We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900
Open access books available

186,000
International authors and editors

200M
Downloads

154
Countries delivered to

Our authors are among the

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

CLARIVATE ANALYTICS
BOOK CITATION INDEX
INDEXED

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

eHealth Projects of the Microgravity Centre

Thais Russomano, Ricardo B Cardoso, Christopher R Jones,
Helena W Oliveira, Edison Hüttner and Maria Helena Itaqui Lopes
Pontifical Catholic University of Rio Grande do Sul
Brazil

1. Introduction

This Chapter aims to present the activities of the Telemedicine Laboratory of the Microgravity Centre/PUCRS (Brazil) and to discuss eHealth initiatives around the globe, emphasising the benefits of the use of telecommunication and computer technologies in remote and deprived areas, where specialised medical care is limited or non-existent. Based on the experience of this Lab in the areas of eResearch, eLearning and eHealth Assistance, a review of virtual tools used in academic activities and of telemedicine endeavours applied for the identification and treatment of a broad range of diseases worldwide is presented. Relevant eHealth terminology is also introduced to help the reader gain a better understanding of the concepts described in this text.

2. The Microgravity centre

Established in 1999, the Microgravity Laboratory emerged as a result of joint efforts between the Schools of Medicine, Aeronautical Sciences, and Engineering at the Pontifical Catholic University of Rio Grande do Sul (PUCRS) in Brazil. The Laboratory grew and expanded over the next few years with an ever increasing work output, and earned international acknowledgement for the pioneering and highly qualified research conducted there. In 2006, the Laboratory of Microgravity was transformed into the Centre of Microgravity (MicroG), and officially integrated the research of several academic departments of PUCRS. Today, the MicroG is, par excellence, a multidisciplinary research centre participating in both undergraduate and graduate courses in numerous areas of knowledge. The Centre currently comprises of seven unique research Laboratories, developing projects in different fields of aerospace sciences and in eHealth (www.pucrs.br/feng/microg).

The MicroG has established several partnerships with both national and international institutions, and with researchers prominent in their field. Consequently, two of the seven Laboratories at the MicroG Centre have been named after internationally recognised professionals who have made significant contributions to their development, and to the area of aerospace science: The John Ernsting Aerospace Physiology Laboratory, carrying out research into the behaviour and adaptation of human beings to aerospace environments, and the Joan Vernikos Aerospace Pharmacy Laboratory, dedicated to studying the effects of microgravity, hypogravity, and hypergravity conditions on pharmaceutical medications and their effects on humans. For the purposes of this Chapter, however, we will concentrate on

one of the fastest growing and innovative research Laboratories currently at the MicroG Centre, working in the dynamic and fast-paced field that is Telemedicine.

3. The telemedicine laboratory of the MicroG centre

Telemedicine, an emerging area of health assistance, research, and education, aims to apply information and telecommunication technologies (ICT) to enable the remote assistance of communities who currently lack specialist healthcare or access to any type of medical assistance. Supported by the São Lucas Hospital of PUCRS, the School of Medicine, the German TEMOS (Telemedicine for a Mobile Society) Project and other Universities, the MicroG Centre established the Telemedicine Laboratory as a research environment for the development of eResearch, eLearning and eHealth Assistance projects and tools.

The establishment of a Telemedicine Laboratory in a developing country, however, is not always an easy task, and the creation of the Telemedicine Lab of the MicroG Centre was no exception. The first years of the Lab were dedicated to overcoming many difficulties that were encountered, such as a lack of ICT knowledge of professionals involved, the hostile environments encountered in sites for planned eHealth projects, a resistance to new technology, poor local infrastructure, and restricted funding.

The most common limiting factors can be summarized as:

- Weak ICT knowledge, strategic planning, and limited experience with complex ICT implementation;
- Inconsistent leadership, especially in remote and rural areas;
- Lack of human resources at all levels;
- Inadequate local funding;
- Resistance to change, poor computer literacy, and technophobia ;
- Lack of culture of data collection and interpretation;
- Weakness in the conceptualization of the eHealth framework.

The Telemedicine Lab of the MicroG Centre has been able to surpass the limiting factors inherent to the establishment of a new area of knowledge in a developing country. With less than half a decade of experience of projects, the Lab has become both nationally and internationally recognised for the excellence of its work. This Chapter will describe and discuss the eHealth activities of the MicroG Centre Telemedicine Laboratory, including originality, experiences, limitations faced, and future proposed researches.

Some important concepts, however, must be first defined for a better understanding of the terminology applied, since these terms will be used often when eHealth projects and activities are presented (eHealth Related Terminology, Glossary of Terms Commonly Used in Health Care; AcademyHealth, 2004)

4. Definition of terms and concepts

eHealth is considered to be comprised of health informatics, teleHealth, and eLearning activities. They include tools for health authorities and professionals, as well as personalised health systems for patients and citizens. Examples are health information networks, electronic health records, telemedicine services, personal wearable and portable communicable systems, health portals, and many other information and communication technology based tools assisting prevention, diagnosis, treatment, health monitoring, and lifestyle management.

TeleHealth is the use of information and communication technologies (ICT) to exchange health information and provide health care services across geographic, time, social, cultural, and political barriers.

mHealth or mobile health is the practice of medical and public health, supported by mobile devices. The term is most commonly applied in reference to using mobile communication devices, such as mobile phones and PDAs, for health services and information.

Health Informatics comprises of the systematic study of the identification, collection, storage, communication, retrieval, and analysis of data about medical care services that can be used to assist decision making by physicians and managers of healthcare organizations.

eLearning is the utilization of technology to deliver learning and training programmes through media, such as CD-ROM, Internet, intranet, wireless, and mobile learning.

Database Management System (DBMS) is a system or software designed to manage a database, and run operations on the data requested by multiple clients.

Clinical Decision Support System (CDSS) is a system or software application primarily used to consolidate, summarize, or transform transaction data; it is specifically designed to assist health care providers in making decisions on care options by using structured (rules-based) information on diagnoses, treatments, and medications.

Electronic Patient Record (EPR) is a patient-centred record with information from multiple institutions. It supports health care providers by offering complete and accurate data, practitioner reminders and alerts, links to bodies of medical knowledge, and other aids.

Electronic Medical Record (EMR) is the repository of electronically maintained information about an individual's health status and health care, stored such that it can serve the multiple legitimate users of the record.

Electronic Health Record (EHR) is a systematic collection of continuously updated and current information relating to the past, present, or future physical and mental health, or condition of a patient, which resides in computers that capture, transmit, receive, store, retrieve, link, and manipulate multimedia data for the primary purpose of providing healthcare and health-related services. Accessible from any location by any provider caring for a patient, it allows the collection of data for uses other than for direct patient care, such as quality improvement, outcome reporting, resource management, and public health communicable disease surveillance.

TeleHealth Site is a geographic location (healthcare facility or clinic) from which one or more teleHealth activities, applications, or services are provided or received. Within any single teleHealth site will be either, or both, teleHealth facilities and teleHealth units.

