the ageing society, pro-active health monitoring, mobile technologies, etc.

### References

- [1] European Commission, "ICT-Information and Communication Technologies-Work Programme 2007. A theme for research and development for specific programme in FP-7" (available at [http://cordis.europa.eu/fp7/ict/programme/home\\_en.html](http://cordis.europa.eu/fp7/ict/programme/home_en.html)).
- [2] P. Anghelescu, E. Sofron, S. Ionita, G. Iana, V. Ionescu, "Stream Encryption using Reversible Cellular Automata" in Advances in Intelligent Systems and Technologies. Proceedings ECIT2006- 4th European Conference on Intelligent Systems and Technologies, Iasi, Romania, Sept. 20-23, 2006, pp.161-170.
- [3] T. E. Bell, "High-Tech Methods to Cut Medical Costs", The Institute (an IEEE trademark), December 2006, Vol. 30, No.4, pp.1&12.
- [4] S. Ionita, M.M. Ionita, "A Programmable Multimedia Homecare Assistant", e-Health Proceedings of Med-e-Tel 2006, April 5-7, Luxembourg, pp. 60-65, 2006.

# VIDEO-COMMUNICATION IN HOME CARE: THE APPLICATION AND THE BUSINESS MODEL

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**Abstract-**It is said that Video Communication in homecare can notably improve the quality of life, for both the elderly and their relatives, by increasing the independence, confidence and security of the elder person while reducing the cost of home care. However, there is a wide gap between the acceptance of video as a useful tool and the actual use of such a system. This paper is the follow up of last year's paper: *Telecare – Practical Experience with Video Communication in Home Care*.

Ageing societies face the challenge of maintaining a high level of care and fulfilling the requirements of a steadily growing clientele, as well as controlling the costs of care delivery. The number of Europeans aged 60 years and over has risen by about 50% over the last 30 years [3 - 4]. This trend is continuing. Governments are trying to find methods which will allow people to stay longer in their homes, the environment they are used to. Additionally, finding ways of getting people out of the hospitals, which is a major contributor to the increasing cost of social systems, has

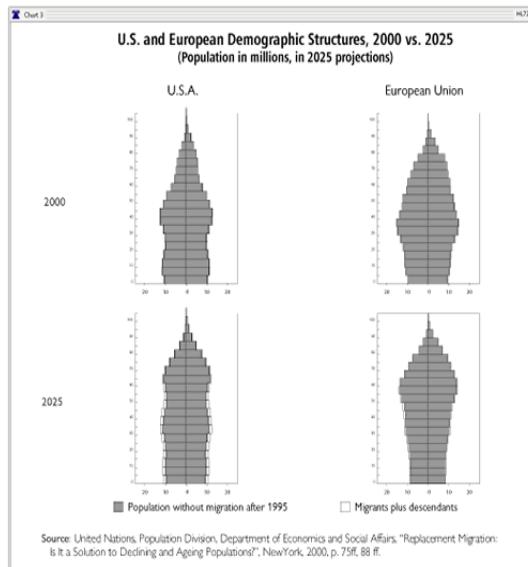


Fig. 1

also priority. This goes hand in hand with finding solutions for the treatment of chronically ill people. Innovative approaches to care delivery must be found in order to confront this challenge. These approaches must enable care providers to maintain a high level of care, while also improving their services. Video communication as an additive to home visits can increase the efficiency and quality of home care as well as enabling closer contact with relatives and friends. Aguilar et al. recommends tele-assistance to include not only the specialized centers but also family members because this increases the confidence, health, and quality of life of the elderly [1].

### **Targets**

Care providers who want to take a closer look into the possibilities video services offer have to consider a number of issues including usability and financials. The following topics are important when initially thinking about video communication:

1. What are the actual requirements of the video system and how should the system be designed in terms of handling by the client?
2. What handling factors are important for the care provider?
3. What is the financial framework a care provider has to consider?
4. What are the costs for call centre personal?
5. What type of financing and business model is applicable?

The presented data and outcome is based on the evaluation of a number of projects in the Netherlands and Austria as well as from some other European projects where data was available. The main focus was on the actual application, the technical barriers, and the cost involved. The size of the projects evaluated was quite different starting with projects including some few video installations going to projects with some few hundred installations.

### **Findings**

The ease of use for the end-user and the technical maturity are important factors for the successful introduction of such services. Additionally, the integration into existing infrastructure is important because the living situation of the end-user should not be changed too much [6]. Only if the system is not affecting a user's daily life, it will be used properly. The success of the introduction is pending on a variety of factors which have direct impact on the use of the system.

For the care provider, who intends to introduce such a system, the most important issue is the training of the call centre operators on how to use the system properly. State of the art contact centre software allows some sort of

remote maintenance and problem solving which shall be done by the call centre agent.

### ***Video phone hardware***

The cost of the video phone hardware reaches from 33 Euro per month to 60 € per month with a 2 year leasing contract. The price is mainly determined by the size of the project and the used hardware but includes the cost of the call centre software licenses, service and maintenance. In case a one time investment is preferred, the cost will be between 1100 € and 1600 €. A big portion of the hardware cost is up to the used camera. There are 2 possibilities: (1) using a professional pan-tilt-zoom camera (PTZ) priced between 400 and 600 € per piece, and (2) - the use of low cost cameras. These cameras have impact on video quality and therefore on the quality of the service.

### ***Network Infrastructure***

A large proportion of the cost is generated by the network connection. There are a number of factors which can reduce the cost of the network connection such as the use of dynamic IP addresses instead of using fixed IP addresses. Dynamic IP is usually less expensive than fixed IP addresses but has a major disadvantage. You cannot reach a person under the same “telephone number”. However, modern technology allows using dynamic IP addresses by providing internal numbers to its participants.

It should also be mentioned that such a DLS line will make a regular telephone line redundant. The cost for such telephone line can therefore be deducted from the cost of the DSL line. Additionally, the video system can also function as a personal alarm system. The cost for such a system can therefore also be deducted.

### ***Personnel Cost***

As found in a number of projects the average call duration is about 7 minutes [6]. Based on an average use of 3 calls per client per week we expect duration of 21 minutes. In case the call centre is occupied 8 hours per day, 5 days a week, a theoretical volume of 114 clients with each 3 calls per week is calculated per operator station (which in this case is a health care professional with appropriate education). To give a bit more flexibility we further calculate with 100 clients per call centre station. The weekly cost for a call centre agent is around 600 euro gross (~2500 per month). The personal cost for each client is therefore 6 Euro per week or ~ 25 – 30 Euro per month.

What we see from the above calculation is that the end-user of such a system has to consider around 70 to 100 Euro for the infrastructure and

around 30 Euro for the delivered health care services. If we now include the cost we saved from the regular telephone line and, in some cases, the cost for the personal alarm system, a complete service could be offered for something between 80 to 100 Euros per month including infrastructure and delivered services. If you put this cost in contrast to the improved living situation, reduced need for medication, and increased efficiency of health care delivery, a relatively high cost-value factor can be achieved. The final question is if insurance companies, which benefit from better health condition and more efficient health care delivery, should contribute more to make current and new projects more successful.

### **Conclusion**

The growing elderly population requires additional services and care, which increase quality of life while reducing costs. One of the major challenges for the successful implementation of video communication is the acceptance by the various stakeholders such as the care provider, the elderly, and their relatives. Since the elderly are often technologically averse, ease of use and the integration into existing home infrastructure such as the television set is critical. Additionally, Wakefield et al. states that usability, clinical appropriateness, training, and support will likely play a crucial role in the future growth of home tele-health. [5].

### **References**

- [1] Aguilar, J.; Cantos, G.; Exposito, G.; Gomez, P.; "The Improvement of the quality of Life for Elderly and Relatives through two Tele-Assistance Services: The TeleCARE approach" InnovaTD – Grupo Skill, Tecnologia 9 41120 Gelves (Sevillia), Spain.
- [2] Asthana, Sheena; Halliday, Joyce; "What can Rural Agencies do to Address the Additional Cost of Rural Services? A Typology of Rural Service Innovation" Health and Social Care in the Community, 2004, 12(6), pp.457-465.
- [3] Banahan, E.; "The Social/Non-Technical Challenges in Developing Technology to Support Elderly Care - The TeleCARE Experience" RoundRose Associates Ltd, Southbank House, Black Prince Road, London SE1 7SJ, UK.
- [4] Camarinha-Matos, Luis; Afsarmanesh, Hamideh; TeleCARE: "Virtual Elderly Care Support Communities" The Journal on Information Technology in Healthcare, 2004, 2 (2), pp.73-86.
- [5] Wakefield, Bonnie J.; Holman, John E.; Ray, Annette; Morse, Jane; Kienzle, Michael; "Nurse and Patient Preference for Telehealth Home Care" Geriatric Times, March/April 2004, Vol. V, Issue 2.
- [6] Pfeller, Thomas; Huber, Elisabeth; VanVenroy, Bart; Striekwold, Rolf; Hermsen, Andre; "Telecare - Practical Experience with Video Communication in Home Care" Published for the Med-e-Tel conference 2006.

**TELEPEDIATRICS: TELEMEDICINE AND  
CHILD HEALTH EXPERIENCES AND  
SUCCESS FACTORS**

## EIGHT-YEAR EXPERIENCE OF TELEPEDIATRICS

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**Abstract:** Telemedical centre in Moscow Research Institute for Paediatrics and Children's Surgery became one of the first telemedical centres in Russia, being created in 1998. During eight years several hundreds of consultations have been performed in various areas of pediatrics and children's surgery; qualified medical services were provided mostly for the children in the distant areas of Russia. The number of consultations per year varied from 4 to 184. Videoconferences (over ISDN and IP) made about 25% of the consultations during last several years. Since 2001 the telemedical centre provides emergency consultations - within 10-15 min after the initial call. Recently, the growing number of multi-specialty teleconsultations can be seen. Traditionally, one of the most demanded areas of consultation was neurology. During the last several years the number of consultations in pulmonology was also growing.

Telemedical centre in Moscow Research Institute for Paediatrics and Children's Surgery was created in 1998, being one of the first telemedical centres in Russia. During eight years of its work several hundreds of telemedical consultations were performed in various areas of pediatrics and children's surgery. A general overview of the telemedical center's activity during 1989-2006 follows below.

The number of consultations per year varied from 4 up to 184, or 74.5 per year on average. The number of consultations was rapidly growing until 2002. Afterwards the decision was made to limit provision of telemedical consultations for free. In 2006 46% of all consultations were provided on commercial basis, but at a very affordable price. Still the fee-for-service principle has somehow restricted the number of clinics applied for the consultations. At the same time it rapidly decreased the share of erroneously sent applications (e.g. requesting the help of the specialists not from our institute, etc.).

Store-and-forward consultations constituted the majority of cases, while videoconferences (ISDN and IP) made about 25% of the consultations

during last several years. ISDN videoconferences appeared to be more reliable in the regions of Russia that is why they were used most frequently (in 70% cases). Nevertheless, during last several years broadband Internet connections in Russian regions become more and more common, which enables wider use of IP videoconferencing in Russian telemedicine.

The consultations were provided mostly for the children of the distant areas of Russia, predominantly Siberian and Far Eastern areas (33%), as well as some northern regions of European Russia (17%), i.e. the areas where face-to-face consultations of high qualified specialists in pediatrics and children's surgery might not be easily performed. Totally, the children from 47 cities of Russia and from 9 foreign countries were consulted during 8 years.

Since 2001 the telemedical centre of our Institute is able to provide so-called emergency telemedical consultations - within 10-15 min from the moment of initial call to our centre (the share of such consultations was 9% in the total number). Now we can also see the growing number of multi-specialty teleconsultations (when several specialists are involved into a consultation, jointly discussing a diagnosis and treatment). The growing number of such consultations can be connected to some extent with more commercial aspect of consultations during the last years, when distant clinics are mostly interested in consulting their most severe patients, while for free less severe cases could be presented to Moscow physicians from the distant regions. In 2006 the share of multi-specialty consultations was as high as 19% (average for 8 years was only 8%).

Traditionally, one of the most demanded areas of consultation was neurology (29.7%), due to lack of pediatric neurologists in distant regions of Russia. Other most demanded specialties were pulmonology (9.9%), medical genetics (8.9%), nephrology (7.2%), and allergology (7.1%) During the last several years the share of consultations pulmonology was rapidly growing (up to 24% in 2006), which might reflect to some extent unfavorable environmental changes due to some "revitalizing" of the Russian industry after economical crisis of 1990s.

At the moment we can see that telepediatric services provided on commercial basis are demanded in Russia, and there is a prospective for the growth of demand in the nearest future. Now we see that the change of business model in telemedicine did result in the changes of demand for telemedical services. It can be expected that deeper changes in the business model would result in further changes of the structure of telemedical consultations.

# **PEDIATRIC ELECTRONIC HEALTH RECORD IN HOSPITAL INFORMATION SYSTEM “SVOGIJA”**

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**Abstract:** The Electronic Health Record (EHR) is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology reports. The EHR is generated and maintained within an institution, such as a hospital, integrated delivery network, clinic, or physician office. Therefore, EHRs that are custom-designed or reside in other health care delivery venues are not reviewed in this document.

Hospital Svoge is a Multiprofile Hospital for Active Treatment (MHAT) that has 7 differentiated sections - Section of internal medicine, Section of emergent surgery, Section of cardiology surgery, Section of surgical gynaecology clinic, Section of paediatric surgery, Section of neurosurgery, Section of anaesthesiology and critical care.

In the current paper it is introduced an EHR for the Paediatric section in this hospital – an inseparable part from the Hospital Information System (HIS) “Svogija”. HIS “Svogija” is developed in 2005, and completely adapted to the National Health Insurance Fund’s requirements for documentation of acceptance and discharge from a hospital, including hospital statistics and billing papers.

## **Introduction**

The purpose of this article is to present quite new and unique for the Bulgarian healthcare EHR for Pediatric section. We investigated our development results with the following summarized questions:

- Motivations driving the need for Electronic Health Record systems,
- EHR applications and functions being implemented or planned,
- IT platforms used to support EHR applications,

- EHR configurations for different environments,
- Major barriers to implementing EHR systems.

Our Hospital Information System is purposefully designed for hospital in Svoje and contains the following blocks:

- Reception Administrative block, Electronic Health Record for Internal diseases section, Electronic Health Record for Paediatric section, Electronic Health Record for Gynecology clinic, Personal access for the Hospitals Procurator and Special functional developed block for access for the Information sector.

Municipality Svoje has a population of 24640 people, determined as follows: under 18 – 4250 people, between 18 and 64 – 15 500 people and above 65 – 2900 people, that is basically treated in Hospital Svoje.

The fundamental document in Bulgarian healthcare that points the patient's reception hospital is called Direction for Hospitalization.

Considering this the electronic administrative entrance of the patient is designed in exactly the same view as the paper type. The patients come with it, preliminary filled by the General Practical, who points the initial diagnosis. The administrative stuff directs the patient to the concrete section – in our case the Pediatric.

Patients' e-way in Hospital Svoje - from Hospitalization to National Health Insurance Fund is shown on Figure 1.

Only the hospitals procurator has the right to give access to the medical stuff. The security is improved except with the Personal access, but with the connection between the Reception directions from the administrative stuff that ensures that patients' data won't be modified by anyone else but the curing doctor from the concrete section.

The system is client server based, and is allowed to be viewed all the data from every section but only in the concrete one is editable.

The obligatory fields that should be filled during the patient's admission at the Registration are:

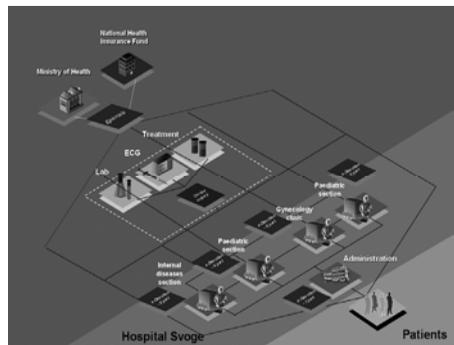


Fig. 1 Patients' e-way

- Personal Identification Number (PIN) - It is provided a correction check of the PIN. Because of the Bulgarian Health Law that states that one patient could not be treated twice per month, the system checks it also.
- Unique Identification Number of the GP.
- Health history Number – unique for every patient – every year the numbers starts from 0 again.
- Section – it is pointed the treatment section, room number and bed number.

