About the Subject

According to well-established definitions, e-health refers to the use of information and communication technologies to meet the needs of citizens, patients, healthcare professionals, healthcare providers, and policy makers.

“e-health is today’s tool for substantial productivity gains, while providing tomorrow’s instrument for restructured, citizen-centered health care systems” (European Commission, 2004).

The Internet has created and continues creating new opportunities and challenges to the health care information technology industry, to organizations and to citizens. However, the type of applications and services enabled by the internet evolved much since the emails and websites of its early days. We are now witnessing a growing number of successful e-health developments in a wide range of domains, including health information networks, electronic health records, telemedicine services, wearable and portable monitoring systems, and health portals. The level of complexity in these systems has continuously grown, and thus it becomes vital to increase our knowledge about them. This knowledge encompasses: a) what is currently available, how we can apply it to different contexts and different scenarios, how it can be made more effective and more efficient, and how we can use user feedback in order to devise future applications; b) what is under development, the goals and obstacles, and what we can learn from failed attempts that will optimize the subsequent developments; and c) what is envisioned for the future, what worldwide changes it will bring, and how the area will adapt to an ever-evolving society.

Simultaneously, e-health encompasses more than mere technological development. In large part because of that, it can drive significant developments in complementary disciplines such as psychology, sociology, law, management of healthcare services, and others. In fact, a simple analysis of any e-health application clearly points out the need to bring together knowledge from different areas. The most obvious are medicine and informatics. However, state-of-the-art applications require considerable expertise in technological areas such as electronics, design, or biotechnology, as well as a very strong input from the social sciences. In fact, innovative e-health follows the engineering systems approach of coupling technology, management, and social sciences.

The multidisciplinary aspect of e-health is one of its most significant features, but also one that creates additional challenges to developers and practitioners. A higher degree of organization and integration between components of the system becomes required. Teams must include experts from different fields, demanding strong coordination efforts and the need to establish an adequate common communication basis.
This is why the most relevant and broad definition that considers the dynamic Internet environment and at the same time demonstrates that e-health encompasses more than just Internet and medicine is that of Eysenbach (2001):

“e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.”

MISSION, OBJECTIVES AND RESULT

The mission of this handbook of research is to provide a comprehensive coverage of the latest and most relevant knowledge, developments, solutions and practical applications, related to this new field of knowledge able to transform the way we live and deliver services, both from the technological and social perspectives, including the discussion of the main issues, challenges, opportunities and trends.

Some of the most significant objectives of this book include:

- To overcome the fragmentation of knowledge concerning the latest developments on the theme and document the most impact contributions, from technology developments to its applications, from approaches and models, to business and managerial aspects, from technology to people
- To incentive and to support future trends for research and development
- To discuss advantages, opportunities, challenges, results and future trends
- To serve as support for higher education courses.

The resulting publication is a valuable and multi-faceted resource that gives the reader a good insight about where the technological developments and social aspects are taking us is this emerging and more and more relevant expanding domain.

ORGANIZATION OF THE BOOK

This handbook is a compilation of 54 contributions to the presentation and discussion of the main issues, challenges, opportunities and developments related with e-health and Telemedicine, from the technological and social perspectives, in a very comprehensive way, in order to disseminate current achievements and practical solutions and applications.

These 54 chapters are written by a group of 158 authors from 23 countries that include many internationally renowned and experienced academicals, professionals and researchers, in this area of knowledge and a set of younger authors, showing a promising potential for research and development. Contributions came from USA and Canada, Latin America, several countries of Eastern and Western Europe, several Asian countries and from Australia. At the same time, the book integrates contributions from academe, research institutions and industry, representing a good and comprehensive representation of the state-of-the-art approaches and developments that address the several dimensions of this fast evolutionary thematic.
Section 1: E-Health Enabling Technologies

The twelve chapters included in the first section of this handbook focus the description of technologies that enable or support e-health developments, applications and solutions.

Many times, medical monitoring requires the use of wires that connect patients with monitoring devices and reduce their mobility and comfort at the same time that hamper the work of doctors and medical staff. The development of transmissions technologies based on wireless communications standards, like Bluetooth or Zigbee, does not conform optimal solutions to develop the communication links in the biomedical wearable systems because of the situation of overexploitation and saturation of the Industrial, Scientific and Medical (ISM) frequency bands, and also due to the consumption of their transceivers. Chapter 1, Intrabody Communications (IBC) as an Alternative Proposal for Biomedical Wearable Systems presents both theoretical and application aspects of Intrabody Communications Technology (IBC) as an optimum solution for wireless communications in the wearable biomedical monitoring domain, which overcomes the previous inconveniences. The chapter is addressed by referencing dense scientific literature of the IBC technologies evolution till nowadays.