Receiving and Delivering Sites - the "delivering site" is the site at which the specialist or referred clinician is located, and the "receiving site" is the site at which the referring clinician and/or patient is located.

Store and Forward is a telecommunications technique in which information is sent to an intermediate station where it is kept and sent at a later time to the final destination or to another intermediate station. The intermediate station, or node in a networking context, verifies the integrity of the message before forwarding it. In general, this technique is used in networks with intermittent connectivity, especially in the wilderness or environments requiring high mobility. It may also be preferable in situations when there are long delays in transmission with variable and high error rates, or if a direct, end-to-end connection is not available.

TeleHealth Unit is a related group of elements (hardware and software, including peripheral devices) that comprises a distinct and functioning apparatus that can be used to

perform a specific teleHealth activity, application, or service. A teleHealth unit may be static, mobile, or handheld, and includes units for off-site use.

TeleHealth Facility is a discrete and identifiable physical location (e.g. dedicated room, or dedicated space within a room) from which clinical, research, education, administration, or mixed teleHealth related pursuits are provided or received. A teleHealth site may have more than one teleHealth facility.

TeleHealth Activity is a teleHealth mediated pursuit, at the experimental, pilot, or formative evaluation stage.

TeleHealth Service is a specific and proven teleHealth application (clinical applications) offered routinely between teleHealth sites typically within a teleHealth programme e.g. forensic telemental health assessment; pre-catheterization teleassessment; home telemonitoring.

TeleHealth Program is a distinct, appropriately conceived, designed, staffed, managed, funded, and accredited set of teleHealth services orchestrated under a common theme and common administrative structure, such as a telemental health programme; a telecardiology programme; or a home teleHealth programme.

eHealth Policy is defined as a set of statements, directives, regulations, laws, and judicial interpretations that direct and manage the life cycle of eHealth. More generically, policy is a plan or course of action of a government, political party or business intended to influence and determine decisions and actions.

A still controversial and debatable area of eHealth is related to the **Ethical Issues** involved in delivering health care from a distance. This theme is evolving daily and still presents a huge variability of applications and definitions from place to place. In general terms, **Ethical Issues in eHealth** include the discussion of the topics described below:

Consent for care in eHealth: Laws differ in many areas of the globe on obtaining consent for care before transferring patient information online, or before arranging video-conferencing sessions, especially when open source softwares are used. Clear policies to guide such consent can benefit and legally protect healthcare institutions and providers.

Liability issues (also called **medical malpractice liability**) and **Medico-legal issues** are related to policies regarding medico-legal issues in eHealth, which are crucial, and must be developed before eHealth programs are implemented. Local laws and policies for healthcare services and providers must be respected, but also adapted to cover aspects related to eHealth issues.

Other **Ethical** topics to be considered are the policies that define the **patient's right** to access his or her own electronic information and database of medical history, diagnoses, exams and treatment history. These policies can constitute an important matter for eHealth decision makers, since it can help managers and providers to safely and legally share the requested information with the patients (WMA, 2007 & 2008).

Establishment of international **policies in eHealth** can be a huge challenge (Scott et al., 2002; Scott et al., 2004). eHealth expectations and requirements differ in the developed world when compared with the needs of the developing world. In a developed country, for example, eHealth programmes are designed to provide products like eCards and aim to decrease the healthcare costs of an aging population by introducing adequate and sustainable homecare services. The developing countries, on the other hand, are generally more concerned with issues such as finding ways of overcoming extreme shortages of healthcare workers, especially in remote areas, and improving rural healthcare, whist at the

same time implementing electronic health information systems. Therefore, what seems perfectly acceptable in the developed world, in terms of data security and quality, patient confidentiality, and privacy, may be major impediments to the eHealth policy of a developing country. A good example is the eHealth roadmap of Europe. The 27 European Member States identified 36 policy targets, with the most common aims being: improved efficiency and quality of care in health system performance; healthcare system reform; citizen-oriented, patient-centred healthcare; quality of care; better data for system management and communication between stakeholders; efficiency; access to care; promoting quality of life; and improved economy via eHealth technology. They are undoubtedly very important goals to be achieved, but every single one is complex, requiring enormous political, social, and economic investments. Developing countries are perhaps those most in need of global assistance but for this to be successfully accomplished they need to have in place adequate and well defined eHealth policies, a difficult enough undertaking for the more structured countries of Europe to achieve, and therefore a far more problematic task for countries still struggling to attain sustainable development (Scott, RE, 2007).

5. Current issues in global health

Since the beginning of the new millennium there has been an increasing emphasis placed on global health, both in the political agenda and within the healthcare profession. In the year 2000, the United Nations outlined Eight Millennium Development Goals (MDG) with the aim of alleviating hunger and poverty by the year 2015 (UN General Assembly, 2000). Health forms a large part of these goals and there has subsequently been an increasing focus on both academic and clinical pursuits, from a national policy level right down to the level of the individual. There is an ever increasing amount of funding available and initiatives in place for the 'big three' infectious diseases – human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS), malaria, and tuberculosis. Furthermore, previously neglected tropical diseases, such as schistosomiasis, leishmaniasis, Chagas disease, and soil transmitted helminths are now beginning to receive some of the attention that they deserve, although there is still a lot more that needs to be done (Fenwick et al., 2009). Disease is a universal entity, not recognising political and continental boundaries, as evidenced by the rapid global spread of the pandemic influenza A(H1N1) virus in 2009. Therefore, a coordinated approach on a global scale with both intra- and intercontinental cooperation is warranted.

However, whilst there have been significant improvements in global health, large inequalities remain, particularly in low and middle income countries. A review by Beaglehole and Bonita (2008) has summarised the recent trends and agendas in global public health. People living in poorer nations have a shorter life expectancy and live more of their lives in bad health, as opposed to those in richer countries. The MDGs have experienced mixed fortunes; progress has been erratic and it is unlikely that any of the goals will be met by 2015 where they are needed the most, in sub-Saharan Africa. The balance between communicable and non-communicable disease has firmly shifted in favour of the latter. It is now cardiovascular disease, diabetes, cancer, chronic respiratory disease, mental disorders, and injuries that are the main threat to health throughout the world. Non-communicable diseases cause substantial morbidity and mortality; in 2005 they were responsible for 60% of

all global deaths (WHO, 2005). It has been estimated that 80% of all deaths attributable to non-communicable diseases occur in low and middle income countries (WHO, 2008). Health gaps within and between countries are widening and efforts at socioeconomic development are impeded by the heavy burden of disease, highlighting the close association between poor health and poverty (Alwan & MacLean, 2009).

Unfortunately it is the people living in remote and resource-poor settings who bear a large proportion of the global disease burden. They commonly live far from health centres and may not have the physical or financial capacity to travel and seek attention. These rural health centres are frequently understaffed, underequipped, and underfunded; they are neglected by the health system and the international community. There is usually a shortage of trained physicians and those that remain within the country often avoid working in remote areas due to isolation caused by difficult access to and from cities, as well as the low availability of resources. Specialist care is hard to find outside of big cities and the healthcare staff working in remote areas often have gaps in their skills and knowledge due to a lack of opportunities and resources for further training. All of this means that when patients do eventually present to a healthcare professional, their condition is at a more advanced stage and therefore more complicated to manage, with a decreased likelihood of a successful outcome.