After Registration, patient is send to the concrete section, where the curing doctor should fill the second part of the Direction for Hospitalization. There from patient’s automatically are generated PIN sex, age, notification that the patient is under 18 and therefore is treated free of charge.

The Electronic Health Record is completely identical to the paper standardized document, and in this way the medical stuff adapts to the global changes faster and more effectively.

In the Pediatrics section the reception doctor enters second part of the Direction for hospitalization; where the built in International Disease Code 10(IDC 10) is strongly connected with the clinical pathways. There is a choice between the systems generated IDC and the clinical pathways to be entered. The clinical path is the organization and sequencing of patient care interventions for a specified procedure or population by the health care team along a timeline to better manage resources, ensure quality of care, and minimize delays.

The design allows fast and comfortable adaptation because of the color scheme - all automatically generated fields from Direction for hospitalization data are in grey color and inaccessible to rewrite or delete.

The yellow are for free writing, again in consideration with the paper document. Whenever there is limited number of choices the field is with drop-down menu.

Fig. 2 Electronic Health History

The EHR contains entire medical data from parents, child's birth, every single system, social environment and etc. in the digitized document called "Anamnesis".

"Anamnesis" contains 8 pages - Family history, Child growth, Sexual growth, Nutrition, Immunizations, Past diseases, Social conditions, Objective condition, Lymph nodes, Head, Respiratory system, Cardiac system, Digestive system, Liver, Laboratory database, Temperature observations. The Laboratory data base contains Hematological analysis, Biochemical analysis and Urine tests.

One extravagant and elegant function of the EHR is the Temperature tests with automatic diagram. The other completely digitized function is the automatic export to Microsoft Word of all data in the standardized to the paper view electronic Epicrisis. It gathers entries from the EHR, anamnesis, biochemical tests, temperature observations, laboratory tests, converts it to Word format and filled in the blank.

### **Conclusion**

Based on the results from our inquiry we can conclude that the main positive features for clinicians in that concrete EHR environment are that they spend less time updating static data, such as demographic and prior health history, because these data are populated throughout the record and generally remain constant. Challenges that EHRs may present to workflow processes include: increased documentation time, decreased interdisciplinary communication, and impaired critical thinking through the overuse of checkboxes and other automated documentation.

### **References**

- [1] Beolchi,L. Telemedicine Glossary, 5 Edition, 2003 Working Documents, Glossary of Concepts. Technologies, Standards and Users, September 2003, European Commission, Information Society Directorate-General, Brussels.
- [2] Electronic Health records overview, NIH, 2006.
- [3] Vinarova J., CD "Workshop Presentation of HIS Svogija", NBU, ISBN 954-535-424-0, Sofia, 2005.
- [4] Vinarova J., M.Vukov, Information systems in medicine and healthcare, ISBN 954-535-392-9, NBU, Sofia, 2005.
- [5] Vinarova J., Annual book of Department Biomedical sciences, ISBN 954-535-400-3, NBU, Sofia, 2005.
- [6] Vinarova J., CD "Annual book 2" of Department Biomedical sciences, ISBN 10: 954-535-447-X, NBU, Sofia, 2006.
- [7] <http://www.ejbi.org/articles/200511/18/10.html>
- [9] <http://mbal.svoje.info/>
- [10] <http://groups.csail.mit.edu/medg/people/psz/6.872/96/notes/Tsien/>
- [11] Electronic Health Records Overview, National Institutes of Health, National Center for Research Resources, the MITRE Corporation, © 2006.

## **TELEMEDICINE VIDEOCONFERENCING: THE RUSSIAN EXPERIENCE**

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***Abstract:* Videoconferencing in telemedicine provides a wider opportunity for discussions of the cases, compared to store-and-forward technology. Physicians can jointly discuss medical images and/or video, remote consultant may ask a patient to perform certain actions and then discuss them. Educational value of videoconferences when a local physician and a known specialist jointly discuss a patient's case cannot be overestimated. Eight-year experience of The Telemedical Centre at Moscow Research Institute for Paediatrics and Children's Surgery demonstrated the growth of share of videoconferences in total number of consultations. Emergency consultations and multi-specialty consultations are preferably to be conducted using videoconferencing.**

### **Introduction**

Nowadays the share of videoconferences in telemedical consultations in Russia is relatively small. Partially it can be explained by the existence of the opinion that interactive dialogue between a consulted physician and a remote consultant is something excessive. Advocates of store-and-forward telemedical consultations are sure that the physicians who have requested consultations could be completely satisfied having received the remote consultant's recommendations as a text. But beyond the recommendations on the further physician's tactics concerning diagnosis and treatment, there also is a possibility for joint analysis of a case, discussing some unclear aspects. Such a joint analysis is often important, as the consulted physician always has to understand the logic of consultant's decisions, but not simply accept or decline them.

In certain cases there may be no real alternative to videoconferences, which provide the possibility for a dialogue either between two (or more) physicians, or between a remote consultant and a patient (or patient's relatives).

In Russia, with its large territories, low population density, and lack of high qualified medical specialists in certain remote regions (e.g. in Siberia

and Far East), telemedicine can be a real mean, which is able to compensate lack of knowledge (e.g. in sphere of paediatric neurology, ophthalmology, etc.) in general practitioners.

### **The role of video consulting**

Telemedical consultations using videoconferencing technologies, which provide interactive audiovisual contact between a physician and a remote consultant, represent a new step in distant consultations. It is especially important that a physician not only receives the consultant's opinion, but he is also able to follow the consultant's logic of diagnosis. In this case a local physician could try to understand the consultant's logic better, which may help him to formulate his own final decision.

The role of direct communication can be seen most demonstratively in discussion of medical images. For instance, so called "White Board" (in Microsoft NetMeeting) allows joint work of both consulted physician and remote consultant, who can show each other the zones of interest on the image, using cursor and colour marks. The possibility to discuss medical images during the remote communication between physicians helps not only making the most substantiated decisions, but also addresses educational purposes.

### **The analysis of patient's movements**

While consulting patients with certain illnesses, there might be a need not only to view the patient's movements (it might be done using pre-recorded video), but to "control" the patient's movements by the consultant. First and foremost, it may concern conditions in neurology and orthopaedics. In hereditary diseases and congenital defects various phenotypic signs, often overlooked by GPs, may be of great importance for diagnosis. For the mentioned categories of patients the possibility to view the dynamics of their movements during the videoconference would surely increase diagnostic accuracy. In cases of psychiatric disorders it is the patient's face expression, his reaction to the physician's questions that are important for diagnosis.

### **Emergency teleconsultations**

The experience of telemedical centre of Moscow Research Institute for Paediatrics and Children's Surgery has demonstrated that the number of so-called emergency consultations (performed within 10-15 min after the initial call) is growing. The share of such consultations reached 7-13 % in 2000-2006. Our experience allows us to conclude that priority in cases of emergency consultations should be given to videoconferences. As an

indirect proof of the efficacy of emergency videoconferences we might mention the fact that among the consulted children only 2 died during the last 5 years (0.15%), though of course it was not solely due to our consultants' merits.

Videoconferences have demonstrated their effectiveness in remote support of pediatric teams providing their services for the children in emergency [1]. We had an experience in telemedical support of field paediatric hospital using satellite communication. It provided the possibility to treat a significant part of children (46%) on site, instead of transporting them to Moscow clinics. When the transportation was actually needed, telemedical videoconferences were used to decide to which clinic a patient should be transported.

### **Multi-specialty consultations**

In contemporary telemedicine it is not uncommon when a number of physicians of different specialties are involved into a consultation, which can be most effectively done only in videoconference. In Moscow Research Institute for Paediatrics and Children's Surgery the share of such multi-specialty consultations reached 19 % in 2006. Up to 4 consultants could participate in such multi-specialty consultations.

The main benefit is that the consulted physician receives not several different opinions from a number of consultants, but a single jointly elaborated opinion of all of them.

### **Organization of the videoconferences**

Our experience has demonstrated the need of strict rules to be followed in the process of teleconsultation. For example, special requirements for the exchange of medical documentation and medical images were elaborated. Now the telemedical consultations are performed for over 40 Russian regions and 9 foreign countries (mostly ex-USSR countries).

### **Educational value**

Additional benefit of telemedical videoconferences is their great educational value, which is most important for the physicians residing in distant areas of Russia. Having provided telemedical services to certain areas during several years our consultants mentioned that the educational level of local physicians was growing, and it often correlated to the number of videoconferences during which consultants thoroughly discussed the cases with the consulted general practitioners.

### **Conclusion**

Videoconferences providing interactive dialogue between a consulted physician and a remote consultant enable better understanding between the specialists, which result in higher quality of patients' treatment. The growing share of videoconferences in emergency consultations and multi-specialty consultations allows us to conclude that now videoconferences constitute an essential part of Russian telemedicine.

### **References**

- [1] A.I. Ehrlich, B.A. Kobrinsky, V.I. Petlakh, et al. Telemedicine for a children's field hospital in Chechnya. *J Telemed and Telecare* (in press).

## **TELEPEDIATRICS: THE UNIVERSITY OF CALIFORNIA, DAVIS CHILDREN'S HOSPITAL EXPERIENCE**

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Telemedicine allows pediatric specialists the means to improve the quality of care provided to children living in rural, remote or other underserved urban communities. Telemedicine helps to address barriers to care (eg, geographic, financial) that contribute to health care inequalities. The use of telemedicine is rapidly growing and it is imperative that general and specialist practitioners (physicians and nurses) and healthcare administrators be familiar with this technology. UC Davis Children's Hospital in Sacramento, California has extensive experience in the use of telemedicine to provide pediatric specialty consultations for both outpatients and inpatients, and has conducted several workshops, symposiums and conferences on Pediatric Telehealth.

In the outpatient setting, a variety of pediatric specialists provide telemedicine consultations to remote areas, including cardiology, pulmonology, infectious disease, genetics, hematology, oncology, gastroenterology, nutrition and obesity, endocrinology, psychiatry and many others. For communities without experienced pediatric sexual and abuse examiners, we are experienced at providing consultations to remote examiners during pediatric child abuse exams to ensure proper evidence collection.

In the inpatient setting, pediatric specialists provide support for critically ill and injured children receiving care in remote adult Intensive Care Units. Also, pediatric cardiologists provide inpatient consultations to Neonatal Intensive Care Units and are able to provide real-time clinical assessments and echocardiogram interpretation. Lastly, several pediatric specialists provide consultations to pediatric patients admitted to inpatient wards at remote hospitals, increasing the quality of care, increasing the efficiency of specialists, and often obviating the need for transport.

There are also other innovative telehealth applications that can be used to increase access, efficiency and quality of care. For example, pediatric emergency medicine specialists consult with physicians in several rural Emergency Departments, assisting in the care of acutely ill and injured

children to support in the Golden Hour of care. Telemedicine technology is used for video-interpreting, robotic surgery, remote physician presence (“robo-doctor”), continuing medical and nurse education, child-care and daycare telemedicine, and even technology that allow physicians to see and treat patients in remote areas from their homes. Also, the Family-Link program provides a connection that allows hospitalized children to interact with family and friends that are limited in their visitation capabilities.

## **E-LEARNING**

# **CAMERINO UNIVERSITY (UNICAM) E-HEALTH AND TELEMEDICINE COURSES: A NEW AREA FOR UNIVERSITY EDUCATION**

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***Abstract:* The purpose and organization of postgraduate courses in the field of e-health and telemedicine organized by the University of Camerino are described. Challenges and possibilities of university education in e-health and telemedicine are discussed**

## **Introduction**

The interest in applications of communication technologies in medical interventions (e-health and telemedicine) is growing world-wide. They probably will contribute to improve in the future the quality of health care. e-Health represents a concerted effort of healthcare and hi-tech industries to harness the benefits available thanks to the convergence of the internet and healthcare. Access, cost, quality and portability represent relevant areas for the e-health care scenario.

There are several e-health products. They are health portals or health information sites; connectivity and communications solutions; e-commerce (on-line health insurance and drug prescriptions); disease diagnosis and management. At the present, areas of development of telemedicine include the possibility for physicians to assist distant patients through telecommunication, video conferencing between local hospital physicians and specialists in different branches of medicine, and/or the transmission of data of medical tests to specialised hospital.

In spite of the advances in information and communication technology (ICT), specific initiatives of education in the field of e-health of university level are sparse. This paper summarizes initiatives developed by the University of Camerino (UNICAM) since 2003 in the field of e-health and telemedicine education.

## **UNICAM, its location and tradition**

Camerino is a small town, with about 7,500 inhabitants today, located 661 meters above sea level, in the heart of Marche, a region in the centre of Italy. The University of Camerino is an old institution been a centre of

learning since no later than 1200 offering degrees in civil law, canonical law, medicine and literary studies. The pope Gregorius XI with the edict of 29 January 1377 authorized Camerino to confer, after appropriate examination, bachelor and doctoral degrees with apostolic authority. On the 15th of July of the same year, the pope Benedict XIII founded the *Universitas Camerinensis Studii Generalis* with faculties of theology, jurisprudence, medicine and mathematics. On April 13<sup>th</sup> 1753, the emperor Franz I Stephan of the Habsburg Lorena extended the validity of the degrees issued by Camerino University to the whole territory of the Holy Roman Empire. Today, more than 10,000 students attend UNICAM. UNICAM has 5 Faculties/Schools (Architecture, Jurisprudence, Pharmacy, Science and Technology, Veterinary Medicine), 13 departments and 5 campuses (Camerino, Ascoli Piceno, Matelica, Recanati, San Benedetto del Tronto).

### **The e-Health Master**

UNICAM involvement in e-health and telemedicine education started with the establishment of a Master course in e-health. This year, the course has reached its fourth edition. Master's activity is based on the attribution of a numerical score to the single disciplines, according to ECTS (European credit transfer and accumulation system). Requirement for admission to the e-Health Master is a second level university degree either in Medicine, Pharmacy, Biology, Informatics, Telecommunication technology or related disciplines. Earning of 60 ECTS is required to obtain the UNICAM e-Health Master. Master's organization is modular, with 6 common modules (36 ECTS), 3 modules for health professionals (18 ECTS) or for informatics and technology professionals (18 ECTS). The course is completed by a stage (4 ECTS) and a final dissertation (2 ECTS).

The syllabus of the Master course in e-health is summarized in Table I.

The fourth edition of the Master (academic year 2006-2007) is proposed for an international audience and is focused on e-health applications to oil and gas medicine.

### **The Postgraduate Qualification Course in Telemedicine and Telepharmacy**

The Postgraduate Qualification Course in Telemedicine and Telepharmacy started in the academic year 2005-2006 with the purpose to provide an academic background and qualification for improving healthcare to remote patients through telemedicine.

Table I

<b>Syllabus of the Master in e-health</b>
<i>Common modules syllabus</i>
<ol style="list-style-type: none"> <li>1. Telecommunication systems and their use in transferring biological and medical data</li> <li>2. Health without borders: ethical and regulatory aspects</li> <li>3. “e “in diagnosis and treatment procedures. Organization, handling and financial problems</li> <li>4. The information and communication technology society: European, National and local strategies. European Union e-health politics.</li> <li>5. Informatic platforms and health WEB sites. Handling of medical data</li> <li>6. Treatment of remote patients: applications of telemedicine</li> </ol>
<i>Health professionals modules syllabus</i>
<ol style="list-style-type: none"> <li>1. Organization of health-care systems</li> <li>2. Practical experiences of telemedicine and telepharmacy. European experiences in the field.</li> <li>3. The virtual vs. real hospital</li> </ol>
<i>Informatics and technology professionals modules</i>
<ol style="list-style-type: none"> <li>1. Technological infrastructures: networks , RDBMS , standards</li> <li>2. Peripherals for “Data input”</li> <li>3. Safety, electronic signature, coding</li> </ol>

Requirement for admission to the Postgraduate Course is a first level university degree either in medical or pharmaceutical sciences. Earning of 16 ECTS is required to obtain the qualification in Telemedicine and Telepharmacy. The Course has a modular organization, with 8 modules (8 ECTS), a stage (6 ECTS) and a final dissertation (2 ECTS). Table II summarizes the syllabus of the course.

The stage represented a key activity of student’s training. It consists in a full-time 4 week stay in authoritative structures with experience in different areas of e-health such as Centro Internazionale Radio Medico (International Radio Medical Centre, C.I.R.M.) and the Società Interbancaria per l’Automazione (S.I.A.). C.I.R.M. is the Italian Telemedical Maritime Assistance Service (TMAS) and represents the historical structure of Italian telemedicine. The Centre provides since 1935 free medical assistance to ships with no doctor on board. S.I.A. is the course’s privileged partner on

the side of information and communication technology (ICT) and has a leading experience in safety of internet communications and privacy protection.