Chapter 2, Microsystems for Wireless Sensor Networks with Biomedical Applications, introduces the concept of wireless interface, followed by the discussion of the fundamental items, concerning the fabrication of microsystems comprising low-power devices. Using as example, a design of a RF transceiver the frequency of 2.4 GHz and fabricated using a UMC RF CMOS 0.18 µm process, authors discuss the main issues in the design of RF transceivers for integration in wireless microsystems. There are also presented two biomedical applications for wireless microsystems: the first is a wireless EEG acquisition system, where it is presented the concept of EEG electrode and the characterisation of iridium oxide electrodes. The other application is a wireless electronic shirt to monitoring the cardio-respiratory function. The main goal of these applications is to improve the medical diagnostics and therapy by using devices which reduces healthcare costs and facilitates the diagnostic while at the same time preserving the mobility and lifestyle of patients.

Conventional wired body sensor networks have been used in hospitals over the last decade; however, the tethered operation restricts the mobility of the patients. In the scenario considered in Chapter 3, “Hierarchical Wireless Networks of Body Sensor Networks for Healthcare Applications”, the signals collected from the patients’ bodies are wirelessly transmitted to a base station, and then delivered to a remote diagnosis centre through a communication infrastructure, enabling full mobility of the patient in the coverage area of the wireless network. The traffic generated by data-intensive healthcare applications may lead to frequent collisions between sensor nodes and the consequent loss of data, if conventional MAC protocols for wireless sensor networks are used. Therefore, this chapter presents LPRT and CC-MAC, two MAC protocols that intend to satisfy the QoS requirements of these applications, but differ in the wireless topology used. Experimental results for an implementation of the LPRT using an IEEE
802.15.4 compliant wireless sensor platform are presented, as well as simulation results comparing the performance of direct communication (between wireless body sensor nodes and the base station) with two other approaches relying on a cluster-based topology (similar to the one proposed by the authors of LEACH), which demonstrate the benefits of using a cluster-based topology on wireless healthcare applications.

Chapter 4, Patient Tracking in Critical Scenarios, describes the work-in-progress aimed at the design of a telemedicine system that is intended to give support to the physicians in critical scenarios and keep a record of the patient status within all the evacuation chain. This system is designated by Patient Tracking System (PTS). The platform described in the chapter integrates the services and functionalities available from the existing e-health infrastructure and provides the physicians with a decision support system in remote and hard-to-reach areas. The main goal is building a simple network hierarchy relying on two kinds of mobile devices: 1) a low-power Medical Information Carrier (MIC), and 2) an MDA (Medical Digital Assistant). A MIC is a device intended to hold personal medical information that may be accessed by a physician through a specialized terminal (the MDA) and, when suitably programmed, may emit a beacon signal to allow patient tracking along the evacuation chain. Authors anticipate that their project will contribute to improve the efficiency in the use of communication resources in telemedicine.

The efficient content-based image retrieval of biomedical images is a challenging problem of growing interest in the research community. Chapter 5, Semi-Automatic Vertebra Segmentation describes a framework with two segmentation methods to analyze X-ray images of the spinal columns in order to extract vertebra regions and contours. Authors describe an application of the proposed methods which consists on an evaluation of vertebra motion induced by their movement between two or several positions. This framework permits to extract the parameters determining vertebral mobility and its variation during flexion-extension movements. The first approach of the framework consists of a new contour vertebra detection technique using a polar signature system combined with a template matching process, and is based on a preliminary selection of vertebra regions. The second approach of the framework is based on automatic corner points of interest detection using the Harris corner detector.

The need to increase the complexity of computational methods to produce improvements in functional performance, particularly in medical image processing applications, leads to find suitable physical devices. Chapter 6, Quantum Computation Perspectives in Medical Image Processing describes two ways of adapting the techniques of image processing to quantum devices. This kind of computing can achieve, for some problems, unparalleled performance as compared to classic computing. In the first method, using the quantum Grover’s algorithm how to implement image processing techniques under quantum rules is shown. In the second method, using diffraction and interference, the possibility of using less complex quantum devices for processing digital images is treated. Using leucocytes images, that mode is tested.

The purpose of the study described in Chapter 7, Technical Perspective for the E-Health Care Management of Adaptive Collaboration Based on Authentication Roaming Between Different Certificate Authorities is to incorporate the authentication roaming technology with existing social infrastructures from the perspective of users instead of that of service providers. By conducting experiments in the Business to Consumer (B to C) environment, the authors research demonstrated and confirmed the effectiveness of the authentication roaming technology to realize a safe and convenient network society. This technology contributes to the construction of a citizen-centric, reassuring system especially for community medicine and healthcare by proposing a cooperation system for the medical information services based on the XML Web Services technology. Authors aim to enable patients and residents to access a variety of essential information for maintaining good health and preventing diseases and enable them to make an educated decision regarding the treatment they may receive in case of illness.
Chapter 8, *Designing a Microcontroller-Based Portable MMC/SD Card Recorder: Time and Frequency Domain HRV Analysis Using Sequential Interbeat Times*, describes a microcontroller-based MMC/SD card recorder design. It can be used as a reference model to build portable data logging systems. In this case authors used this design to get the 500 Hz rated samples of Electrocardiography (ECG) signal, and evaluate them for R-wave peak detections by using an on-line procedure. The system measures the interbeat times between the consecutive peaks, and records them into a file in the recording media. Heart Rate Variability (HRV) of the two recordings, each has 12-hours length from a healthy and a cardiac disordered man, have been analysed in MATLAB environment. Further analysis has been completed by using the time series of Instantaneous Heart Rates (IHRs) obtained from 48-sets of ECG recordings in the Physionet database. The results support the fact that some of the time and frequency domain parameters reflecting the variability of heart rate can be used as early predictors for some of the heart disorders.