6. How can eHealth help?

Bashshur and Shannon (2009) present telemedicine as a cost-effective and clinically useful option for those planning healthcare interventions. They provide a comprehensive summary of how it can be applied and its potential benefits. Whilst the authors focus on a developed country, there are several principles that can be extracted and applied to developing countries also. Telemedicine can provide specialist healthcare in remote environments without the need for patient or physician to travel, saving money and time as well as making the patient's life more convenient. The reach of specialists at tertiary care centres is significantly extended. Telemedicine can link primary and tertiary care, providing access to specialist information and advice when required for general practitioners. It enables a sensible triaging of patients and can minimise the duplication of diagnostic tests and clinical services. As well as access to specialist information and opinions at initial appointments, it can also be used for ongoing follow-up care after previous treatment.

Telemedicine can:

- Stabilise rural providers and local economies;
- Facilitate the care of institutionalised populations;
- Integrate medical services across multiple delivery sites;
- Enhance chronic disease management, both in rural settings and in long-term care institutions;
- Put the patient at the centre of the focus of care;
- Decrease the difficulty of accessing healthcare due to socioeconomic, geographic, and cultural differences.

Emerging and re-emerging infectious diseases in Africa, such as cholera or viral haemorrhagic fevers, can be considered examples of how telemedicine can help. There are regular outbreaks of disease that cause many problems in the African continent because of complex environmental, economic, and political factors. Many countries in Africa have a

decreased capacity to monitor disease trends and instigate appropriate public health action. This is because of a lack of laboratory facilities and poorly integrated disease surveillance systems. To be able to rapidly and efficiently tackle an emerging public health threat, the following are required: good local level disease surveillance; a network of reference laboratories on a national and international scale; and rapid collection and dissemination of data. Without the aforementioned features, outbreaks may reach epidemic proportions before they are detected at a local or national level. eHealth networks can bring together the activities of district laboratories, enable efficient data collection and transmission, and provide support through quality control and technical advice. This has the potential to improve disease surveillance and enable healthcare systems to react and get on top of disease outbreaks rapidly (Shears, 2000).

There are several factors that must be considered for a telemedicine initiative to be successful. It is important that the group of patients to be referred for a virtual outreach programme is selected carefully. The staff working in the receiving site must possess the correct skills and equipment to be able to undertake the appropriate history and examination, the results of which must be carefully documented (Rinde & Balteskard, 2002). Other aspects that must be addressed are the costs involved in any new project, limited internet connectivity, and unreliable power supplies, especially in sub-Saharan Africa. Telemedicine needs to be considered at a policy level to ensure that a sustainable budget is available. Ongoing training must be provided to receiving staff to ensure that computer literacy is sufficient and that technical support can be provided in the event of a system failure. The unpredictable nature of politics means that changing priorities or conflicts may disrupt local infrastructure and the healthcare system (Mars, 2009).

Furthermore, as previously discussed, there are ethical and legal considerations, which are of utmost importance when planning a telemedicine initiative. Rather than creating new ethical and legal considerations, telemedicine accentuates existing ones. Patient privacy, confidentiality, and consent must be comprehensively addressed, as it is frequently these issues that concern patients most. When storing, transmitting, receiving, or disposing of confidential information, it is the eHealth technical personnel that are responsible for ensuring the protection against improper disclosure (Stanberry, 2001).

7. The main areas of the telemedicine laboratory of the MicroG Centre

The Telemedicine Lab has three main areas of activity – **eResearch**, **eLearning and eHealth assistance.**

8. eResearch

Globalisation has allowed researchers to share information regarding projects and studies being developed around the world. eResearch, however, aims to foster greater national and international multidisciplinary collaboration, enabling researchers to actively participate in practical studies taking place in other countries, without the need to leave their own universities.

The Telemedicine Laboratory/MicroG Centre has successfully performed a series of eResearch activities. These are related to the development of software and hardware that have been used in eHealth projects and in the teletransmission to national and international partners of live surgeries, lectures, and data collection for several studies.

8.1 Virtual data collection

In order to facilitate greater international collaboration for aerospace physiological studies at the MicroG Centre, the Telemedicine Laboratory has used video-conferencing technology to allow virtual participation during data collection (Figure 1). This has allowed partner researchers from European institutions to take part in joint studies whilst remaining in their own laboratories. This technique has enabled new interactions between professors, researchers, and students from different countries during project development, with the benefit of reducing costs and avoiding the need to travel.

Fig. 1. Virtual participation of researchers from Lithuania during data collection at the MicroG Centre in Brazil

8.2 Research and development eHealth equipment – digital camera illuminator

Ensuring standard lighting conditions for the collection of image data is not possible in remote locations lacking in proper infrastructure, or in healthcare unit consultation rooms, without the proper equipment (Miot, 2006). Therefore, having learnt from the experience of several assistance missions to the Amazon region of Brazil, the Telemedicine Laboratory has developed a series of illuminator prototypes to provide a standard light intensity and colour contrast, during acquisition of skin and mouth lesion images (Figure 2). One of the main objectives of these missions was to enable remote second opinion of dermatological issues though the exchange of electronic patient records between teleHealth receiving and delivering sites (Cardoso, 2007).

Consequently, a research project was conceived to develop and validate an illumination device which would be adaptable for use with multiple brands of amateur and semi-professional digital cameras. This equipment, when employed together with electronic patient record systems, enables the implementation of teledermatology and teleodontology services, improving healthcare delivery in locations with no specialised health professionals. The development of these prototypes was accomplished through a series of studies conducted at the Telemedicine Laboratory, the dermatology clinic of PUCRS Academic Extension Unit for Health Care Services, and during the Amazon missions. The resultant images obtained permitted the identification of different problems in each project, allowing solutions to be suggested and improvements in prototype design and construction (Figure 3).

An image acquisition protocol was created to standardise the methodology utilised by users, preventing misplaced camera configuration, incorrect illuminator assembly, or equipment positioning difficulties when acquiring lesion pictures.

Fig. 2. Image acquisition of patient lesion using illuminator prototype attached to a Sony digital camera

Fig. 3. Current Illuminator prototype. 1: Sony Digital Camera. 2: Illuminator power supply support. 3: Illuminator. 4: Colour ruler (size, colour and focus reference)

Electronic patient record

In order to allow the electronic patient record exchange between teleHealth receiving and delivering sites, the telemedicine laboratory has developed several asynchronous communication platforms, which can be divided into two groups:

Desktop applications

Due to the lack of internet access in remote locations, electronic patient record software in these areas requires local database management systems in order to employ "store and forward" methodology for data communication. A Delphi desktop application, associated with File Transfer Protocol (FTP) and MySql database servers, was considered most suitable for use in these conditions (Figure 4). As a result, data exchange between sites takes place upon internet availability, allowing a greater flexibility and mobility of the specialised virtual assistance service.