Table II

<b>Syllabus of the Postgraduate Qualification Course in Telemedicine and Telepharmacy</b>	
1.	Telecommunication systems and their use in transferring biological and medical data
2.	e-Health: guidelines, ethical and regulatory aspects
3.	Health care systems: handling and organization through telematic systems
4.	The real versus virtual hospital
5.	Preparation, storage and transmission of medical data
6.	On-line teleconsultation
7.	Home care teleassistance
8.	Telemedicine, telepharmacy and practical experiences of assistance of remote patients

### **Conclusions**

Education in the fields of e-health and telemedicine of university level is of critical importance for the development of new applications of medicine and pharmacy. The mission of our Master and Postgraduate Qualification Courses is to provide to health professionals and related figures an independent evaluation of the different fields of e-health science and of their practical applications.

To better guarantee end users of telemedicine and telepharmacy, future professionals in these areas should receive adequate and business-independent university training. The development of European networks of university institutions working in the field will contribute significantly to establish specific and widely accepted curricula for satisfying the needs of qualification in the different applications of e-health, telemedicine and telepharmacy.

# **EVALUATING THE USE OF AN INTERNET COURSE WITH VIDEO DEMONSTRATION AND VIRTUAL MAN FOR TRAINING MEDICAL STUDENTS IN LIFESAVING PROCEDURES IN TRAUMA CARE**

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## **Introduction**

The efficacy of image based learning is a natural support for the use of illustrations such as pictures and movie pictures for training medical students in surgical procedures, allowing demonstrations of correct procedures, as well as simulated errors. In the 3-dimension animation project called The Virtual Man, developed by the Telemedicine Division of USP-SM for teaching/training medical students, we developed an internet Trauma Course that includes video demonstrations in 3-D animation of basic medical/surgical procedures based on records of real trauma patient care, and on demonstration in cadavers. The course is available through the internet, and includes texts, photos, diagrams, videos, and clinical cases. Two modules of the course are presented here: 1) Airways management; 2) Chest drainage.

## **Method**

The course was applied to the 6<sup>th</sup> year medical students (12 students per group) during their 3-week shift internship training periods at the Emergency Surgery Service (ESS) of the Hospital das Clínicas of the University of São Paulo School of Medicine (HC-USPSM), during the second semester of 2006. At his free registration for the optional participation in the course during 3-week stay, each student received his password to access the internet and course content (texts, figures, videos).

### Description of the course

The objective of the internet accessible course is to teach, update, systematize, and guide the student to perform medical procedures employed in emergency clinical situations.

Initially two modules were created: the first demonstrates airways permeabilization procedures employed in emergency situation, such as orotracheal intubation and cricothyroidostomy; and the second demonstrates the thoracic drainage, that is the therapeutic method for the treatment of pneumothorax and/or hemothorax, two clinical situations commonly diagnosed in trauma patients.

The theoretic content of the course included: clinical indications of the procedures, diagnosis of the diseases where the procedures are indicated, the techniques and complications of the procedures. The procedures presentation comprised: description (text and photos), and demonstrations presented in video and 3-D animation (virtual man). The videos were structured in such a way that allowed the student to recall and learn:

- 1- The anatomy of the body region where the procedure should be performed is identifying the anatomic structures and visualizing the sites of possible iatrogenic injuries. With this purpose, cadaver anatomy dissection videos were employed.
- 2- Moving pictures showing moving anatomic structures of interest during the performance of orotracheal intubation were recorded during a fibrobronchoscopy, with visualization of laryngeal anatomic details that have to be observed through the oral cavity during the intubation procedures. It can be observed, for instance, where the laryngoscopic lamina is placed during the procedure, as well as the vocal cords movements.
- 3- In the 3-D animation of the virtual man, it is used a technique that allows transparency of all structures of the head and neck, making it possible to demonstrate the movements of the anatomic structures and instruments during the procedure.
- 4- By means of purposefully performing a procedure in a wrong way, the student can realize how it is easy to make a iatrogenic technical failure, unless one follows carefully the correct technical steps of the procedure.

The application of the course was applied as follows:

- Presentation with pre-test
- Student registration via internet
- Taking the course via internet during three weeks

- Evaluation of the course – Final course evaluation questionnaire

### **Population aimed**

This course was applied to the 6<sup>th</sup> year medical students of the University of the USPSM. These students are in their last year of the medical course, taking their practical training period in the ESS of the HC-USPSM, in groups of 12 students, in a 3-weeks turning shift during the second semester of 2006.

### **Pre-test**

A questionnaire was applied on the first day of the training period of the student. After the answer of the pre-test, the student receives the information concerning the internet site, and instructions to perform his/her registration, and to take the course.

The pre-test contained:

- Questions aiming to know if the student knew, or had performed some of the procedures demonstrated in the course.
- Questions (multiple choice questions) aiming to evaluate the knowledge of the student about these procedures.

### **The course**

Using a personal computer, with access to high speed internet, the student accesses the course module and starts reading the theoretic content of the course. After reading each topic, he/she answers some reinforcing questions. The video presentations are distributed along the text, and may be accessed via internet. Owing to the heterogeneity of the PCs and of the velocity of the access to the internet, the student receives a CD containing the videos that may be individually visualized. At the end of each module, there is a questionnaire for evaluating the course content.

### **Final test**

In the last day of the training period at the ESS of the HC-USPSM, the students took a final test with questions aiming to evaluate the course, and also asking how many times during the training period he/she had performed one or more procedures mentioned in the test. This information was optional.

### **Result**

The course was applied in two phases. The first phase was a pilot course applied to a group of medical students during the second semester of 2006.

This pilot course served to identify the difficulties to access the internet site and the text, as well as the difficulties with the text. Some difficulty to access the internet provider was observed. No test was applied in this pilot phase. In the second semester of 2006 the course was applied to 77 students during their training period at the ESS of the HC-USPSM.

Concerning the knowledge acquired by the students in their medical course, previously to the beginning of our internet course, they informed that:

- 75 of them had performed and/or participated in the performance of orotracheal intubation,
- 30 of them had observed the performance of cricothyroidostomy (surgical access to the airways) and only two students informed to have assisted participated in this procedure,
- 55 students informed to have participated in a thoracic drainage.

Concerning the answer to the questionnaire on the knowledge previously acquired by the students, it was observed a mean of 84% of right answers. The questions more frequently answered wrongly were related to the diaphragm movement, and to the careful manipulation of the thoracic drain. During their training period, all the students have had the opportunity to perform at least one orotracheal intubation and one thorax drainage. Concerning the surgical access to the airway, only one student had participated the performance of this procedure. This is explained by the fact that orotracheal intubation is restricted to severe trauma patients, being therefore indicated in a small number of the ESS of the HC-USPSM patients, thus limiting the opportunity for students to train during the patients care.

As the participation in the evaluation of the course was voluntary, only 42 students answered the questionnaire. Five students pointed out the difficulties to access the internet site, usually related to the personal computer, and for this reason they did not take the course. Seven of 37 students reported difficulty to visualize the figures.

Concerning the video demonstrations of the procedures:

- 32 students indicated that the demonstrations were helpful for the learning of the procedures.
- 30 students indicated that the videos were helpful in the performance of the procedures,
- 29 students indicated that the videos accomplished the demonstration of the complications of the procedures.

The course was evaluated with a mean score of 8, in a scale of zero to 10 points. 33 of the 42 students who answered the final test, reported to be interested in participating of other similar models.

### **Conclusion**

One of the great problems in teaching the urgency/emergency medical care is that the diagnosis of the diseases or injuries, that rarely implies the risk of the patient's death, has to be achieved rapidly. Owing to the severity of these injuries or diseases, it is very difficult to train and update a great number of students (medical doctors or medical students). The teaching method here employed, using images (videos, moving pictures, and virtual man) and text, and taking advantage of the informatics and image editing resources, seems to have reached effective result in this studied population. More experience is warranted to better evaluate its structure, application, and efficacy.

# THE ORGANIZATION AND IMPLEMENTATION OF DISTANCE EDUCATION IN GEORGIA

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**Abstract:** World Wide Web (WWW) and compact disc-read only memory technologies have introduced new prospects for delivering continuing medical education (CME) to regional healthcare professionals. However, evidence concerning the effectiveness of these technologies in providing CME, and approaches to their evaluation, is limited. The rationale of the present article is to present a model for evaluating the effectiveness of computer-mediated CME courseware. The model is the second-year result of NATO Networking Infrastructure Grant, which aims to promote the development of telemedicine in non-NATO countries. The project implemented a pilot to organize the creation of national eHealth network in Georgia and to promote the use of innovative distance consultation and eLearning services in Georgian healthcare system.

## Introduction

In recent years, the landscape of the distance education field has been transformed. Significant advances in information and communication technology have enabled the rapid movement of information to almost anywhere in the world. The increased capacities of these information and communication technologies have also contributed to a movement away from traditional continuing medical education (CME). Reference [1] state, "We believe that the forces that are currently changing health care will shortly provide opportunities to create a new CME, one that will be more accessible, more convenient, and more relevant. This will be the new paradigm for CME". The first experiments with computer-assisted instruction (CAI) in medical education began in the 1960s at Ohio State University, where computers were used as instructional tools for simulating patient encounters [2]. Since these early studies, CAI has grown and

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proliferated among medical schools and colleges. In the United States, the Association of American Medical Colleges has greatly recommended the production and use of educational software in medical schools [3].

In recent times, the growth of the Internet and the World Wide Web (WWW) has created new opportunities for providing CME at a distance. Marshall University's School of Medicine has produced a CME Web-based course to improve physicians' clinical and history-taking skills, which is accredited for 1 hour of CME credit [4]. The system stimulates an actual patient encounter, with the learner playing the part of examining physician and the program acting as patient. Similarly, the University of Iowa College of Medicine has developed an online "virtual hospital" [5]. This WWW program includes multimedia teaching files, current diagnostic and therapeutic algorithms, patient simulations, historical information, patient instructional data, and access to online CME materials.

The modern computer technologies of the Internet and CD-ROM offer significant opportunities for addressing the CME needs of rural and remote physicians. However, given the novelty of the media for CME delivery and educational research, there is little understanding of how effective these new computer-mediated learning technologies are in providing CME at a distance. Reference [6] believes that considerable experience has already been accumulated with regard to the use of information and communication technologies in distance education. Evaluation research studies are needed if these new instructional technologies are to be successfully developed and effectively used in the continuing education of rural and remote healthcare providers. Rural communities need guidance before they invest scarce resources in expensive technologies that may not be appropriate or adequate for their needs. Governments, healthcare boards, and medical education providers need additional information to assure that new rural "telemedicine" and distance education projects are appropriate and effective. As well, reliable information about how well different technologies work for different purposes, the effectiveness of these technologies in achieving identified outcome measures, and the lessons that have been learned by the pioneers in this field could help other avoid the same mistakes and improve on their efforts.

Educational evaluation has since evolved and newer approaches have tended to advocate a focus on the actors and stakeholders in educational programming, the process of teaching, and the intricacies of the instructional context. Reference [7] notes, that "as evaluation has changed from an algorithmic to a more heuristic methodology, it has become situation-specific". The evaluation approaches have constantly been adapted and/or new ones have been invented to meet the varying needs of programs

and program audiences [8]. Far from working against the prospective evaluator, the evolution of evaluation approaches and the array of evaluation models and methods from which an evaluator may choose can be used to a practitioner's advantage. Reference [9] reports that experienced evaluators rarely follow a specific evaluation model; rather they are more likely to modify a model or models to suit a particular situation. Reference [9] states the following: "In many situations, rather than extensively adapting a particular approach, you might be better off to construct your own, borrowing the parts of other approaches that are most useful and building patterns and processes that are appropriate to your needs". Reference [10] suggests that there is no consensus around a best or right model of evaluation. She points out that there are a variety of approaches and methods to choose from and those evaluators can choose one approach or a combination of approaches to meet the purposes and resources available to them at the time. The procedures of an evaluation should be designed to address the local purposes for which the evaluation is being set up; this will obviously change according to the program being evaluated.

### **Description of the System**

The "Virtual Health Care Knowledge Center in Georgia" project is providing a new teaching/learning service based on collaborative and bi- and multi-directional communication processes. Interest in co-operation does not affect only teaching but all intellectual and cognitive activities, "collaborative learning" refers to a method in which actors work together towards a common task. Healthcare professionals are traditionally responsible for their own and their fellow's learning; in this way, individual success helps all other to achieve positive results. In fact an active exchange of ideas in between small groups does not only improve the interest in communicating but also promotes a development of a more critical thinking. The project's main telemedicine applications concern remote second opinion consultations and teleconferencing, but the main application that has been implemented is eLearning. Health is now following a "delocalization" process: information and especially knowledge and skills should be moved, rather than people or tools. The "Virtual Health Care Knowledge Center in Georgia" project offers healthcare organizations the chance to extend their information services to a larger medical community [11].

### **Objectives and Advantages**

eLearning may be defined as the application of communication technologies to acquire new knowledge or skills across the whole range of

areas which will affect healthcare professionals. And enrich their experience in rendering the best possible care to patients through out the process of medical care. eLearning has the ability to apply new concepts, and ideas in which the learner becomes an owner of that knowledge, without any respect to distance. eLearning is significant part of healthcare revolution, since the event of modern medicine. The addition of technology should not substitute for failed pedagogical process, but technology should allow that educational process, and the message to be disseminated, and tailored to individual groups and professionals, by retaining along some of the educational principles of traditional education. eLearning centres on the following principal issues:

- Distance education;
- Continuous medical education (CME) for medical professionals;
- Advanced healthcare professionals education in the changing environment;
- Patient's education in health related issues in the information age.

The question how technology will change our world is not anymore relevant. The answer to this question is obvious. Advanced technologies such as computers, diagnostic imaging, robotics, voice-activating machines, and remote controls have changes hospitals and operating theatres in hospitals around the western world. In parallel with these developments, the patient has become an educated and informed consumer who:

- Questions the decisions of the practitioner and demand explanations and an evidence based medicine approach;
- Validates his or her expertise through web sites and other forms;
- Requires that the doctor offers care, current with world standards.

eLearning has potential to:

- Change the delivery of existing medical care and will create more efficient and economically sound healthcare systems, where advanced medical knowledge will prevent unnecessary transfers of patients to countries who can care for those patients, and/or prevent death and morbidity because country's medical professional will be well prepared.
- Will bring together a coalition of new partners with innovative boundaries and clear vision.

This last element is most important, especially in countries with middle and low income, devastated by wars, suffering, political neglect or poverty. The implementation of eLearning as an expression of needs and demands from the public and healthcare providers is based on a growing concern for medical errors, advances of patient-centred healthcare systems; need to

improve cost-benefit ratios and rationalizations of healthcare and citizen mobility.

The entire aspects of needs and demands as pertained to eLearning process needs to be centred in described issues of distance education, advanced healthcare professionals education in the changing environment, continuous medical education (CME) for medical professionals, and patient's education in health related issues in the information age, and change. Furthermore, one should have in mind the core competencies needed for healthcare professionals that have been created and require common vision across the professions. These competencies are:

- Patient centred care;
- Work on inter-disciplinary teams;
- Employ evidenced-based practices;
- Apply quality improvement techniques; and
- Utilize informatics.

The origin of these five competencies comes from the need to redesign better systems to address the health needs of the population. The Quality Chasm report has identified important rules that guide the transition to a health system, to better meet the patient's needs. Among these rules, most important one are those that make patient a central part of the entire equation. While all five competencies are extremely important, the utilization of informatics as an important element of eHealth can effectively:

- Reduce the medical errors;
- Helps manage the knowledge and information, and support the decisions making process based on evidence based practice guidelines;
- Ensures better communication between healthcare providers and patient;
- Advance the goals of redesigning the healthcare systems.

As a result, the core competencies help implement new evidence based medicine protocols, and support the notion that, every citizen of the world need to receive the best possible existing care.

### **Results and Future Perspectives**

The second year of implementation of NATO Networking Infrastructure Grant "Virtual Health Care Knowledge Center in Georgia" was focused upon implementation of continuous medical education programs by application of distance education possibilities. Moodle and Skype were used as the technological background. The use of well defined education

programs for healthcare providers will be the cornerstone of the new revolution of the “e-era”. Current specific challenges in implementing eLearning and other revolutionary advances for healthcare professions educations are:

- Lack of funding, lack of faculty and faculty development programs;
- Lack of coordination and integration of, accreditation, licensing, and certification process at the governmental and institutional level;
- Lack of application existing evidence based medicine;
- Shortage of visionary leaders and champions;
- Crowded curricula of medical education for healthcare professional, often with irrelevant courses;
- Insufficient channels to share the information on the best practices, among medical professionals, governments and institutions.

As it was already mentioned above, eLearning is a very important element of overall progress in the eHealth. In order to be able to advance this, as an accepted culture and part of the daily practice of healthcare professionals, there are many initiatives that need to be taken, or existing one to be supported. Few issues that need resolved in order for eLearning education to prosper and be accepted are:

- “Product” acceptance by traditional medical educators, scholars, and legislators;
- Changing the old style of education to the new one and thus breaking the “traditional” classroom medical teaching and learning methods;
- Lack of capability and availability of technology in most of the world for disseminating the knowledge, or in other words lack of communications;
- Language and cultural diversity;
- Socioeconomic and political status of the countries in need for eLearning;
- Legislative policies and championships for new information age.

While technological means for broadcasting and transmission of the eLearning programs and clinical data is becoming abundant around the world, there is a great part of the planet that is not covered by Internet and will not have the ability to overcome the digital divide for decades to come. This should be our chance to advance the cause, and the issue, of eLearning among the countries and the nations that need help, lack technological infrastructure and perhaps a vision in some cases. The web-based

technology's support of eLearning programs has the most outstanding capacity to ensure this process has flourished. The benefits to mankind are enormous.

### **Acknowledgment**

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### **References**

- [1] DE Moore, JS Green, SJ Jay, JC Leist, FM Maitland. Creating a new paradigm for CME: Seizing opportunities within the health care revolution. *Journal of Continuing Education in the Health Professions*, 1994, 14, pp.4-31.
- [2] TE Piemme. Concurrent formative evaluation: Guidelines and implications for multimedia designers. *Educational Technology*, 1995, 35(6), pp.24-31.
- [3] K Hayes, CU Lehman. The interactive patient: A multimedia interactive educational tool on the world wide web. *M.D. Computing*, 1996, 14(4), pp.330-334.
- [4] JR Galvin, MP D'Alessandro, WE Erkonen, TA Knutson, DL Lacey. The virtual hospital: A new paradigm for lifelong learning in radiology. *Radiographics*, 1994,14, pp.875-879.
- [5] BA Collis. Evaluating instructional applications of telecommunications in distance education. *Educational Technology & Training International*, 1993, 30(3), pp.266-274.
- [6] BD Kerr. A responsive evaluation of a graduate distance education course offering. Unpublished thesis, Memorial University of Newfoundland at St. John's, 1997.
- [7] BR Worthen, JR Sanders. *Educational evaluation: Alternative approaches and practical guidelines*. New York: Longman, 1987.
- [8] SM Steele. *Contemporary approaches to program evaluation and their implications for evaluating programs for disadvantaged adults*. Syracuse, NY: ERIC Clearinghouse on Adult Education, 1973.
- [9] M Thorpe. *Evaluating open and distance learning*. London: Longman, 1993.
- [10] M.-O Berndt. Setup and Administration of the Base-Server of the "Virtual-Health-Care-Center of Georgia". Diploma thesis, 2005.

## **VIRTUAL MAN, CYBERTUTOR: A PROJECT IN DENTISTRY**

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**Abstract:** The virtual man and “the cybertutor” have been used in Sacred Heart University (USC) since 2004. Our students had difficulties to understand what happened with the teeth, TMJ (temporomandibular joint) and muscles during the lateral, protrusion, opening and closing movements [3]. They could see these different situations only in 2D, using a slide show. Because of this, we developed the virtual man CD-ROM associated with “the cybertutor”. These learning tools help the graduate and post graduate students to understand the physiology movements of the mouth. The project combines 3D images (TMJ CD-ROM) with lessons using a web-based electronic teacher (“the cybertutor”). Using this new technology (TMJ CD-ROM and “the cybertutor”) the students answered qualitative questions and they showed to be able to learn a large amount of information in a short time.

### **Introduction**

The project of the Telemedicine Discipline (University of São Paulo-FMUSP) is based on the concept of learning tools and combines images and movements of high visual and didactic quality [1]. “The cybertutor” is a web-based electronic teacher. In Dentistry, there is a TMJ (temporomandibular junction) that is very important to understand all the movements of the human mouth.

This paper presents a CD-ROM which combined with “the cybertutor” offers a more efficient way for the students to learn [2].

## Objectives

To qualitatively evaluate the acceptability of undergraduate students using a new learning tool which includes 3D images associated with “the cybertutor”.

## Methods

The virtual man CD-ROM and “the cybertutor” were applied to 62 students associated with a previous traditional class about TMJ anatomy and physiology. The CD-ROM presents TMJ anatomy as well as lateral, protrusion, closing and opening movements. The students answered a 7-question based survey about the applicability of this method of learning.

## Results

(1) The method was evaluated as very good (58.06%), good (38.71%),



*Fig. 1 Students using the virtual man*

reasonable (3.23%), and bad (0%).

(2) 93% of the students reported this method could be extended to all disciplines in Dentistry.

(3) 48.39% preferred the traditional method while 56.45% “the cybertutor” method.



*Fig. 2 Students accessing “the cybertutor”*

(4) 83.87% agreed this method should be used prior to expository class.

(5) 96.77% believe this method helps the learning process of traditional classes, however does not substitute them.

(6) The presence of a teacher would result in a more productive learning for 50.0% of the students, while for 46.77% on-line answers would be sufficient.

(7) First contact with the technology was reported by 64.52%.

### **Conclusions**

The possibility of 3D visualization, establishment of anatomic correlations, utilization of transparency resources, subtraction (exclusion) and inclusion of functional dynamics, transforms the virtual man model combined with “the cybertutor” in an absolute new way of transmitting a large amount of information in a short time. Due to the development of modern iconographic resources, it increases the educational efficiency, and is largely indicated according to the students interviewed.

### **References**

- [1] C. L. Wen et al. Telemedicine and Education in Brasil. *Journal of Telemedicine and Telecare*, vol. 5, pp. 137-138, 1999.
- [2] C. L. Wen et al. Internet discussion lists as an educational tool. *Journal of Telemedicine and Telecare*, vol. 6, pp. 302-304, 2000.
- [3] J. P. Okeson. *Tratamento das desordens temporomandibulares e oclusão*. Artes Médicas, 2000.

**EHEALTH SOLUTIONS FOR DIABETES  
MANAGEMENT**

# A COMPLETE MOBILE EHEALTH SOLUTION FOR DIABETES MANAGEMENT

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**Abstract:** Monitoring of blood glucose is an integral part of treating diabetes as it supplies essential information to the health care personnel to adjust the therapy. Self-monitoring of blood glucose gives the patient the possibility of immediately seeing the effects of certain activities, foods and drinks on glucose level. This paper introduces a mobile diabetes management system that represents a complete home-care diabetes solution integrating seamless and real-time patient-doctor communications with the patient's medical record and nursing support. The system mainly consists of a mobile platform wirelessly collecting the information from the measuring devices, and a server platform receiving the collected data and forwarding them to the existing diabetes management system. The mobile platform can be used on different devices such as mobile phones, smart phones and Personal Digital Assistants (PDA).

## Introduction

Diabetes mellitus is a lifelong, chronic condition that is characterized by the body's inability to control glucose levels in the blood [1].

Diabetes affects about 22.5 million adults in the European Region and it is rapidly increasing in most countries. Moreover, it has changed from mainly affecting older people to also afflicting people in the first half of their lives [2].

Recent projections, based on the assumption of a stable obesity rate, foresee that at least about 26 million citizens in Europe (about 6 per cent of the population) will be affected by diabetes in the EU by 2030 [2].

Monitoring of blood glucose is an integral part of treating diabetes as it supplies essential information to the health care personnel to adjust the therapy [1]. Self-monitoring of blood glucose gives the patient the possibility of immediately seeing the effects of certain activities, foods and drinks on glucose level [1].

eHIT Ltd's mobile diabetes management system presents a complete home-care diabetes solution integrating seamless and real-time patient-

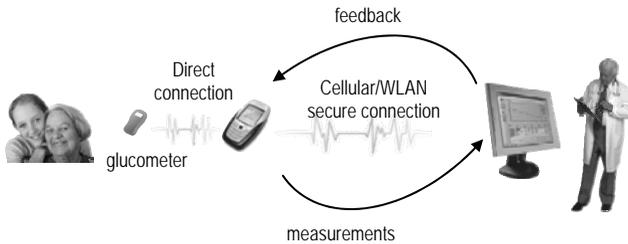


Fig. 1 Use of Health Gateway Diabetes management solution

doctor communications with the patient’s medical record and nursing support.

The system utilizes eHIT’s Health Gateway [3 - 5], an effective and secure tool that transfers data from different measurement devices to the health care provider via a mobile platform by using cellular network (such as GSM, GPRS, CDMA and 3G) or wireless LAN network. Health Gateway ensures that measurement results are accurate, available and both cost and time effective, providing the best patient and nursing communication.

Timely review of patient data with close to real-time feedback is a critical success factor in today’s disease management environment. With this eHealth solution maintenance and treatment become faster and easier as compliance improves.

### System functionality

The presented system mainly consists of a mobile platform wirelessly collecting the information from the measuring devices, and a server

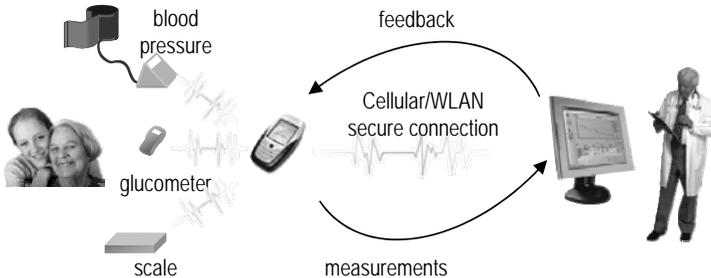


Fig. 2 Use of Health Gateway Diabetes management solutions to register key information in diabetes care

platform receiving the collected data and forwarding them to the existing Diabetes Management System.

The mobile platform can be used on different devices such as mobile phones, smart phones and Personal Digital Assistants (PDA).

A single mobile device can collect, store and transfer information from different measuring devices, making possible the integration of devices from different manufacturers. For instance a blood glucose meters from Lifescan [6], Bayer HealthCare [7], Roche Diagnostics [1], ARKRAY [8] or Menarini Diagnostics [9] can be used with the same mobile solution.

The collected data is automatically transferred to the health care provider by using a secure cellular or wireless LAN connection. This information can be stored in the Health Gateway [3][4][5] server or directly forwarded to an existing diabetes management system. In this way measurement results are always unbiased and they are available to the health care professionals in real-time and in the correct form.

The patients have the possibility to browse the results from a list or to have them displayed in a clear graphical follow-up form directly on the display of their mobile device just like a personal diabetes diary. This gives the patient an immediate overview of his/her blood glucose behavior.

In addition to collecting information from the glucometer, the same Health Gateway mobile device can wirelessly collect measurements also

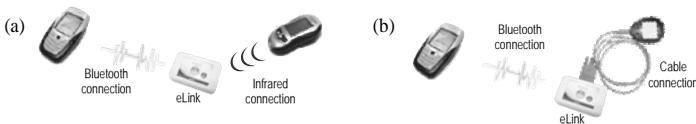


Fig. 3 Use of eLink to enable (a) infrared and (b) cable connections

from an electronic scale and a blood pressure monitor.

This additional weight and blood pressure monitoring helps in giving the health care personnel a more complete picture of the condition of the patient. All of this information is linked together and sent to the health care professionals, who can send a feedback to the patient after analysis or consultation.

Therefore, in addition to instantly viewing their progresses on the mobile device display, patients can also receive information from the caring personnel regarding for instance changes to the treatment, diet or exercise program.

### Device Integration

Most manufacturers of modern mobile devices are replacing infrared and cable interfaces with a wireless Bluetooth connection. However, the communication possibility offered by a number of existing glucometers is still limited to infrared or cable. This restricts the number of glucometers that can be used with a given mobile device. To overcome these connectivity issues we have used a special hardware adapter module called eLink [5]. eLink is a standalone, battery-operated and small-sized module, which transparently converts measurement device cable and infrared communication into wireless Bluetooth communication. With eLink, a wide range of existing glucometers, which would be otherwise impossible to interface, can be taken in use. This also allows the use of different manufacturer devices with the same mobile solution without a problem.

A special feature of the eLink adapter is the “smart connect” function, which is the capability of initiating a connection to the mobile device. By using the “smart connect” function, the data extraction procedure from the measurement device can be initiated automatically from eLink.

### Conclusion

The presented system shows its potentiality in improving care and treatment by making them more effective, faster and easier. Direct download of the measured values means also unbiased results.

The use of the system is very intuitive as patients are guided step by step through the procedure. Patients feel themselves more motivated, as they can follow the progress of the treatment directly on their mobile devices regardless of time and location. Also the possibility of receiving an immediate feedback from the health care provider can be seen as an important aspect, which increases self-confidence in the patient.

### References

- [1] Roche UK website, <http://www.rocheuk.com>.
- [2] The European Health Report 2002, WHO.
- [3] A. Holopainen, F. Galbiati, K. Voutilainen, “Health Gateway – a complete solution for wireless data transfer and follow up of patient data,” in *Med-e-Tel 2006 Proceedings*, 2006, pp. 93-97.
- [4] A. Holopainen, F. Galbiati, K. Voutilainen, “Use of Smart Phone Technologies to Offer Easy-to-Use and Cost-Effective Telemedicine Services,” in *First International Conference on the Digital Society (ICDS'07)*, 2007, pp. 4.
- [5] A. Holopainen, F. Galbiati, K. Voutilainen, “Use of modern mobile technologies to enhance remote self-care services,” in *Proceedings of the 6th Nordic Conference on eHealth and Telemedicine*, Finland, 2006, pp. 139-140.
- [6] Lifescan Inc website, <http://www.lifescan.com>.
- [7] Bayer HealthCare Diabetes Care website, <http://www.bayercaresdiabetes.com>.
- [8] ARKRAY website, <http://www.arkray.co.jp>.
- [9] A.Menarini Diagnostics website, <http://www.menarini.com>.

## **EHEALTH IN DAILY PRACTICE**

# **AN ELECTRONIC HEALTH RECORD FOR SCOTLAND: LEGAL PROBLEMS REGARDING ACCESS AND MAINTENANCE**

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**Abstract: This paper examines the problems of liability related to the access to and maintenance of Electronic Health Records**

## **Introduction**

Scotland intends to introduce an Electronic Health Record (EHR) to provide an open data system for the health service. This paper examines the problems of confidentiality and liability, regarding, first, a question of creation and control over the EHR, and second, a problem of access.

## **Four Models for an HER**

Terry and Francis have suggested four types of models for an EHR: [1]

The Personal EHR model focuses on the patient as the chief manager and custodian of the record, which is composed of fields into which the patient enters the relevant data or manages the data export from the GP's records. The Shared EHR model sees responsibility for maintenance and control shared between patient and GP. Responsibility can shift from resting on both patient and GP to a fairly one-sided arrangement with either party being more responsible for maintenance and control over the record. For the Trustee model, patients enter into a contract with a third party, the trustee, to keep and control the EHR. Overall control, however, will still rest with the patient. The Interoperable EHR model is a fully longitudinal system, transforming the current paper records system to its electronic equivalent, either at regional or national level with patient input reduced to a minimum.

Obviously, a record managed by the patient creates less confidentiality problems, as the patient herself determines access. In the shared record, it will depend on where the responsibility for maintenance will ultimately lie. The more patient involvement, the less confidentiality problems can be expected. In the trustee model, confidentiality is secured as the patient decides what data are transferred to the fiduciary. Still, the trustee may break the contract and process data. Hence, maintaining confidentiality will depend on the fiduciary's trustworthiness. The final model carries the greatest risk of breaches of confidentiality with little patient involvement, as

sharing of data in a legally and ethically sound way rests solely within the responsibility of the health care providers. Without a stringent access policy, unauthorised staff members of the healthcare provider may have access to sensitive personal data. With proper systems having been instituted, however, this could also be the most protected system.