The tool data input is divided into general patient information and the specialised areas, such as dermatology, odontology, cardiology, pharmacy, and nutrition. Each area is used according to the need of the receiving physician for second opinion.

All patient data is secure and its access is protected by user login into the system.

Fig. 4. Electronic patient record software developed by the telemedicine laboratory of the Microgravity Centre – FENG/PUCRS. User login window

Web application

The rapid change of modern technology demands a fast adaptation of computational tools and systems for the evolving requirements of its users. Cloud computing, well known for Google applications such as Google Docs, can provide cost-effectiveness, flexibility, and ease of access benefits leading to a wider scale of use of electronic patient record platforms by hospitals, health units, and remote locations. It allows users to access patient data in real time or from record, from any internet connection point via a web browser, without the need for software installation or update.

In order to provide such a service, the Telemedicine Laboratory developed a web portal (Figure 5), which enables receiving and delivering health professionals to communicate over geographical distances. Medical records and short messages can be securely exchanged over the internet, thus allowing physicians in remote teleHealth facilities to obtain expert second opinion.

Web technologies, such as Hypertext Preprocessor (PHP), Asynchronous Javascript (AJAX), Structured Query Language (SQL), Database Management System (DBMS) and File Transfer Protocol (FTP) were employed in the platform development, creating a dynamic display of stored clinical information.

8.3 Telesurgery system

eHealth education programs are becoming a reality in universities, providing the opportunity for students to have greater interaction at live surgery classes by means of virtual participation. Undergraduate students can be introduced to new concepts of medical care, remote second opinion delivery, and to telecommunication systems, whilst virtually experiencing surgical procedures and lectures. The improved access this provides to the operating theatre environment, the patient, and the surgeon, can improve the learning process for students.

At PUCRS, an analogical system was developed and used for transmitting video and audio from the surgery theatre to a lecture hall (Figure 6.A). The telesurgery lectures were also transmitted to other national and international partner universities by means of a video-conference system (Figure 6.B), featuring H.323 communication protocol, located in the São Lucas University Hospital. Telemedicine technology has proven to be an important

Fig. 5. Web portal developed by the Telemedicine Laboratory of the Microgravity Centre – FENG/PUCRS. User login window

instrument for the improvement of medical education and health care. This methodology allowed health professionals, professors, and students to have greater interaction during surgical procedures, thus enabling a greater opportunity for knowledge exchange.

(a) PUCRS students and professors watching live transmission

(b) Live transmission from PUCRS to students and

Fig. 6. Telesurgery lecture. Image and audio transmission of surgery procedures from the surgery theatre and the lecture hall

8.4 3D virtual eye

The establishment of a partnership between the Telemedicine Laboratory of the Microgravity Centre, the School of Informatics at PUCRS, and the Telemedicine Centre of Kaunas University of Medicine, enabled researchers from both universities to develop successful joint projects in the area of telemedicine. The 3D Model Eye project, with a graphic design team of students and professors from the School of Informatics, PUCRS, aimed to develop a virtual tool for educational and medical proposes. As a result of knowledge exchange between the two universities, a 3D stereo animation of a healthy

human eye was created using open source graphic modelling software. This model (Figure 7) was accepted by consultant ophthalmologists of both universities as a clear representation of a human eye.
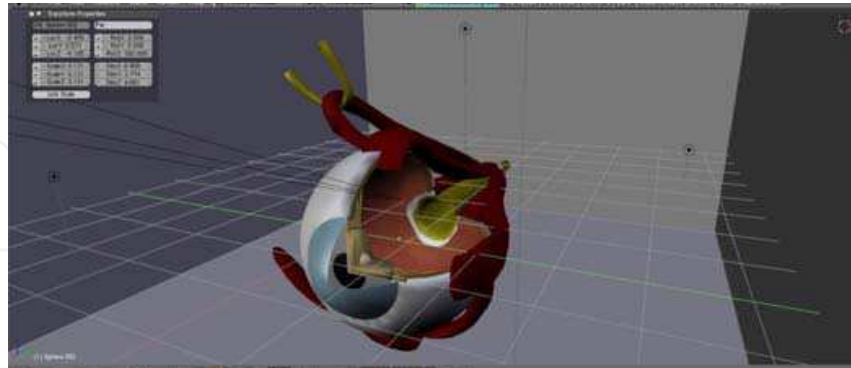

Fig. 7. 3D virtual eye model developed at PUCRS in partnership with the Kaunas University of Medicine.

9. eLearning

The recent development of numerous virtual and electronic communication systems and tools allows learning to be a real time process, which for students and professors is dynamic, challenging, and creative. It eliminates distance and walls in the classroom, giving participants greater motivation with multiple perspectives, promoting connections to be established with other cultures and nations.

In the health area, clinical case discussions and transmission of virtual live surgeries allow for the exchange of specialist medical opinion and treatment suggestion between different countries. Through the establishment of eHealth programs as educational tools, students can become involved in the process, thus making them more aware of the diversity or convergence of clinical conducts, enabling them to develop a more critical judgment, greater autonomy, and an enhanced competence to create and act in knowledge networks, therefore being better prepared for professional reality.

This new educational method has facilitated the diversification of teaching techniques and the development of new ways of interaction among students, professors, and the content, being defined as the use of electronic information and communication networks to disseminate health knowledge.

The MicroG Telemedicine Laboratory has developed multicentre, multidisciplinary virtual activities in order to encourage Brazilian students to experience contact with new telecommunication technologies, and to share educational experiences as an integral part of their learning process.

The Multipoint eHealth Education Programme was established in collaboration with PUCRS, the TEMOS project (Telemedicine for a Mobile Society) of the German Aerospace Centre (DLR), the Faculty of Medicine at the RWTH Aachen University (Germany), the Medical University of Warsaw (Poland) and the Medical University of Kaunas (Lithuania).

The activities of the Multipoint eHealth Education Programme aim to stimulate the interest of undergraduate and postgraduate students to different cultural and social realities and to enable the exchange of health knowledge through videoconferences, and to develop virtual medical education tools.

The eLearning activities comprise of several multipoint and point-to-point virtual lectures among different Brazilian universities and also between educational institutions from Brazil, Germany, Lithuania, Poland, England, Colombia, Mexico, USA, Panama, South Africa and Pakistan. Students from each university choose the topic to be covered and prepare a Microsoft PowerPoint presentation under the supervision of a designated professor. All the presentations and discussions occur in English.

Scientific themes selected were related to diseases, new available treatments, development of technology for medical exams, bioethics, local and international health politics, space life sciences, aerospace medicine, and physiology. In order to carry out the telelectures, different virtual communication systems via the internet were used, with the common characteristic of the capacity to employ H.323 protocol for the transmission of the information between participating universities. The institution in charge was responsible for making the link between the other members of the activity, using a video-conference system with a Multipoint Control Unit (MCU) able to hold a maximum of five connections at the same time. The speed connection between the participants, which varied between 768Kbps and 2Mbps, was configured by each taking into consideration equipment and internet bandwidth capability.

The set up of the virtual lecture room was intended to give all those present eye contact when speaking to each other directly, as this plays a large role in conversational turn-taking, perceived attention and intent, and other aspects of group communication. An important tool used to accomplish this task was Continuous Presence, a feature of MCUs, which enables multiple parties to be seen on-screen at once, allowing presenter and audience to interact in a more effective way (Figure 8). To show close up images of the participants during subject discussions, remote controlled cameras with zoom ability were used together with table microphones capable of efficient echo cancelation.

The Microsoft PowerPoint 2003 files containing presentations were sent in advance to all participants in order to ensure the quality of the display for the classes, allowing them to locally administer the slides. The presentations used multimedia content, including videos and animations, which provided a greater clarity for the explanation of the topic discussed.
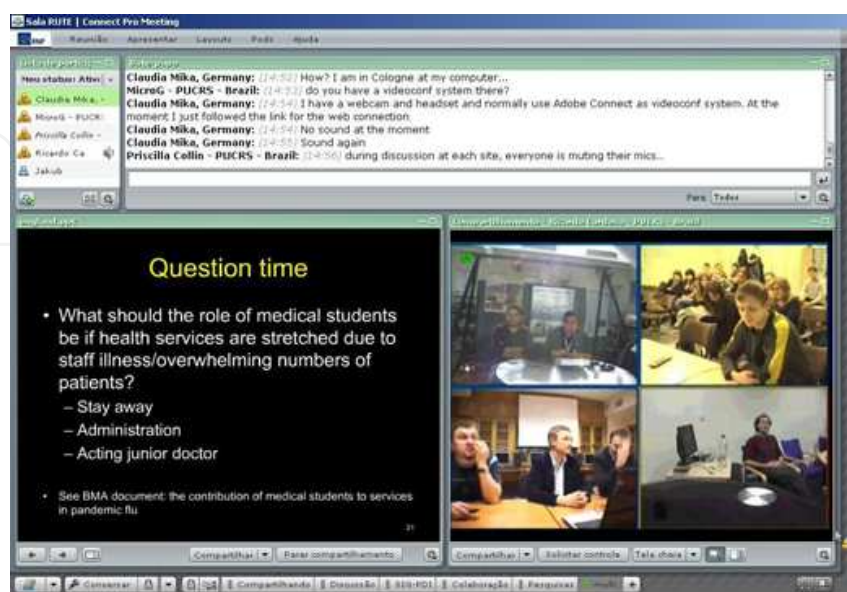

Fig. 8. Continuous Presence set up: Camera placed close to the projected image

10. eHealth assistance

Brazil is a country with continental dimensions, an uneven distribution of financial resources, and diverse social problems. Physicians often avoid working in remote areas due to the isolation caused by difficult access to and from cities, the low availability of resources, and a lack of local infrastructure and comfort. Consequently, these locations are often deprived of specialist care, which has proven to delay the diagnosis and adequate management of several medical conditions.

The Brazilian Amazon assistance projects conducted by PUCRS

eHealth Assistance initiatives, such as the eHealth Amazon Project developed by the Telemedicine Laboratory, are an example of the improvements in health service that can be provided by the use of telemedicine in isolated areas. This project aimed to make available specialised medical assistance to remote and deprived communities using telecommunication systems, software development, mobile technologies, and biomedical engineering. As a consequence of providing this assistance, the Telemedicine Laboratory could validate the tools and systems developed.

These projects were organized in partnership with the Nucleus of Research in Indigenous Culture and the schools of medicine, odontology, and pharmacy of PUCRS, and were divided into two distinct phases: system development and team training; and eHealth missions – validation.

10.1 System development and team training

- Technological tools
  - Data delivery system – *Store and Forward* technique
    - Data storage: Mysql database
    - File Storage: FTP server
    - Interface development: Delphi language
    - Software test and adjustments
  - Illuminator device
    - Improvement from previous developed systems
      - Better camera attachment
      - Stronger structure
      - Better light distribution
  - Multidisciplinary eHealth team training
    - Data delivery software and equipment familiarisation
    - Lectures regarding local cultures
    - Presentation of previous experiences

10.2 eHealth missions – validation

The validation activities were carried out by multidisciplinary eHealth teams, composed of PUCRS professors and students from technical and health areas, such as dentistry, pharmacy, engineering, nutrition, medicine, education, and nursing. Participating students were selected by curriculum analysis and interview or by their previous or present involvement in eHealth projects.

Remote areas of Brazil were chosen as receiving sites due to their lower population density and human development index (Table 1), in order to enable a greater impact on local health care. The sites were as follows:

Delivering site – Sao Lucas hospital of PUCRS

The São Lucas Hospital (HSL), a tertiary hospital, occupies an area of 57.700m² divided into the hospital area (49.000m²) and the clinic centre (8.700m²) in Porto Alegre, Rio Grande do Sul, Brazil. The hospital has a capacity of 603 beds, of which 495 are for conventional hospitalisation, 87 for intensive care (general, cardiovascular, paediatrics, and neonatal), and 21 for observation (emergency patients). 52 specialities are available in hospitalisation care and 31 in emergency and clinic care.

Receiving site – remote locations

The visited areas were characterised by the provision of primary care facilities, where a general practitioner would be responsible for all healthcare delivery. The availability of resources with which to work would typically range from a nurse's station in a healthcare centre to a more basic environment requiring a degree of improvisation to provide the comfort and privacy for patients and the eHealth team.

Local / Aspects	Area (Km²)	Population	Population Density (inh/Km²)	Human development index	GDP (R$) (thousand)	GDP per capita (R$)
Porto Alegre	497	1,436,123	2,890	0.865	33,434,026	23,534
Ji-Parana	6,897	111,010	16.2	0.753	1,121,152	10,412
Alto Xingu	10,000	2,907	0.2907	-	-	-

Table 1. Comparison between receiving sites and delivering site (Porto Alegre city)

The Telemedicine Laboratory successfully organised three missions to the Amazon region of Brazil, which are summarised in Tables 2 and 3:

Mission	Date	Local	Specialities (N° of health interviews)		Total of interviews	Total of patients
I	8th – 28th Jan 2007	Region of Ji-Parana City, Rondonia State	Dermatology	(181)	181	181
II	5th – 23rd Jan 2008	Region of Ji-Parana City, Rondonia State	Dermatology	(146)	176	167
			Odontotology	(30)		
III	18th Jul - 3rd Aug 2008	Xingu Area, Mato Grosso State	Dermatology	(62)	117	112
			Odontotology	(12)		
			Cardiology	(43)		

Table 2. Summarised information from the missions

Mission	Main Findings
I	The main diagnoses made by the specialist were superficial mycosis (32.6%), eczema (8.84%), and keratoses (6.1%). Among interviewed cases, 11.6% were inconclusive. The high incidence of dermatological lesions of fungal origin in adults and children in villages is believed to be influenced by close contact with domestic (i.e. chickens, ducks, and pigs) and wild animals (i.e. birds and monkeys), often kept within the communities. This mission is illustrated in Figure 9.A
II	A second opinion was provided remotely by specialists in odontology and dermatology. From all dermatologic cases analysed, 21.2% were inconclusive and further medical information was required. This mission is illustrated in Figure 9.B
III	Expert opinion analysis verified that 62.7% of electrocardiogram (ECG) exams were normal, while 37.3% had alterations of some degree. In dermatology, the most common diagnoses were eczema (19.3%), Pityriasis Versicolor (14.5%), and Tinea (12.9%). In odontology, angular cheilitis (25%) and traumatic ulcer (25%) were the most frequent findings. Among all, 6 cases (5.12%) were inconclusive due to lack of available information.