Liability issues: In the current system, if an error in the medical records leads to a negative development in the patient's health, the healthcare professionals responsible for the entry and the subsequent treatment will be held liable, no matter whether they are one and same or different persons. A larger patient involvement in creating and controlling the record may shift this liability. The UK courts have developed a complex means to determine liability for healthcare. The main prerequisite is that negligence must be proven, [2] with three requirements: the healthcare professional owes the patient a duty of care; a breach of this duty has occurred, i.e. the standard of treatment was below the ordinary skill of an ordinary man exercising this particular art, [3] and causation can be proven, i.e. the sub-standard treatment led to harm. The duty of care, again, consists of three different aspects: the risk of harm is foreseeable, a sufficient proximity exists between healthcare professional and patient, and it is fair, just and reasonable to impose the duty of care.

If a patient is responsible for maintaining the EHR, this liability could shift. If she transfers data from the GP's record into the EHR, does the responsibility for accuracy rest with the GP? If due to a mistake in the EHR, the patient receives a wrong treatment, is the doctor liable? The duty of care is not in doubt and the existence of a breach of this duty is also unquestionable. Finally, causation must be proven. *Prima facie*, the wrong treatment led to the patient being harmed. The question, however, is: when and where do we need to start looking for causation. Do we start at the beginning of the treatment, or where the hospital doctor consults the records, or at the point where the mistake in the entry occurred? This leads to the rather astonishing conclusion that the patient herself must be held liable for the harm she suffered. On the other hand, however, should we consider it part of the healthcare professional's duty to check the accuracy of the record? Would it not be negligent to proceed on the basis of the record alone? The answer is that it would depend on the setup of the record. If the record is checked after the patient has entered the details, then the healthcare professionals could certainly be held liable for not noticing the mistake. If, however, the record is only checked at certain intervals, or immediately before the information is required, then, in an emergency situation, the record might not have been checked.

In the shared model, with both healthcare provider and patient responsible for maintaining the record, determining liability can prove complex and, again, causation constitutes the problem. Only in this case, what if it cannot easily be determined whether the patient or the GP made the mistake. In the worst case scenario, a complex IT investigation would have to take place. It is also perfectly possible for several people to have caused the harm and be jointly liable. It is unlikely; however, that any record system would place all of the blame on the patient, but chances are that the nature of the duty owed by the healthcare professionals will shift if the error in record keeping is indeed to be found to rest with the patient.

For the trustee model, it is obvious that the fiduciary cannot be held liable as he only keeps the records, but does not maintain them or add to them. Like the shared record, liability will have to be determined through deliberating who holds overall responsibility for the entry in question. For the last model, as an outpatient without GP transferral, patients currently get a print-out of diagnosis and prescription to give to their GP, i.e. they are responsible for a decline in their health due to failure to hand the print-out over. With the new EHR, patient involvement is no longer required; hence, patients won't be responsible for inaccuracies in the record.

### **Access to records in healthcare**

The main problem arising from access relates to confidentiality. Patients are looked after by an extended health care team with linked datasets joining different bodies, from ambulance to A&E to intensive care unit and normal ward. If these do not communicate, there is a potential risk for the patient. The EHR will facilitate communication, if, healthcare professionals will be able to access the data. At the same time, care will need to be taken that only authorised people have access. But where will the line be drawn?

As regards the access problem, Social Services can serve as an example. While they *may* have an important role to play in some patients' care, their involvement is not automatically given. So, should Social Services be included? A look at data protection law may provide an answer. In the UK, the Data Protection Act protects personal data and safeguards against unlawful processing. Health data may only be processed if one condition each of Schedule 2 and 3 of the Act is fulfilled [4]. For sensitive medical data, more stringent requirements are set and two conditions need to be fulfilled. The two schedules in the Data Protection Act offer many justifications for legitimate data processing. Schedule 2 states, e.g., that processing has to occur in the vital interests of the data subject. Schedule 3 8 (2) allows processing for medical purposes, including, amongst others, the provision of care and treatment and the management of healthcare services.

Clearly, this is unproblematic for those mentioned above, as they are involved in the patient's care. But what about, for example, Social Services who are only involved in a percentage of cases? For Schedule 3 8 (2), it needs to be decided whether 'care and treatment' will need to be read together as one item or interpreted as 'providing care *and* providing treatment'. If we agree on the latter, then providing Social Services with access is unproblematic. Or should we err on the side of caution and prefer the narrow interpretation? If we consider the structure of the sentence, the narrow interpretation would be more accurate, each individual purpose is separated from the others by commas and two conjunctions. Since in a properly structured syntax the conjunction 'and' is only used to link the last two parts of the sentence, the conclusion can be drawn that 'care and treatment' should be read together. If we accept this, then there is a strong case for not providing Social Services with access to the data.

Schedule 2.4 introduces a broader notion by permitting data processing when it is necessary in order to protect the vital interests of the data subject. If, however, the situation does not call for Social Services' involvement, it could be argued that the vital interests of the patient are not affected.

In both cases, whether we consider Schedule 2.4 or Schedule 3.8, the outcome depends on the point of view. If we consider the individual patient, then the above argumentation would apply. If, however, we were to look at healthcare in general, then the situation would be different and either condition might apply. However, the Information Commissioner promotes a case-by-case approach in cases of doubt. This approach, however, is problematic for practical purposes, as it defies the purpose of the EHR – providing easy shared access.

### Conclusion

As the above demonstrates clearly, the application of information technology to healthcare and medical research is accompanied by considerable legal and ethical problems. Ideally, the multiple questions raised should be answered to a large extent before the EHR is converted from theory to practice. Before adopting any of the four models or developing a different approach altogether, considerable more research will need to be performed.

### References

- [1] N Terry and L P Francis, "Ensuring the privacy and confidentiality of electronic health records," *University of Illinois Law Review* (Forthcoming 2007).
- [2] The much discussed *Bolam* test, derived from *Bolam v Friern Hospital Management Committee* [1957] 2 All ER 118, [1957] 1 WLR 582.
- [3] *Caparo Industries plc v Dickman* [1990] 2 AC 605; [1990] All ER 568 (HL).
- [4] {[www.opsi.gov.uk/ACTS/acts1998/80029](http://www.opsi.gov.uk/ACTS/acts1998/80029)}--n.htm#sch2; --o.htm#sch3.

## **BRAZILIAN NATIONAL TELEHEALTH PROGRAM**

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Although a lot has been said about the use of Telemedicine and Telehealth to improve the efficiency of health systems, and all other benefits that they can provide, it is wise to mention a fundamental aspect: new technology can only get its whole potential when there is a commitment of human resources concerning the use of these new technology and an effective integration among member institutions in order to add efforts to multiply results. When it is worked that way technology becomes a useful tool to manage a process or a strategy, which makes team collaboration easier allowing integrated activities within the communities. Besides that, a successful project at national level must always respect regional differences, cultural, geographical, social, economical and infrastructure characteristics.

The Brazilian health scenario has changed with the implementation of the Health Family Program (PSF). Nowadays there are about 26,000 teams which cover approximately 100,000.000 inhabitants, being present in 85% of the 5,564 Brazilian municipalities.

The Telehealth National Program has as its goal to integrate the health family teams among the several regions of the country with universities and university hospitals, to improve the quality of services rendered to wards primary care. Thus, it is expected to lower costs concerning health services by professional qualification, to reduce the number of transportation of patients and to increase disease prevention activities [1-2, 12]. The participating states and respective universities of the pilot project are: Federal and State Universities of Amazon, Federal Universities of Ceará, Pernambuco, Goiás, Minas Gerais, Santa Catarina, Rio Grande do Sul and Universities of the State of Rio de Janeiro and São Paulo. The actions of the pilot project are focused on the qualification of the health family teams by the creation of a educational center using interactive Tele-education, together with a virtual library that will help the Family Health Program (FHP) professionals to have continuous access to updated scientific information. The disease prevention activities are one of the priorities, so easy understanding audio-visual resources will be used. E.g.: (Projeto

Homem Virtual and Geração Saúde) so that the FHP professionals can be able to motivate populations to commit themselves to improve life quality in their communities [1-4].

The specialized support from the second opinion provided by a specialist in education shall make the family health teams access easier to professional counseling for problem solving, exempting the need to remove the patients from their homes in order to be treated. This is a modern form of qualifying professionals according to the region needs. The decision making process are facilitated because of the integration of the FHP posts with the Telehealth Nuclei implanted at the universities [5-10].

The creation of a community to share experiences allows that the difficulties and solutions from a region may be used by professionals from other regions [11]. The created network also allows the practical transit of epidemiologic information, which may be spread by health family teams. Continuous education and *tele-appointments* feed a large and strategic database to be used for decision making in relation to endemics and pandemics [5, 9].

The program foresees the integrated qualification of all professionals involved with primary care: doctors, nurses, dentists, dentist auxiliaries, nursing technicians and auxiliaries, and health community agents. Understanding the need of the multi institutional participation to unite the academic expertise with the governmental needs of public health, to add resources through an inter-ministerial participation together with state and municipalities managers, the Ministry of Health has developed several initiatives. For instance: Creation of the Permanent Commission of Telehealth of the Ministry of Health, involving representatives from several institutions, universities and the Ministry of Education, Ministry of Science and Technology, Ministry of Health and the Ministry of Defense. The activities of this commission have as their main goal to establish a National Development Plan of Telehealth in Brazil.

The signature of the Protocol of Intention by the Ministry of Health, Ministry of Science and Technology, and Ministry of Education, shall provide the implementation of the (NRN) National Network of Research and to integrate 32 links. This will allow the implementation of at least two posts of Telehealth in each of the 27 Brazilian states.

## Reference

[1] Chao LW, Oliveira Filho J, Arouca LV, Oliveira MR, Böhm GM. Web educational model for the brazilian population using VRML and interactive evaluation. *Telemedicine J and e-Health*, 2001; 7(2):132.

[2] Chao LW. Virtual ambulatory model (Cyberambulatory) e eletronic tutor (Cybertutor) for medical second opinion and used in e-learning. [thesis – Associate Professor]. Faculty of

Medicine of University of São Paulo,; São Paulo; 2003. Available on <http://www.saudetotal.com/teseChao2/00IndiceAnalítico.htm>.

[3] Malmström MFV, Marchi MM, Wen LW, Böhm GM. Use of a virtual 3D model for educational purposes em odontology. The 9<sup>th</sup> European Congress of DentoMaxilloFacial Radiology, 17-19 of June 2004, Malmö, Sweden, page 33.

[4] Kavamoto CA, Chao LW, Battistella LR, Böhm GM. A Brazilian model of distance education in physical medicine and rehabilitation based on videoconferencing and internet learning. *Journal of Telemedicine and Telecare*, 2005; 11:S1:80-82.

[5] Chao LW, Cestari TF, Bakos L, Oliveira MR, Miot HA, Böhm GM. Evaluation of an Internet-based tedermatology system. *Journal of Telemedicine and Telecare*, 2003; 9:S1:9-12.

[6] Chao LW, Enokihara MY, Silveira PSP, Gomes SR, Böhm GM. Telemedicine model for training non-medical persons in the early recognition of melanoma. *Journal of Telemedicine and Telecare*, 2003; 9:S1:4-7.

[7] Oliveira MR, Chao LW, Festa Neto C, Silveira PSP, Rivitti EA, Böhm GM. "A Web site for training nonmedical health-care workers to identify potentially malignant skin lesions and for teledermatology". *Telemed. J. e-Health* 2002; 8(3):323-32.

[8] Chao LW, Oliveira MR, Festa neto C, Macea JM, Alves ACF; Rivitti EA; Böhm GM. On line teledermatological diagnostic using digital images and conventional telephone lines. Conference Proceeding of the 9<sup>th</sup> International Conference on Telemedicine and Telecare, Telemedicine & e-Health – "Telemed '02", London. TM02/15:220, 2002.

[9] Taleb AC, Chao LW, Avila M, Böhm GM. Teleophtalmology as a tool for cataract campaigns in Brazil. *Telemicine J and E-Health*, 2004; 10 (S1):33.

[10] Massad E, Marin HC, Azevedo Neto RS, Lira ACO, Rocha AF, Leão BF, Chao LW, Ferreira DP, Zanetta DMT, Böhm GM, Novaes HMD, Moura Jr LA, Amaral MB, Silveira PSP, Furie SS, Levy S, Tachinardi U, Rodrigues RJ. O prontuário eletrônico do paciente na assistência, informação e conhecimento médico (The medical electronic records in assistance activity and the medical knowledge)- Editores Massad E, Marin HC, Azevedo Neto RS, Março 2003.

[11] Chao LW, Silveira PSP, Azevedo Neto RS, Böhm GM. Internet discussion lists as an educational tool. *Journal of Telemedicine and Telecare*, 2000; 6:302-304.

[12] Campos F, Haddad AE, Chao LW, Alkmim MB Telessaúde em apoio à Atenção Primária à Saúde no Brasil. In: Telessaúde: Um Instrumento de Suporte Assistencial e Educação Permanente. Santos AF, Souza C, Alves HJ, Santos SF. Editora UFMG, Belo Horizonte, 2006. p.59-74.

# CONSUMER ATTITUDE TOWARDS EHEALTH IN GREECE

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**Abstract:** An eHealth Consumer Trends Survey that investigates perceptions and attitudes towards use of the Internet for H&I began in 2005 and will be repeated in 2007 in order to establish eHealth consumer trends in seven European countries. Results reflecting consumer attitude towards eHealth in Greece are presented.

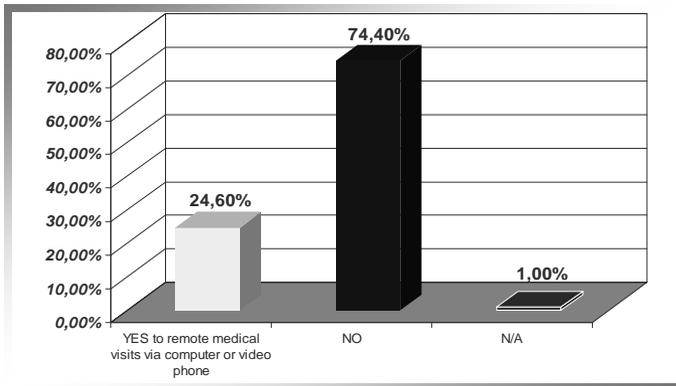
## Introduction

An eHealth Consumer Trends Survey that investigates perceptions and attitudes towards use of the Internet for H&I was carried out in 2005 and will be repeated in 2007 in order to establish eHealth consumer trends across Europe. The participating countries are Norway, Latvia, Germany, Denmark, Portugal, Greece and Poland. In the context of this survey, questions specifically designed for Greece explore attitude and willingness to pay for innovative eHealth services such as remote medical visits and online access to personal Electronic Health Records (EHRs).

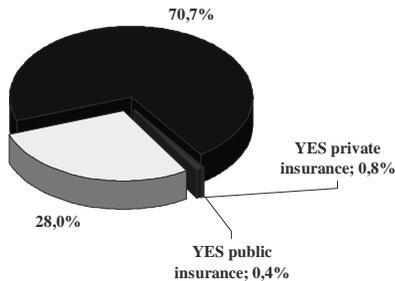
## Methods

In telephone interviews conducted in October 2005, 1000 men and women from Greece between ages 15-80 expressed their opinion on the use of the Internet for Health and Illness (H&I). The sample was stratified for age, occupation, and residence. The base questionnaire consists of 19 questions. Four additional questions were designed specifically for Greece and investigated the perception of telemedicine in the form of remote medical visits, remote diagnosis, and online access to the EHR.

The questionnaire is based on earlier Norwegian surveys and was translated to Greek using the dual focus method [1]. Professional translators and a focus group of seven people in the age group 17-65 were employed to discuss the questionnaire to clarify notions and select appropriate wording that reflects the intended meaning in the Greek language. The telephone interviews were performed with a Computer Assisted Telephone



(a) Attitude towards remote medical visits in Greece (n=1000)



(b) Willingness to pay 10€ per visit among those positive (n=246)

Fig. 1 Attitude towards remote medical visits in Greece

Interviews (CATI) system linked to the fixed line directory (86% coverage in Greece).

### Results

Findings suggest that just 25% of the Greek respondents fell comfortable with remote medical visits by computer or video phone. However, 70.7% of the Greek respondents favoring the service were willing to pay 10€ for each tele-visit. An additional 1.2% responded spontaneously that they would be willing to pay through public or private insurance (see Fig. 1).

When asked if they would be willing to grant remote access to their medical data in order to expedite diagnosis, more than half of the Greek

respondents were hesitant, with just 44% willing to grant access to their medical data. This attitude can be explained in part by the low levels of Internet use (42.2%) and of Internet use for H&I (22.9%) in Greece [2].