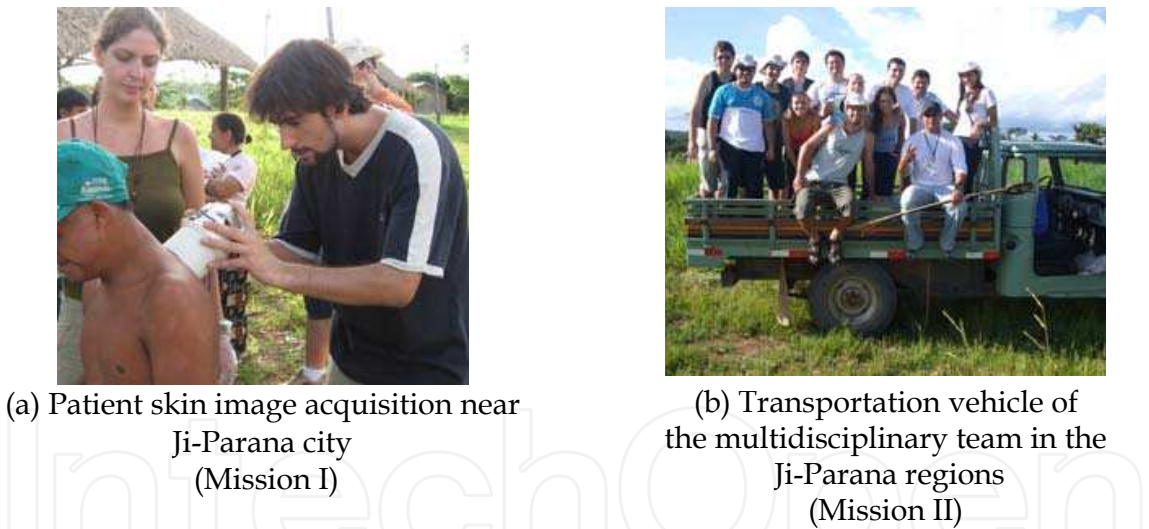Table 3. Main Findings of missions and second opinion data analysis

(a) Patient skin image acquisition near Ji-Parana city (Mission I)

(b) Transportation vehicle of the multidisciplinary team in the Ji-Parana regions (Mission II)

Fig. 9. Amazon missions

During each mission, the activities were divided into the following steps:

1. Patient screening

Interviewed patients were pre-selected by the local health team (receiving site) for each location visited, taking into consideration patient ailments and family medical history. An initial interview was carried out by the PUCRS team to determine the health area to which each patient would be referred, and to create a record on the database.

2. Patient interview - electronic patient record information input

Once referred, each patient was interviewed regarding specific aspects related to their health condition. This information was uploaded to the electronic patient record together

with skin/mouth images or electrocardiogram (ECG) exams, depending on the referred area.

2.1 Image acquisition

A Sony digital camera, together with the developed illuminator, was used to acquire images of mouth and skin lesions. Subsequently, pictures with the best quality were uploaded to the software;

2.2 ECG exam

A digital ECG machine was used to acquire electrical wave patterns from patient hearts. After each exam, a data file was generated and uploaded to the electronic patient record.

3. Data transmission – specialist access to patient information

Upon internet availability, the system was programmed to connect to the Microgravity Centre's main server and to synchronise all collected data. Specialist health professionals had secure access to the electronic patient records via this server, through use of an application installed on personal computers.

4. Expert second opinion

Patient information, images, and exams were analysed by health specialists at the delivering site, and an opinion and treatment suggestion was offered. The inconclusive cases were due to lack of available information or need for further laboratory exams. The opinions were secured in an encrypted PDF envelop and sent back to the receiving site, where final diagnosis and treatment were the responsibility of the local health team.

The experience gained from organizing and conducting such activities highlighted important issues which should be addressed when developing assistance projects:

- Team training proved to be crucial for the success of the missions as it prepared the groups to: 1) deal with the local conditions of the Amazon region; 2) better interact with the local communities; 3) Solve equipment problems if required.

- The use of software capable of managing all patient data proved to be essential for avoiding information loss or misplacement during data collection. Importantly, the software also enabled users to operate from multiple workstations connected to the same database, allowing access to information uploaded by colleagues, and optimising an efficient team effort.

- The illumination system developed proved to be an essential tool to ensure standardisation of light conditions for all images. This procedure enabled the specialist to better compare and contrast patient skin colour lesions, an important characteristic for dermatological diagnosis.

Telemedicine tools and telecommunication systems proved to have a great applicability in remote regions for the diagnosis of dermatological skin and mouth lesions as well as cardiologic diseases. Each mission completed proved successful at making possible the remote diagnosis of patient ailments in a short period of time, at low cost, and without the need for patient transportation to another location. It is believed that the eHealth assistance model applied in this project can be transferred to any location having access to an internet connection.

11. How else has telemedicine been used around the world?

The scarcity of healthcare professionals in developing countries, particularly specialists, has long been recognised. SatelLife is a charitable organisation set up in Boston in 1987 with the

aim of meeting the needs of healthcare providers in the developing world by bridging the digital and information divides. It was a pioneer for telemedicine in resource-poor settings. It provided E-mail access in more than 100 countries serving more than 10,000 healthcare workers, using a low earth orbit satellite and telephone lines. A store and forward technique was applied; E-mails containing the pertinent clinical details and image attachments were sent to specialists for advice on the management of difficult cases. This proved to be a cheap and rapid way of seeking a second opinion (Fraser & McGrath, 2000). SatelLife has since expanded its operations keeping in line with technological advances and continues to provide information and support services for healthcare professionals in resource-poor settings. In 2001, it began to explore the potential use of Personal Data Assistants (PDAs) in Africa (Lucas, 2008), which led to the development of the Uganda Health Information Project (UHIP) in 2003. Initially involving two districts in Uganda, more than 200 PDAs were distributed amongst healthcare workers, and these were linked to connection points at health facilities allowing data communication. This enabled the electronic compilation of Ministry of Health routine data forms, as well as the dissemination of information about planned Ministry of Health activities, and details of disease outbreaks. This venture significantly increased the rate of compliance on weekly disease surveillance reporting. Furthermore, this initiative proved popular with healthcare staff who displayed a strong demand for access to additional information over the network. This project has subsequently expanded and now involves more than 600 workers in five districts throughout Uganda. SatelLife also organise a similar project in Mozambique. This is a good example of how improvements in public health can be achieved through the rapid dissemination of vital information across a large area, in a resource-poor setting, using telemedicine.

Zolfo et al. (2006) describe a HIV/AIDS telemedicine initiative in a resource-poor setting. Doctors at the Institute of Tropical Medicine in Belgium created a hybrid E-mail/web support telemedicine service in order to support physicians in resource-poor settings, using remote consultations to provide expert advice on antiretroviral therapy (ART) and the management of opportunistic infections. The patient's history, examination findings, laboratory results, and questions to be answered were sent along with any relevant images to the telemedicine website, where an HIV/AIDS specialist from the institute in Belgium could assess the case remotely. The price of ART is reducing rapidly, thus opening up the market to more and more developing countries, however, for the treatment to be efficiently and safely used it is important that the healthcare staff have the appropriate knowledge and skills required. This telemedicine service provided an opportunity for clinicians from resource-poor settings to receive training and advice on difficult HIV/AIDS cases, as well as providing resources for their ongoing education.

Bagayoko et al. (2006) performed an evaluation of an internet-based telemedicine network in developing countries in Africa, using the Réseau Afrique Francophone de Télémédecine (RAFT) project as an example. The RAFT project was born out of a partnership between the Mali University Medical School and the University of Geneva. Its focus is sustainable development of an international network, enabled through low cost telemedicine and an appreciation of local necessities. It facilitates interaction between healthcare staff from both sites using teleeducation and teleconsultations. Similar initiatives were deployed in other countries in West Africa and by 2006 a total of nine countries were connected. The RAFT project contains an online database of weekly seminars; it broadcasts scientific conferences

over the web; it provides specialist advice for physicians in countries where certain medical fields are under-represented or even absent; it allows European physicians to seek advice and education on tropical diseases that are usually rare in Europe; and it creates opportunities for healthcare staff to receive education or training at the partner institutions. The authors conclude that any telemedicine strategy must be adapted to local needs and realities. Whilst links between developed and developing countries are useful, there still exist vast differences in resources and sociocultural contexts, and as such, an intra-regional network with links to developed countries may be more beneficial. Finally, it is important to avoid a digital divide within a health system by involving the periphery in the development of any network.

Breslauer et al. (2009) combined light microscopy with mobile phones to enable the remote diagnosis of infectious diseases in resource-poor settings. Furthermore, the role of mobile phones in assisting the diagnosis of tuberculosis in developing countries was recently evaluated (Zimic et al., 2009). Tuberculosis is a highly infectious bacterial disease that causes substantial morbidity and mortality around the world, but predominantly in developing countries. Fortunately, it is curable and therefore timely detection and treatment of infected patients is vital to improve their health and prevent further spread. A new tool for the rapid diagnosis of tuberculosis (including multidrug resistant tuberculosis) and determination of drug susceptibility has been developed – the Microscopic Observation Drug Susceptibility (MODS) assay. This test uses inverted microscopy to visually recognise the characteristic pattern of growth of mycobacteria in liquid medium. Whilst it provides a rapid diagnosis and advice on the management of tuberculosis, it also requires specially trained personnel to assess the results in order to achieve the best sensitivity and specificity. This creates a problem for developing countries, where there is a shortage of staff, yet the test is arguably most needed. In this study, mobile phones were used to take and transmit an image of the MODS culture using a web server, with subsequent specialist analysis of the image online and return of the results back to the mobile phone. Concordance between readings directly from the microscope and from the mobile phone image was 98.7%. The authors concluded that this is a cheap and effective way of overcoming the limitation of a shortage of trained personnel.

In addition to its potential in developing countries, telemedicine also has an important role to play in remote areas within developed countries. Raza et al. (2009) report their experiences using videoconference telemedicine for providing outpatient pulmonary consultations in a remote area of the USA. Patient referrals from primary care to a pulmonary specialist were categorised as either urgent or non-urgent; the former went to a hospital whilst the latter were considered for remote teleconsultation. A nurse at the receiving site obtained a history and vital signs before the patient interacted with a specialist at the delivering site via live two-way videoconference. An electronic stethoscope was available for the specialist to perform a physical examination if required. The authors found that a definitive diagnosis was possible in 94% of cases and that a clinically significant alteration in management was achieved in almost 50%. Furthermore, more than 90% were able to receive care close to home, with the remaining few needing to travel for an in-person consultation. This approach made the lives of both patient and clinician more convenient and improved specialty coverage in remote areas, whilst at the same time maintaining a high quality of patient care.

Teledermatology has become one of the most successful and widely implemented areas of telemedicine in recent years. Schmid-Grendelmeier et al. (2000) report on one of the first teledermatologic connections in Sub-Saharan Africa. A link was formed between the Regional Dermatology Training Centre in Moshi, Tanzania and the University Hospital of Zürich, Switzerland. Both store-and-forward and real time approaches were taken, enabling the exchange of digital images and histopathology slides to facilitate diagnosis in challenging and interesting cases. Not only were the clinicians in Tanzania able to seek expert advice, they were also able to provide assistance to Swiss clinicians for tropical diseases in returning travellers.

Surgical telemonitoring has been used in Ecuador to guide inexperienced surgeons through advanced procedures in remote areas within a mobile theatre (Rosser Jr et al., 1999). The original initiative did not use telemedicine, meaning that surgeons needed to travel long distances across difficult terrain to reach the patients in order to perform preoperative and postoperative evaluation. This obstacle has now been overcome, decreasing costs, saving time, and increasing efficiency. Clinicians at the delivering site are able to effectively guide surgeons at the receiving site through procedures with which they may be inexperienced. Of course, with any application of telesurgery, patient safety and satisfaction are arguably of more importance due to the nature of the intervention, and this aspect must be considered when designing a programme.

This is just a selection of what has happened around the world recently and is designed to stimulate ideas and imagination. There are many initiatives occurring within and between countries, and the area is so vast that one could dedicate a book to this area alone. Throughout it all there is one very important consideration. The emphasis in modern medicine is on the biopsychosocial model of health and disease (Engel, 1977). There are many individual factors at play when considering why a particular illness has occurred in a particular patient. The temptation with telemedicine can be to focus purely on the biological aspects of disease, neglecting the equally important psychological and social factors. Therefore, any initiative should take care to incorporate a more rounded assessment of the patient to ensure that they are provided with the best level of care possible.