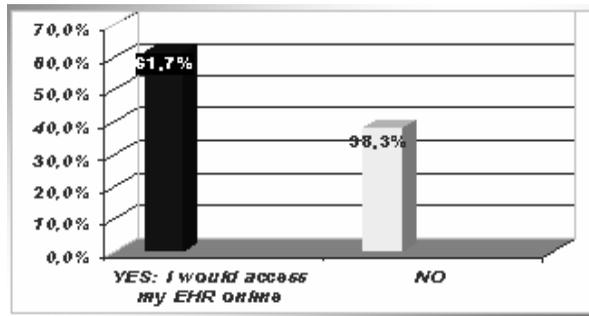
According to the results of the survey, access to one's EHR appears to be the most attractive online service related to H&I. When asked if they would go online to access their EHR assuming they were given the opportunity, 61.7% of the Greek respondents was affirmative. Moreover, 59.2% of those looking favorably into the idea of online access to their EHR were even willing to pay 30€ a year for the service. An additional 3.9% suggested spontaneously that they would pay through public or private insurance (see Fig. 2).

It is also worth noting that although the use of the Internet for H&I differs considerably

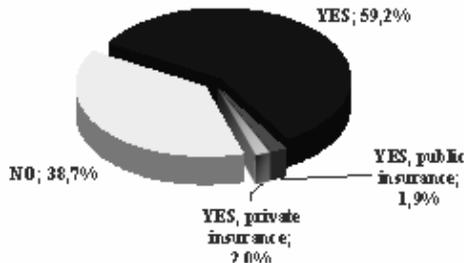
between large urban areas and the Greek islands (29.5% vs. 18.5%), willingness to access their EHR online was much higher in Greek islands (72.8% vs 63.3%) suggesting the presence of a digital divide and a recognized need (see Fig. 3).

### Conclusions

The presented results reflect on the growing trend to use the Internet for



(a) Willingness to access their EHR online (n=1000)



(b) Willingness to pay 30€ per year for online EHR access (n=617)

Fig. 2 Attitude towards online access to their EHR

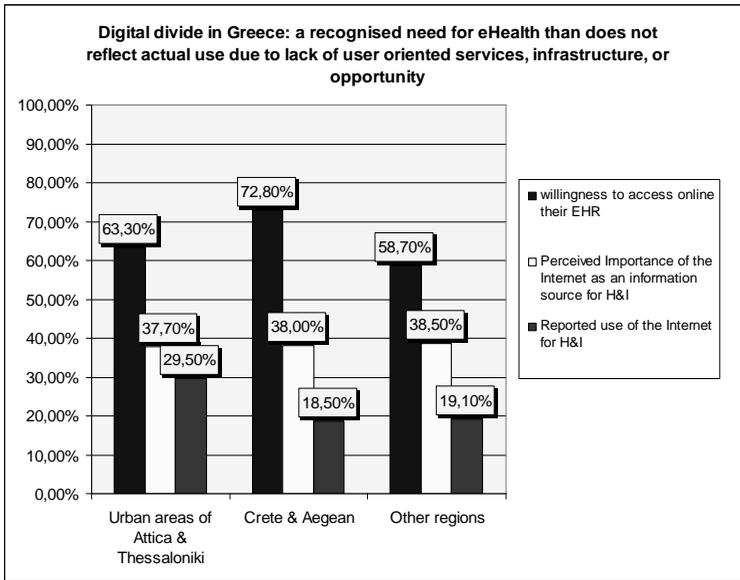


Fig. 3 Perception and reported use of the Internet for H&I in Greece in contrast to willingness to access the EHR online

H&I e.g. to interact with health professionals, to expedite diagnosis, and to access one's own personal EHR. In Greece, people are inclined to access their EHR online, but reluctant towards remote medical visits and granting remote access to their medical data, perhaps due to their lack of experience with eHealth. Awareness initiatives, user-oriented services, and incentives for remote areas should be used to promote eHealth services among consumers.

### Acknowledgments

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### References

- [1] Erkut et al., Creating bilingual measures. Journal of Cross-Cultural Psychology, Vol. 30 No. 2, March 1999, 206-218.
- [2] C. E. Chronaki et al, "Internet Use for Health and Illness in Greece: Preliminary Results of a European Study on eHealth Consumer Trends", in Archives of Hellenic Medicine Magazine (forthcoming).

# **DESIGN GUIDELINES FOR THE IMPROVEMENT OF TELEMEDICINE ACCEPTANCE BY MEDICAL PROFESSIONALS**

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***Abstract:* The objective of this study is to generate design guidelines for the development of telemedicine services that can improve the acceptance by medical professionals. This paper describes the motive and setup of the research project. A conceptual framework will be developed, based on literature and other studies. Subsequently, a participative research-through-design cycle on the island of Ameland will be initiated. Finally, a translation will be made of the results into design guidelines.**

## **Introduction**

The diffusion of telemedicine into current healthcare delivery remains low despite expectations of a positive impact on aspects of care such as efficiency, cost-effectiveness, accessibility and quality [1]. These disappointing results are generally explained in terms of barriers. Beside barriers such as organizational, technical, legal and financial boundary conditions, a significant problem facing the successful development of telemedicine services has been found to be acceptance by medical professionals [2, 3]. Previous surveys support this by showing for instance a fear of added complexity to medical tasks, an unwillingness to change and suspicions of low reliability and low user-friendliness [e.g. 4].

The question that is raised then is: what factors of a telemedicine service influence acceptance by medical professionals and how? In order to find answers to this question, a research proposal is developed.

## **Objective**

The initial goal of the research project is to determine what factors of a telemedicine design influence acceptance of a telemedicine service by medical professionals, what the relations and proportions between the

factors are and what influence they actually have. From this, however, a second objective can be achieved: the construction of design guidelines.

Complex systems such as telemedicine services, ask for a vision on an integrated approach, taking into account different aspects of the users, tools, tasks and context. Current initiators of the development of a telemedicine service, however, are mostly stakeholders themselves, which makes it difficult to have an independent overview of the issues that need to be considered.

Therefore, to support developers of telemedicine services, there is a need for guidelines and the overall goal of the research project is determined to be: to generate design guidelines for telemedicine development by systematically investigating the factors of a telemedicine design that influence acceptance by medical professionals. Other starting points for the development of design guidelines, such as the patient perspective, could outline other interesting research projects.

### **Proposed method**

Two empirical research methods will be used, following the perspectives that are taken in the project: the user-perspective of the medical professional and the designer-perspective of the telemedicine service developer. These perspectives lead to the adoption of a participative and a research-through-design method respectively, as can be seen in fig. 1. The participative approach means that the end-user (the medical professional) will be actively involved in the development process, allowing the researcher to collect the expert knowledge of the user. The research-through-design approach on the other hand, enables design guidelines for future designs to be made by testing prototypes in a design cycle [5].

In order to provide a basis to the research, some initial studies will be conducted to set up a first model describing the factors that influence medical professional telemedicine acceptance and their relations. These studies will consist of a literature review of previous research, interviews with medical professionals, case studies and an experiment. The case studies will consist of two existing cases resembling the intended case that is planned for the research-through-design approach, to learn from the experiences of similar interventions, and a case study that will consist of a theoretical investigation of the intended case, by means of personas or fictional users [6]. The experiment, finally, will test simulations of simple telemedicine applications for the response of medical professionals to different types of media for a predetermined task, possibly for different types of illnesses. The experiment will result in a narrower scope of the kind

of telemedicine service that will be developed in the intended case rather than an elaboration of the set of factors.

Resulting from this part of the project, propositions will be formulated which will be based both on a review of previous research results and practical findings of the performed case studies, hence the use of propositions as opposed to hypotheses.

The actual body of the research, the research-through-design field in fig. 1, will consist of a singular case study combined with an experiment (intervention). The case in which the intervention takes place should be situated within the Dutch province of Friesland, to meet with the requirements of the Cartesius Institute who is an associate in the research project. The island of Ameland provides an excellent case here, due to the division of the chain of care by the Wadden Sea, which makes aspects such as costs and accessibility probable to improve when telemedicine is implemented.

Using an iterative design process, prototypes of the designs will form interventions that will be tested with actual end-users. Results of the user tests will on the one hand enhance the initial telemedicine acceptance model and on the other hand will serve as input for the subsequent design that will be made. After a number of these cycles, the body of knowledge that has developed will be translated into design guidelines.

### Conclusion

An exploration of the subject of telemedicine has made clear that there is a need for a vision on an integrated approach to the development of new telemedicine services. Therefore, the research problem that is defined in this project finds its relevance in the design guidelines that can be formulated on

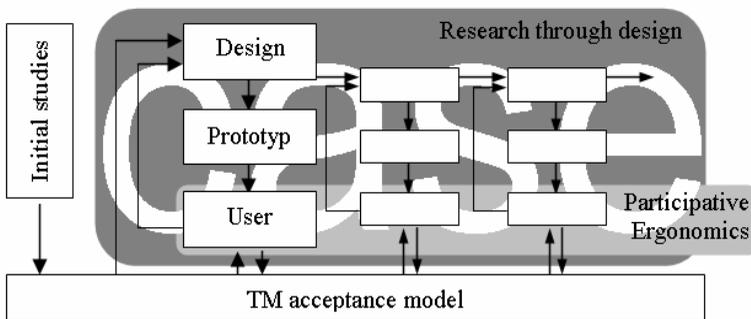


Fig. 1 Research setup

account of the answers to the research questions.

Research into the abovementioned problem fits into the research program of the Design for Sustainability group of the faculty of Industrial Design Engineering at Delft University of Technology by touching upon the social dimension of product-service systems and of the Medisign group by giving attention to the user-product interaction during professional use in a medical setting.

### **Acknowledgment**

The authors would like to thank the Cartesius Institute for their support.

### **References**

- [1] H. Tanriverdi, C.S. Ianoco, "Knowledge barriers to diffusion of telemedicine," in *Proceedings of the international conference on Information Systems*. Atlanta: Association for Information Systems, 1998, pp 39-50.
- [2] M.P. Gagnon et al., "An adaptation of the theory of interpersonal behavior to the study of telemedicine adoption by physicians," *International Journal of Medical Informatics*, vol 71, pp 103-115, 2003.
- [3] P.J.H. Hu, P.Y.K. Chau, O.R.L. Sheng, "Investigation of factors affecting healthcare organisation's adoption of telemedicine technology," in *Proceedings of the 33 rd Hawaii International Conference on System Sciences*. 2000, pp 1-10.
- [4] S.O. Karlsson, L. Karlsson, "What are the barriers facing telemedicine? A report from the project on "Telemedicine – Regional and National Collaboration" Subproject: Incentives and Implementation," Stockholm, Federation of Swedish County Councils, 2000.
- [5] P.P.M. Hekkert et al., "The Delft ID-StudioLab: Research for and through design," in *Proceedings of the Symposium on Design Research in the Netherlands*, pp 95-103.
- [6] M. Bueno, L. Rameckers, "Understanding people in new ways," Philips research paper, presented at the ESOMAR conference, 2003.

# **PROVIDING AFTER HOURS WORKFORCE SUPPORT TO RURAL GENERAL PRACTITIONERS IN TASMANIA, AUSTRALIA: A PRACTICAL APPLICATION OF ICT IN PRIMARY CARE**

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**Abstract:** GP Assist (Tasmania) is an innovative service delivering one of the most progressive After Hours General Practice solutions in Australia. GP Assist involves nurses (RNs) and doctors working together, aided by ICT to provide rural GPs with workforce support.

## **Introduction**

GPs, especially in rural and regional areas, are in short supply and burdened by after hours work, which is a key reason for them leaving country towns. Patients can not always tell how urgent their problem is so access to prompt medical advice is essential. This advice doesn't necessarily need to be provided by their doctor or even face to face.

GP Assist allows GPs to divert their after hours calls to its dedicated triage centre where registered nurse, using decision-support software and assisted where necessary by a 'triage doctor', advise patients on the best course of action for their problem. If it is decided that the patient needs to be seen, the 'triage doctor' contacts their local on-call GP personally to refer the case.

Experience has shown that more than 80% of calls can be handled by GP Assist without disturbing the local GP. GP Assist (Tasmania) is funded by the Australian Governments Department of Health and Ageing.

## **How it Works**

Patients, of GPs who use GP Assist, ring the dedicated triage centre number where the call is answered by a RN who creates a medical record, assesses the problem using decision-support software (Teleguides™), and provides advice. If the patients require further medical assessment the call is transmitted to a GP Assist 'triage doctor'.

The triage doctor (who is alerted by a text message) consults with the patient, accessing and appending the clinical record remotely on a laptop

computer via a virtual private network. A secure web-based database provides information on-call GP, pharmacies etc. Rural GPs are only contacted by the triage doctor when local patient care before the next working day is required.

### **Why is GP assist different from other health call centres?**

Some 'nurse only' health call centres operate in parts of Australia but generally these do not work with General Practice – and they advertise to attract calls. GPs using GP Assist provide their patients directly with information about the service.

The decision support software used by health call centres has a tendency to recommend face-to-face care. However, when combined with assessment by triage doctors the number of calls referred for face-to face care is substantially reduced. This is shown in figure 1.

### **Impact**

Figure 2 illustrates the way an average 100 calls are handled by GP Assist. Before GP Assist, all these calls would have been answered by the rural GP. Calls are now answered by a **GP Assist RN** who provides advice in 70% of cases. When further medical assessment is required (30%) calls are passed to the **GP Assist Triage Doctor**. In less than 10% of all calls the patient is referred back to the rural **GP** for face to face care.

If triage doctors were not involved referrals to rural GPs would be 4 to 5 time higher. More than 50% of patients referred by the Triage Doctor to 'self care' receive services which nurses alone can not provide, eg, arranging a prescription, changing a medication chart, interpreting pathology results etc

All calls received from other health care professionals (eg Ambulance Officer, RNs in Aged Care Facilities), are passed **directly** to the triage doctor, by-passing the nurse assessment process.

### **Results**

GP Assist handles more than 70,000 calls per year and provides assistance to 83% of Tasmania's GPs, who's after hours work, has been reduced by more than 80%.

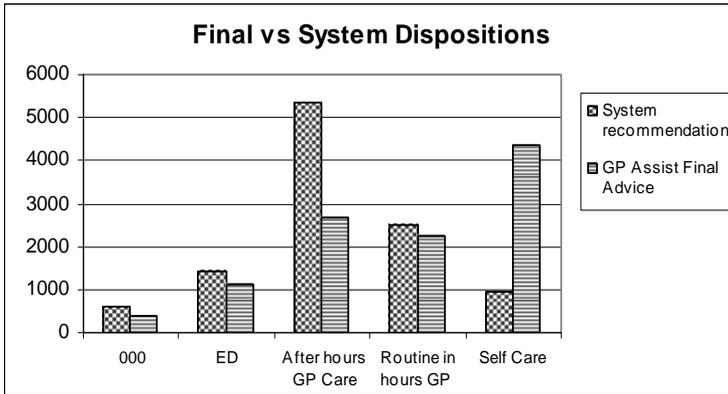


Fig. 1

### The Future

GP Assist continues to explore ways of better managing the challenges of after hours care for the benefit of patients, doctors and the health care system.

These include:

- Developing a data link with the Tasmanian Ambulance Service and public hospitals to improve direct exchange of clinical information;
- Developing a secure electronic messaging system for the exchange of patient information.
- Providing other telephone advice lines – such as the Parenting Information Line
- Improving the management of chronic disease through home monitoring and video links;
- Benchmarking ,developing standards for RN triage
- Further developing teaching links with the University of Tasmania, School of Medicine.

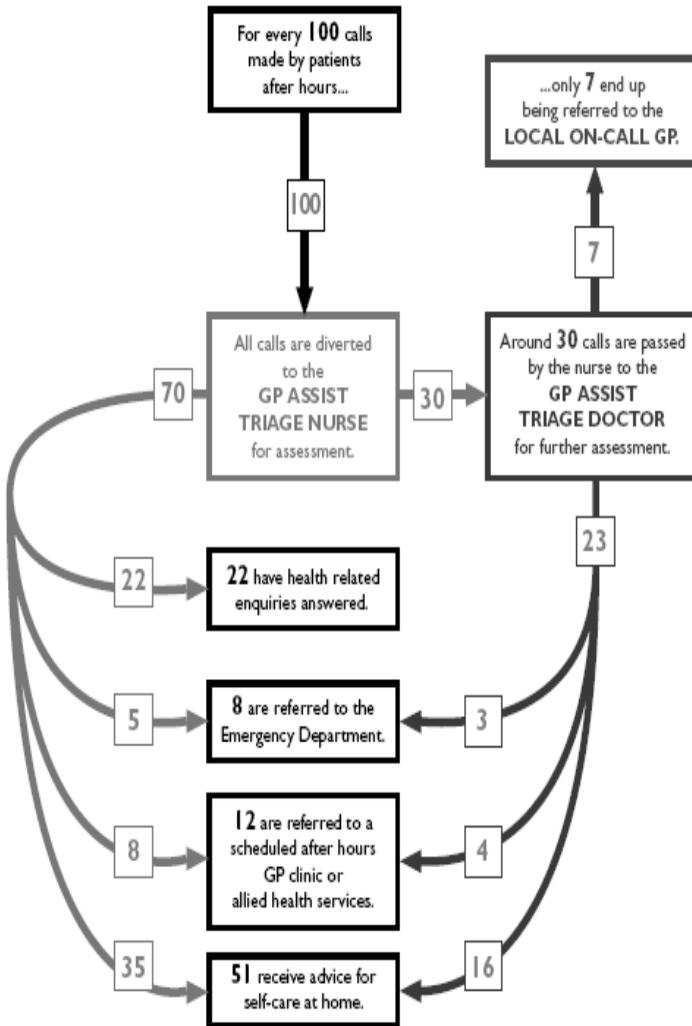


Fig. 2

# REPORTING OF A TELEMEDICINE CENTRE TO INVOLVED INTEGRATED CARE PLAYERS

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**Abstract: Quality Assurance reporting of a telemedicine centre inside Germanys integrated care model using business intelligence software and web development.**

## Introduction

The current increasing costs in the German health care system are a term of failures on different levels of the health care accommodations. An essential part of this goes to the stringency of resources which leads to multiple issues. Patients care and treatment is not proved as satisfying and it gets harder to maintain the quality for the care providers. This progression could be counter steered from different positions. With the help of new care models combined with modern technologies in the background there is the approach to achieve non-critical care transparency providing an improvement of the patients all over care life circle. Within the current health system, heart failure constitutes a relevant clinical and health economic problem. As one strategic solution telemedicine lends itself as a central service and information instrument that guarantees optimized therapy management through the consistent monitoring of the chronically ill patient. Predetermined vital parameters are automatically transmitted to the telemedicine center; in the event that predefined threshold values are exceeded, therapeutic measures are initiated immediately. The center can be reached by the patient experiencing cardiopulmonary symptoms 24 hours a day, 365 days a year. Results show that in this model the number of emergency calls, hospitalizations, and doctor's visits can be reduced significantly and, from a health economic standpoint, constitutes a distinctly more cost-effective treatment strategy in spite of the initial additional therapy costs.

Within the IV (GER: Integrierte Versorgung, ENG: integrated care; cp.: case management) the insurance companies are enabled to sign contracts directly with the care providers. These contracts are supported by push-start

factoring with the amount of 1% of the total volume of the ambulant and inpatient costs.

### **Objectives**

A telemedicine monitoring with a central, full capable telemedicine centre should achieve the following requirements:

- Patient data management in an electronic health record that captures demographic, anamnestic and medical parameters
- Patient monitoring for therapy guidance with a 24/7 attendance plus emergency management
- Quality insurance with therapy control mechanisms based on national and international medical guidelines
- Education and instruction for patients, doctors and medical staff
- Reporting with event triggered reports, statistics to evaluate the economical efficiency, if necessary for budgeting

Within the model of the IV an independent company like PHTS Telemedicine takes a central role. With the help of the continuous, daily receiving of medical data, PHTS Telemedicine middle wares the information to both sides of the health system. MROL (**M**edical **R**ecord **O**n**L**ine) gives physicians and patients the ability to check their health record via the internet. MROL shows beside the usual health record the transmitted vital signs e.g. blood pressure, weight, 12 lead ECG, glucose data, medication and provides a communication platform for physician patient communication.

The subordinated usage of this data collection becomes essential for the evidence of effectiveness and quality of a telemedicine centre using the data for internal research and provides data for external studies. The subordinated processing is one pillar for providing high-quality integrated care in interaction with all involved players. These players are mostly clinics, doctors, insurance companies and other involved organizations, e.g. universities.

### **Implementation**

On the one hand there is patient data that needs to be processed within the aspect of the national law. On the other hand there are funding agencies (e.g. insurances) that wanted to have high transparency of the integrated care processes. In this area of conflict there is a need of an information technology solution that provides both the best service.

This implementation highlights the last bullet of the above listing (part II.), the economical and quality assurance reporting to participating players / funding agencies.

The data source for the reports is provided by an electronic health record. All data was transferred to a data warehouse. All patient related data has been anonymized in the ware house that is located in the medical, high security network, only accessible by authorized medical staff. With the help of OLAP (**O**nline **A**nalytical **P**rocessing) tools several patient collectives have been identified, analyzed and created. In parallel there was a survey with different integrated care players to evaluate and ensure high level parameters that needs to be reported. Thereafter this list was confirmed by medical lawyers to not disobey any interests of the different integrated care players. The result of this evaluation is the list below (abstract of reporting parameters), that can now be easily reported to the regarding partners via a web-based application called mrai (medical record analysis). The user is able to receive the important information, fully automated in an individual time interval as well as time and location independent over a secured internet application.

The challenge of the implementation was to route the data in one direction only, means from the medical network to a web service and not to enable

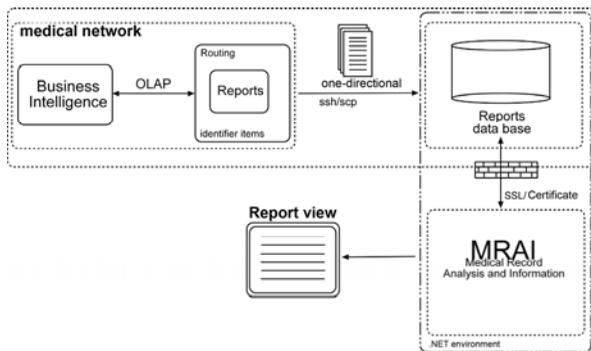


Fig. 1 Network structure overview of MRAI (Medical Record Analysis)

any processes to connect to this network from the outside. The designed middleware pushes the persistent reports to a data base that is connected to the web. The OLAP tools of the data

warehouse enables to assign parameters in a XML (eXtensible Markup Language) file that is generated together with the report itself. These parameters are used to distinct identification of the report recipient. The routing was implemented via a .NET service that contains XML procedures. The communication between the web enabled data base and the secured

medical network is enabled through a SSH/SCP one-directional tunnel to the target system with the content data base.

The .NET application connects through a dedicated firewall to the reports data base. The information about new reports is stored in an index file. Triggered through the user interface the latest reports are loaded with the help of the index file into the web application.

## **Results**

The data ware house is queried in a regular interval which the customer/partner is able to define, so there is the possibility to receive reports daily, weekly, monthly, quarterly, etc. The report parameters may vary for different recipients, because they can be used unitised in the information depth. The standard report shows the following information which can be presented in different visualisations like list, tables, cross-tables and any type of diagram.

### **General information:**

- Total number of patients in telemedicine service
- Active and passive patients
- Distribution by sex
- Average age
- Number of patients sorted by diagnosis groups

### **Medical Information:**

- Top ten list of diagnosis
- Top ten list of pharmaceuticals

### **Monitor Centre activities:**

- Total number of calls in the telemedicine centre with follow up characteristics
- Total number of emergency calls
- Number of (medical) complain calls;
- Time distribution of calls in the telemedicine centre, business days to weekend and percentage
- Emergency management, time distributed, business days to weekend and percentage

### **Timeline:**

- Active patients
- Incoming calls
- Medical complain calls

### **Information given through patient:**

- Number of hospitalisations during the telemedical care

- Retention period of hospitalisations during telemedical care

The format of the reports is mainly a PDF document (Portable Document File). The advantage of this file format is that nearly every pc user has an Adobe Acrobat Reader installed. Furthermore this is a closed document that can't be modified easily. There is the possibility for a digital signature inside the document to identify the author and display the integrity of the document. Even though it is possible to receive the report data in other file formats like Microsoft Excel 2000/2003, HTML (Hypertext Markup Language), XML.

Although the front end web application called MRAI (**M**edical **R**ecord **A**nalysis) does not display patient related data, the security implementation is the same as for the health record MROL. Within the web application the user has various options to search for the reports. The report itself opens in the application window (PDF behaviour). Standardized it is possible to download, print through the application, comment the reports.

The back end handles the identifying process for new reports, administrates users, groups and handles notification functionalities. It is possible to assign many users to one organization/group. In case of a new report was generated the user may define whether he will be informed by e-mail about this event. Also the back end generates secure passwords by a specific procedure.

# TELECENTERS NETWORK FOR COMPLEX MEDICAL SERVICES - TELMES

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**Abstract:** This paper presents a pilot model for a regional medical telecenters network, based on scalable multimedia platform, which should allow implementing some complex medical teleservices.

## Introduction

National Communication Research Institute – INSCC, together with four Romanian partners, develops a Romanian telemedicine project, *Multimedia platform for Complex medical teleservices implementation – TELMES*. The main propose of this project is to implement a scalable medical telecenters network, based on new ITC technologies that are available in Romania.

This paper presents a pilot model for a regional medical telecenters network, based on scalable multimedia platform, which should allow implementing some medical teleservices, in order to enhance the opportunities for medical care targeted to a large category of patients, especially for those that are in the responsibility of General Practitioners GP. A valuable benefit is expected for isolated and rural communities.

### Regional medical telecenter: Model

*The regional medical telecenter - RMTc, fig.1 [3], is a structure having all needed logistics, furniture, IT systems, and telecommunications devices, made up at a region level, and designed for medical*

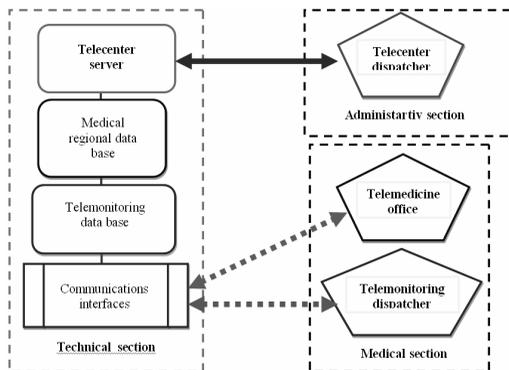


Fig. 1 Telecenter structure

teleservices implementing and exploiting.

The **RMTc** have three mainly sections: technical section, medical section and administrative section.

The role of *Technical sections* is to *host a local server* to assure the users access to the network *to enable the integrity and the safety for the data* that are processed in the network and *to assure the connectivity with other regional telecenters*. The technical section includes two types of medical data bases:

1) **Regional data base – RDB**, contains all patients and doctors that reside inside that region. **RDB** use standard SQL for managing data. Because one of the main system architecture is to define a database independent layer we are able to interact with different database systems that support standard SQL language. Current implementation supports MySQL, Posgress, MS SQL database systems.

**RDB** contains the following main information categories:

- *Doctors related data.*
- *Patients related data.*
  - ✓ *Identification date of the patient*
  - ✓ *Medical historical of the patient.*
  - ✓ *Medical Consultations*
  - ✓ *Laboratory*
  - ✓ *Other medical information* as digital image, monitoring EKG, EEG, outlets of medical equipment, chemotherapy protocols etc

The role of *Medical sections* is to *enable the conditions to run the teleconsulting* activities by telemedicine office, to *run the telemonitoring applications* by telemedicine dispatcher.

The role of *Administrative sections* is to assure all administrative and technical conditions to run the telemedical applications.

2) **Tele-monitoring data base – TmDB** contains all medical data resulted from mobile telemonitoring unit.

### **Pilot model of networking**

The TELMES project proposes to develop a hierarchical network structure that should include three hierarchical layers, fig.2.

**Layer 1** is the *local layer - user's zone*. This contains the possible interfaces that are offered to the users, depending on the concrete technical opportunities. **Layer 2** is the *regional medical telecenters layer*. This includes the telemedicine regional nodes by which the certain region local areas' users are connected.

**Layer 3** is the *network management center - NMC layer*. This is a central node that is responsible with the management of the communications and hosting a central server to ensure the telecenters access to the network, the central database, software

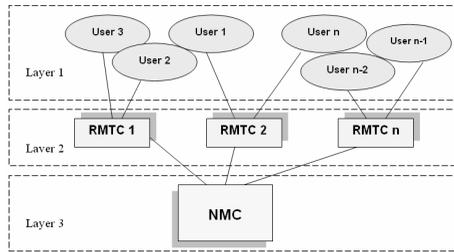


Fig.2. TELMES hierarchical layers

applications used for network management services and ensures the connectivity between regional telecenters, within the TELMES network. In

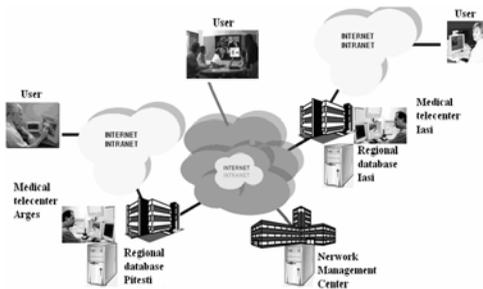


Fig.3 TELMES pilot network

Fig.3 is depicted the model based that we are developing a pilot network of TELMES including two regional telecenters, located in two Cities in Romania - **Pitesti** and **Iasi**.

**Medical Teleservers**

Few applications are currently experimented

on TELMES network as follows:

**a) Teleconsultation services**

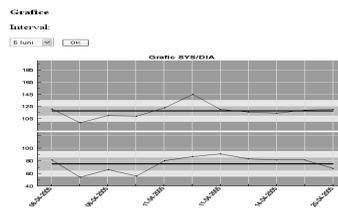
Remote discussion, in real time, of the concrete clinical case for the answer to precisely formulated questions for the help in acceptance of the clinical decision.

**b) Telediagnostic services**

Remote consultations that not involving real time network



a)



b)

Fig.4 a) Mobile telemonitoring unit, b) Results from TmDB

communication (video, chat etc.).

*c) Telemonitoring services*

Telemonitoring services - *home-based applications*, enable physicians and other health care providers to monitor physiologic measurements, test results, images, and sounds, usually collected in a patient's residence or a care facility.

Telemonitoring system must comply with the **interoperability principle**: ***“anytime, anywhere, by anyone which is authorized and in any manner.”***

Within the project it was made an experimental model for a home telemonitoring application of a patients' health status, by considering the blood pressure and the pulse. The main focus was on the designing of a *simple telemonitoring unit for “home using”* and a telemonitoring network for a realistic application implementing that could be used with or without a specific information support. On one hand, it was necessary to consider the market mobile communications solutions currently available in Romania and the suitable medical monitoring devices on the other hand.

In Fig. 4a is presented a custom designed **Mobile Telemonitoring Unit – MTmU**, [5], which enables:

- The interface with the measuring medical device for measuring the blood pressure and the pulse;
- Data gathering from the medical device for the blood pressure and pulse measuring;
- Local processing of the data to establish the framing of the measured parameters within the stated limits;
- Interface with CDMA mobile communications network;
- Packing data acquired from the patient, personalization data attachment in order to transmit them using a TCP/IP protocol;
- The immediate transmission of data to the MTmU unit server;
- The alarms sending, if the measured values overcome the stated alarm thresholds.

The results of medical measurements are collected to regional telecenter, via **MTmU** of the patient, and stored on **TmDB**. In Fig.4b are presented the web based data monitoring application accessible from everywhere by doctors.

### Conclusions

In this paper was presented the medical telecenters network, based on multimedia system, designed for medical teleservices. The main goal is to build a complete pilot system that will connect several regional telecenters into a national telemedicine network

### **Acknowledgements**

This work is supported by a grant from the Romanian Ministry of Education and Research, within CEEEX programmer contract No. 26/10.10.2005.