12. References

Alwan, A. & MacLean, DR. (2009). A review of non-communicable disease in low- and middle-income countries. *International Health,* Vol. 1, No. 1, (September 2009) 3-9, ISSN 18763413

Bagayoko, C.O., Mueller, H. & Geissbuhler, A. (2006). Assessment of internet-based telemedicine in Africa (the RAFT project). *Computerized Medical Imaging and Graphics,* Vol. 30, No. 6-7, (September-October 2006) 407-16, ISSN 08956111

Bashshur, R.L. & Shannon, G.W. (2009). National telemedicine initiatives: essential to healthcare reform. *Telemedicine and eHealth,* Vol. 15, No. 6, (July-August 2009) 600-10, ISSN 15305627

Beaglehole, R. & Bonita, R. (2008). Global public health: a scorecard. *Lancet,* Vol. 372, No. 9654 (December 2008) 1988-96, ISSN 01406736

Breslauer, D.N., Maamari, R.N., Switz, N.A., Lam, W.A. & Fletcher, D.A. (2009). Mobile phone based clinical microscopy for global health applications. *PLoS ONE,* Vol. 4, No. 7 (July 2009) e6320, ISSN 19326203

Cardoso, R.B., Huettner, E., Hoppe, A., Winter, C., Huettner, E., Celia, S., Duval, V., Fernandes, J., Sparenberg, A.L.F. & Russomano, T. (2007). A successful telemedicine experience in the Brazilian Amazon region. *Acta Informatica Medica*, Vol. 15, No. 4 (December 2007) 211-15, ISSN 03538109

Engel, G.L. (1977). The need for a new medical model: a challenge for biomedicine. *Science,* Vol. 196, No. 4286 (April 1977) 129-36, ISSN 00368075

Fenwick, A., Zhang, Y. & Stoever, K. (2009). Control of the neglected tropical diseases in Sub-Saharan Africa: the unmet needs. *International Health,* Vol. 1, No. 1 (September 2009) 61-70, ISSN 18763413

Fraser, H.S.F. & McGrath, J.D. (2000). Information technology and telemedicine in sub-Saharan Africa. *BMJ,* Vol. 321, No. 7259 (August 2000) 465-66, ISSN 00071447

Glossary of Terms Commonly Used in Health Care. AcademyHealth. 2004 www.academyhealth.org/files/publications/glossary.pdf (accessed on 28 August 2010)

Lucas, H. (2008). Information and communications technology for future health systems in developing countries. *Social Science and Medicine,* Vol. 66, No. 10 (May 2008) 2122-32, ISSN 02779536

Mars, M. (2009). Telemedicine in sub-Saharan Africa, In: *Telehealth in the developing world,* Wootton, R., Patil, N.G., Scott, R.E. & Ho, K., (Ed.), 232-41, The Royal Society of Medicine Press Ltd, ISBN 9781853157844, London

Microgravity Centre/PUCRS-Brazil. www.pucrs.br/feng/microg (accessed on 28 August 2010)

Raza, T., Joshi, M., Schapira, R.M. & Agha, Z. (2009). Pulmonary telemedicine – a model to access the subspecialist services in underserved rural areas. *International Journal of Medical Informatics,* Vol. 78, No. 1 (January 2009) 53-59, ISSN 13865056

Rinde, E. & Balteskard, L. (2002). Is there a future for telemedicine? *Lancet,* Vol. 359, No. 9322 (June 2002) 1957-58, ISSN 01406736

Rosser Jr, J.C., Bell, R.L., Harnett, B., Rodas, E., Murayama, M. & Merrell, R. (1999). Use of mobile low-bandwidth telemedical techniques for extreme telemedicine applications. *Journal of the American College of Surgeons,* Vol. 189, No. 4 (October 1999) 397-404, ISSN 10727515

Russomano, T., Cardoso, R.B., Duval, V., Lopes, M.H.I., Celia, S., Hutter, E. & Hutter, E. (2009). Space technology used to improve health care in remote areas. *Aviation Space And Environmental Medicine*, Vol. 80, No. 1 (January 2009) 61-63, ISSN 00956562

Schmid-Grendelmeier, P., Masenga, E.J., Haeffner, A. & Burg, G. (2000). Teledermatology as a new tool in sub-Saharan Africa: an experience from Tanzania. *Journal of the American Academy of Dermatology,* Vol. 42, No. 5 (May 2000) 833-35, ISSN 01909622

Scott R.E., Chowdhury, M.F.U. & Varghese, S. (2002). TeleHealth policy: looking for global complementarity. *Journal of Telemedicine and Telecare,* Vol. 8, No. 6, Supp. 2 (December 2002) 55-58, ISSN 17581109

Scott, R.E., Jennett, P.A. & Yeo, M. (2004). Access and authorisation in a glocal eHealth policy context. *International Journal of Medical Informatics*, Vol. 73, No. 3 (March 2004) 259-66, ISSN 13865056

Scott, R.E. (2007). Future proofing telehealth in developing countries. *Journal of Telemedicine and Telecare, Vol. 13, No. 8, Supp. 3 (December 2007) 70-72, ISSN 17581109*

Shears, P. (2000). Emerging and reemerging infections in Africa: the need for improved laboratory services and disease surveillance. *Microbes and Infection,* Vol. 2, No. 2 (February 2000) 489-95, ISSN 12864579

Stanberry, B. (2001). Legal ethical and risk issues in telemedicine. *Computer Methods and Programs in Biomedicine,* Vol. 64, No. 3 (March 2001) 225-33, ISSN 01692607

UN General Assembly, (2000). United Nations Millenium Declaration. http://www.un.org/millennium/declaration/ares552e.pdf (accessed 23 August 2010)

World Medical Association. World Medical Association statement on accountability, responsibilities and ethical guidelines in the practice of telemedicine 1999. 2008: http://www.wma.net/e/policy/a7.htm (accessed on 28 August 2010)

World Medical Association. World Medical Association statement on the ethics of telemedicine, October 2007. 2007: http://www.wma.net/e/policy/t3.htm (accessed on 28 August 2010)

World Health Organization (2005). *Preventing chronic diseases: a vital investment,* World Health Organisation, ISBN 9789241563000, Geneva

World Health Organization (2008). *World Health Statistics 2008,* World Health Organisation, ISBN 9789241563598, Geneva

Zimic, M., Coronel, J., Gilman, R.H., Luna, C.G., Curioso, W.H. & Moore, D.A.J. (2009). Can the power of mobile phones be used to improve tuberculosis diagnosis in developing countries? *Transactions of the Royal Society of Tropical Medicine and Hygiene,* Vol. 103, No. 6 (June 2009) 638-40, ISSN 00359203

Zolfo, M., Lynen, L., Dierckx, J. & Colebunders, R. (2006): Remote consultations and HIV/AIDS continuing education in low-resource settings. *International Journal of Medical Informatics* Vol. 75, No. 9 (September 2006) 633-37, ISSN 13865056

Biomedical Engineering, Trends, Research and Technologies

Edited by Dr. Sylwia Olsztynska

ISBN 978-953-307-514-3

Hard cover, 644 pages

Publisher InTech

Published online 08, January, 2011

Published in print edition January, 2011

This book is addressed to scientists and professionals working in the wide area of biomedical engineering, from biochemistry and pharmacy to medicine and clinical engineering. The panorama of problems presented in this volume may be of special interest for young scientists, looking for innovative technologies and new trends in biomedical engineering.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Thais Russomano, Ricardo B Cardoso, Christopher R Jones, Helena W Oliveira, Edison Hüttner and Maria Helena Itaqui Lopes (2011). eHealth Projects of the Microgravity Centre, Biomedical Engineering, Trends, Research and Technologies, Dr. Sylwia Olsztynska (Ed.), ISBN: 978-953-307-514-3, InTech, Available from: http://www.intechopen.com/books/biomedical-engineering-trends-research-and-technologies/ehealth-projects-of-the-microgravity-centre

INTECH
open science | open minds