### **References**

- [1] Puscoci,S. Serbanescu,F. "Use of Mobile Communications for Telemonitoring Medicine System. The Romania's potential and perspective" The Tromso Telemedicine and Health Conference, June 27-30, 2004, Tromso, Norway.
- [2] Puscoci,S. Serbanescu,F. "Medical Telemonitoring based on mobile communications systems" Workshop, Medicine University Cluj-Napoca, october 28-31, 2004, Romania.
- [3] Puscoci,S. Hariton,C. Ionia,S. Serbanescu,F. "Multimedia platform for Complex medical teleservices implementation – TELMES" Research Romanian project supported by Ministry of Education and Research. CEEEX Programme 2005-2007.
- [5] Puscoci,S. Serbanescu,F. "Telemonitoring systems based on mobile communication networks, with applications in telemedicine" Research Romanian project supported by Ministry of Education and Research. INFOSOC Programme 2004-2006.

**THE CARINTHIAN NOTARZT (EMERGENCY  
PHYSICIAN) INFORMATION SYSTEM  
(CANIS)  
WORKSHOP**

# CANIS – QUALITY ENHANCEMENT IN EMERGENCY MEDICINE THROUGH WIRELESS WEARABLE COMPUTING

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**Abstract:** The main priorities of emergency medicine are to rescue lives and to limit as much as possible the damage to live and the limb of the patient. To ensure a chronological documentation of all relevant medical treatments during an emergency situation, a report protocolling system is being used. Emergency response documentation systems in Austria are still largely paper based as it is probably in most parts of the world. There are ongoing endeavors to establish a new software-based protocol standard (Emergency Patient Care Report Form – EPCRf). The research project CANIS<sup>1</sup> (Carinthian Notarzt Information System) aims to develop an electronic EPCRf to establish and optimize a wireless and bidirectional information stream between the emergency physician at the accident site and the receiving hospital.

## Introduction

The required by law emergency accident protocol is usually completed by hand and after the patient has been transferred to the emergency room. This makes an optimal preparation for the reception of the injured person impossible and delays the necessary therapeutical measures. It is a challenge for the emergency physician to follow the legal obligation for recording all relevant medical events and keep the quality of care of the patient at the highest possible level.

## Motivation

This paper gives an overview of the research goals of CANIS. The following list shows the development goals identified within the project:

- Development of a mobile medical information system to support medical emergency situations and to increase the quality of care.

<sup>1</sup> CANIS is co-financed by the Austrian Research Promotion Agency (FFG) through the program FH Plus.

- Establishment and optimization of a bidirectional, digital and secured information stream between the emergency rescue vehicle

(ERV) or emergency rescue helicopter (ERH) and the receiving hospital using GPRS/UMTS technology.

- A required by law reporting standard for all medical relevant events.
- Reduction of latency time until the necessary treatment and concurrently increasing the quality of care.
- Contactless identification of the physician and the patient using RFID technology or Health Professional Card.

Furthermore, the physician as well as the medical personnel in the hospital will be supported through many other aspects. To achieve a hands-free working approach, the emergency physician is also equipped with speech recognition software to allow simultaneous data acquisition during medical treatment. Because of early information, the hospital is able to react and prepares the necessary resources.

### **System integration**

To ensure the availability of the captured data in the Emergency Services Call Center (ESCC), but as well as in the Hospital Information System (HIS), a secured connection between both systems is necessary. Figure 1 illustrates the different communication scenarios. An emergency call is obtained by the ESCC, and as a result, the required medical personnel will be informed and the relevant emergency data transmitted to CANIS. The emergency physician can now decide whether to accept the transmitted data and information or to change the data in his sole discretion. In this case it is essential to match this data with the data provided by the ESCC. Patient relevant data – which are used to inform the receiving hospital in advance – will be transmitted by CANIS using wireless communication channels (GPRS, UMTS). The entire communication with the ESCC and the HIS uses the Health Level 7 (HL7) standard [2].

### **Security**

A mobile information system, which actually deals with patient relevant data, has to meet certain criteria according to law.

- Authentication of involved people and objectives
- Data confidentiality – no unauthorized access to information
- Integrity of data
- Liability of reproduction of all performed actions
- 24/7 system availability for local and mobile resources

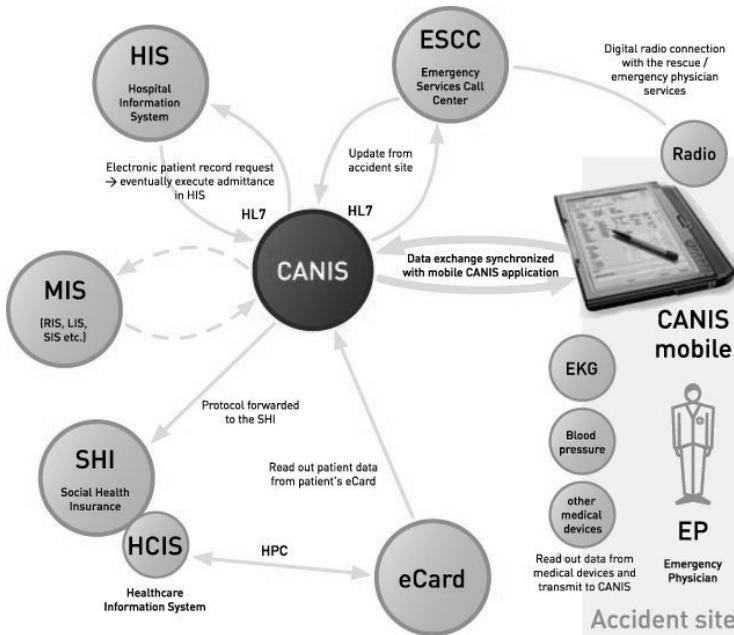


Fig. 1 CANIS Systemarchitecture

### Usability

The usability of the CANIS system is one of the most important concerns, because it has to support the physician and must not hinder him or her. Therefore a lot of work has been done regarding the graphical user interface (GUI) design. To flatten the learning curve for the involved medical personnel, the design of the GUI is based on the paper version of the report form. Special attention has been drawn on graphical elements for a better illustration of injuries (anatomical diagram) and the recording of chronological events (sequence diagram). Many paper-based report forms already include graphical elements like diagrams or tables.

But there are also some problems within the paper versions [3]:

- No standardized set of symbols
- The lack of segmentation of the anatomical figure
- The higher complexity with the growing number of treatments
- Difficult recording of chronological measurements

Whereas the software-based solution provides advantages such as:

- Clear and well structured

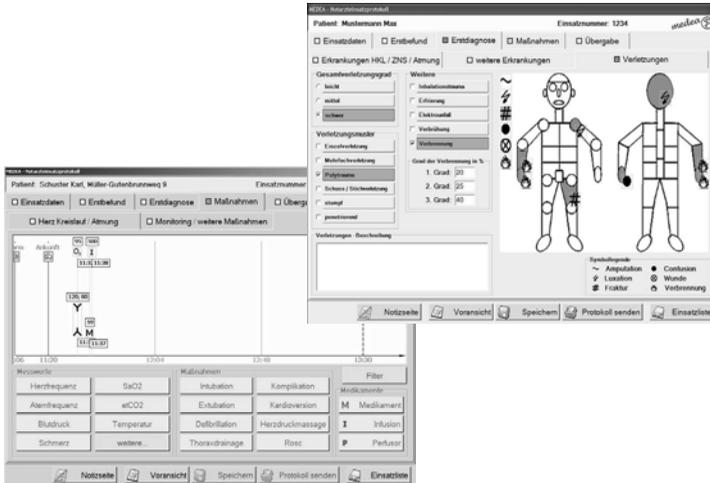


Fig. 2

- Intuitive to use
- Drag and drop functionality
- Direct data input
- Highly interactive
- Speed up of the input process

### Conclusion

An emergency physician's responsibility is to rescue lives. Therefore the medical emergency report form is a very important tool in the field of medical emergency medicine. The common handwritten paper-based protocol is in most cases not going to be filled out until the patient has reached the hospital, whereas the CANIS system allows the protocolling of relevant medical data during the treatment using either a very intuitive designed user interface or speech recognition as well. This means that the data can be transferred at an early stage to the receiving hospital through wireless communication. This allows an optimal preparation for the patient and the necessary therapeutical measures. Additionally, digital protocolling provides a better documentation standard in medical emergency medicine.

### References

[1] CANIS – Carinthian Notarzt Information System, [www.fh-kaernten.at/canis](http://www.fh-kaernten.at/canis), 2005-2007.  
 [2] HL7. Health Level Seven Inc., [www.hl7.org](http://www.hl7.org), Copyright 1997-2007.  
 [3] Waldther, F.: "Schritte in Richtung eines vereinheitlichten europäischen Notarztprotokolls", Diploma Thesis 2006, University of Applied Sciences, Klagenfurt, Austria.

# **THE EMERGENCY PHYSICIAN: A BEAST OF BURDEN?**

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***Abstract:* New mobile technologies are being introduced in emergency medicine with the aim to ease the work of the emergency physician (EP), but to whose advantage? The research project CANIS (Carinthian Notarzt Information System) proposes project different hardware setup scenarios for the task of data acquisition, among which the EP can select the most suitable one. Furthermore, important human aspects of speech recognition and the digital pen technology are presented.**

## **Introduction**

Documenting medical emergency events in Austria involves largely the paper-based application of the emergency patient care report form (EPCRf). However, more and more researches focus on the introduction of electronic emergency response information systems, which includes the application of new mobile technologies. In reference to their sizes, weight, and robustness, many of them do not optimally fit into the environment of medical emergency events and even hamper the live saving work of EPs, as they overburden the user physically as well as psychically.

## **Motivation**

This paper focuses on suitable hardware setups, to support data entry for electronic emergency medical response systems with the emergency physician on-site as the primary actor. Our research is part of the CANIS (Carinthian Notarzt Information System) project (CANIS is co-financed by the Austrian Research Promotion Agency) (FFG) through the program FH Plus which aims at the establishment and optimization of the information stream between the emergency rescue vehicle (ERV), and/or the receiving hospital. As the introduction of an electronic EPCRf demands the application of mobile devices in order to acquire and edit data, extreme care must be taken when selecting the most suitable one.

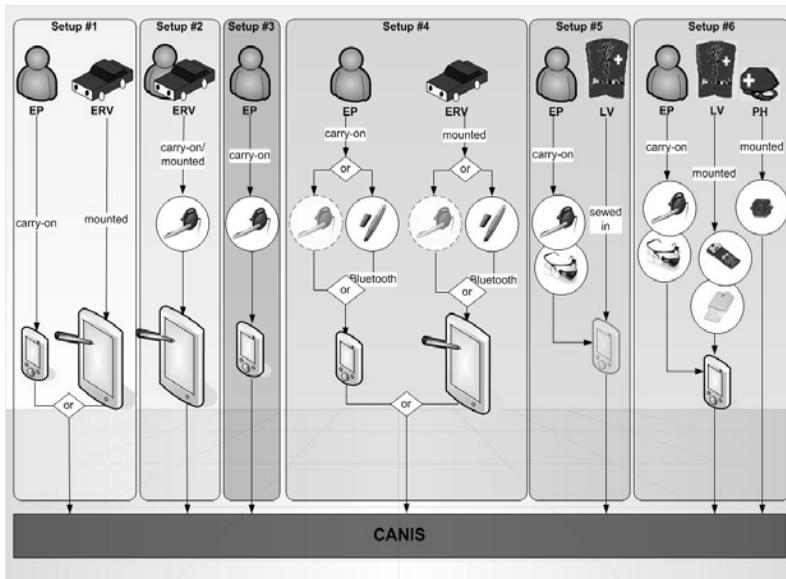


Fig. 2. Six different hardware setups for emergency scenarios

### Wearable devices and possible setup scenarios

Depending on the range of capabilities and cost structure, EPs can determine the ideal IT support combination for their work settings.

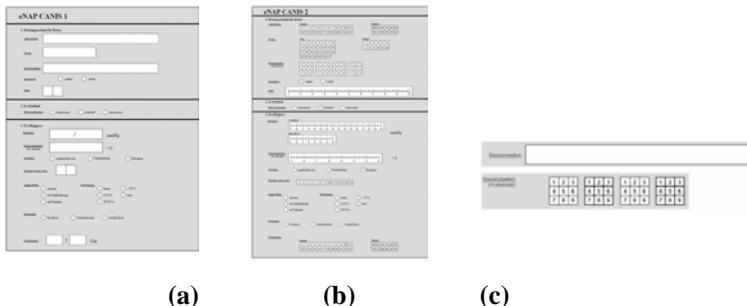
Six different hardware setup combinations have been established, as can be seen in Figure 2. *Setup #1* supports the EP with either a Tablet PC or a PDA, whereas on the one hand the Tablet PC would be mounted stationary in the emergency rescue vehicle (ERV), and on the other hand, the emergency physician would be equipped with a PDA. *Setup #2* contains only a Tablet PC, which can be either taken to the accident site by the EP as carry-on (rugged device), or can be mounted stationary (standard device) inside the ERV. Either way, the EP will be enabled to enter data via voice. *Setup #3* focuses on the PDA as carry-on device including speech recognition. As an extension of *setup #1*, *setup #4* provides the choice of Tablet PC or PDA, plus electronic data acquisition through the digital pen or via speech recognition. Within this setup, the application of the digital pen is recommended, and speech recognition should be seen as an optional, but less-emphasized alternative. *Setup #5* focuses on the hands-free approach, as the PDA will be either mounted on the user's body or sewed in the emergency physician's suit (ES). This, however, prevents the user from

receiving visual feedback directly from the display. To solve this problem, a wearable VGA computer monitor (Head Mounted Display (HMD)) is being introduced, on which the content of the standard display is projected. *Setup #6* additionally equips the EP with two card readers (RFID, Smart Card) in order to be able to identify the EP himself or the patient, as well as with a tiny wireless camera (Figure 1). This camera is mounted on the user's helmet and enables the emergency physician to take photos of the accident scene as well as of the patient, which increases the value and quality of documentation. It should be noted that wearing a helmet is not mandatory in Austria, but would increase the safety of the medical emergency team substantially.

In order to gain an optimal support for their working environment, emergency physicians are now able to select any given setup.

### Human Factors: Digital Pen, Speech Recognition

The “lessons learned” so far include usability issues as well as technical aspects in regards to both technologies: the digital pen and the speech recognition. Both input modalities have passed various test series, whereas the overall outcome shows that the general acceptance towards the digital



*Fig. 2 DigiPen Forms (a) with and (b) without OCR/handwriting recognition; (c) Close look-up on the differences in the form designs (here: emergency site/zip code) [1]*

pen is higher than towards the speech recognition prototype [1].

As the digital pen supported speech paper-based eEPCRF is based on the common EPCR, it contains free text areas as can be seen in Figure 2 (a). Because OCR or handwriting recognition was not implemented in the first prototype, a second, more complex form needed to be designed (Figure 2 (b)) in order to ensure appropriate data acquisition. However, after having tested both forms, the results showed no user preference for either of the two [1].

In order to achieve the best recognition accuracy of a speech recognizer, several *characteristics* have to be examined [2]. *Speaker dependency* relies on the potential user group. Within CANIS, a speaker independent recognizer has been chosen in order to allow any emergency physician to use the speech-based system. As voice input needs to remain as natural and fluent as possible, a continuous *speaker mode* is required, whereas the isolated mode requires pauses between individual words. Concerning the speech recognizer's *vocabulary size*, it needs to consist of a variable size, in order to adapt to the limited vocabulary set found in common emergency protocols (approximately 400 words). Naturally, the choice of equipment also affects the recognition rates and has to be considered when high accuracy is to be achieved [2]. Therefore, the use of a headset with a sensitive microphone as *input type* is essential [1].

In order not to narrow the user's *speech instruction set*, the gained results lead to the assumption that multiple instruction choices for one action should be offered. Therefore, the user should not be limited to a certain command or instruction when operating the application. Furthermore, users should not be forced to adapt to the application, rather the application should be adapted to fit the users and their tasks [3].

### Conclusion

The main actor concerned in this paper is the emergency physician, who performs his or her tasks under constant mental and physical stress. An eEPCRf in combination with a suitable hardware setup can support the EP in this very sensitive environment. The key factor for the optimal teamwork of user and device is in this context, a feasible hardware setup which has been evaluated and optimally adapted to the EP.

### References

- [1] Hafner, C. Evaluation of Mobile Data Acquisition Modalities in the Context of Medical Emergency Events. Diploma Thesis, Klagenfurt University, Klagenfurt, Austria, January 2007.
- [2] Susen, A. Spracherkennung: Kosten, Nutzen, Einsatzmöglichkeiten, VDE-Verlag GmbH, Berlin, Offenbach, Germany, 1999.
- [3] Cooper, A. (1999): The Inmates Are Running The Asylum, SAMS, A Division of Macmillan Computer Publishing, USA.

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