Chapter 9, *Processing and Communication Techniques for Applications in Parkinson Disease Treatment* deals with processing and communication techniques for Parkinson’s disease treatment applications. First, the chapter summarizes the background of physiological dynamics related to degenerative disorders of the central nervous system and common clinical procedures using microelectrode recordings (MER) for detecting brain areas. This summary is followed by a discussion of different aspects related to the inclusion of a communication platform for specialized assistance by expert neurologists to remote hospitals. Next, the chapter introduces different techniques derived from biomedical signal processing for analyzing non-stationary and complexity components, with the aim of developing an automatic recognition system that will support computer-based clinical decisions in detecting brain areas. In addition, authors explain each component of medical teleconsult, and discuss the whole integrated system, including the advantages, limitations and viability of this clinical procedure based on modern technology resources.

Chapter 10, *Electrocardiographic Signal Processing Applications in Telemedicine*, focuses on telecardiology, as a significant example of telemedicine applications. Essential elements regarding the benefits and importance of telemedicine are presented first, followed by the introduction of specific telecardiology terminology, theoretical grounds, and existing practical applications. In the final part of the chapter new practical approaches are outlined by the authors, mainly related to modern signal processing tools such as wavelet analysis and neural networks.

Multi-agent systems gave an important contribution to the development of the theory and practice of complex distributed systems and, in particular, have shown the potential to meet critical needs in high-speed, mission-critical content-rich and distributed information applications where mutual interdependencies, dynamic environments, uncertainty, and sophisticated control play a role. Therefore, multi-agent systems can be considered a suitable technology for the realization of healthcare applications, as shown in Chapter 11, *Multi-Agent Systems for the Application and Employing of E-Health Services* where the use of loosely coupled and heterogeneous components, the dynamic and distributed management of data and the remote collaboration among users are often the most relevant requirements.

Disasters can be described as natural or manmade events such that occurs unexpectedly and disrupting human life. Today there are several kinds of tools to provide information flow, such as the Global System for Mobile Communications (GSM). The applications could be developed to deploy immediately after disaster on these GSM networks which need short time for working. On Circuit Switched Data (CSD) lines that are used as data lines, the GSM Networks that work after any disaster could be used to rescue operations after disaster. Chapter 12, “*Mobile Communication Tools Using for Disaster Recovery Model*” describes a study and makes recommendations on using mobile communication tools for disaster recovery. The authors suggest an application model defining data to be carried such as priorities, kind of information between rescue coordination centre and disaster rescue area, etc.
Section 2: Social Challenges, Opportunities and Impact

This section discusses, in seven chapters, the main challenges, opportunities and impact of the new developments and solutions in the domain of e-health and telemedicine.

Virtual Communities (VCs) emerged in the beginning of the 1990’s due to the proliferation of the World Wide Web. Researchers explored the potentials of virtual communities in health and created different types of Health VCs. There is growing evidence that health virtual communities can empower patients with knowledge, facilitate health information dissemination, and provide social and psychological support. Although Health VCs present several advantages, many challenges are still ahead and opportunities as well. Chapter 13, *Health Care Virtual Communities: Challenges and Opportunities*, provides an overview of non-mobile and mobile VCs, as well as of Health VCs research and applications, highlighting their advantages and challenges. The chapter ends with an outline of the main future opportunities and perspectives for Health VCs.

On September 5, 2006, a legal precedent was set for web accessibility in the U.S. Federal judge Marilyn Patel sustained discrimination claims by the National Federation for the Blind against Target Corporation, one of America’s largest retailers. She established that websites must be fully accessible to the blind under the Americans with Disabilities Act. Past research has indicated that organizations doing business on the Web have largely ignored W3C guidelines for making their sites accessible. The study reported in Chapter 14, *Website Accessibility for the Blind: A Study of E-Health Providers Under the Lens of Corporate Social Responsibility*, examines web accessibility of e-health providers under the lens of Corporate Social Responsibility. A model is developed linking accessibility behaviour to a provider’s propensity to engage in CSR activities, the types of medical services offered, complexity of visual web content, and perceived threat of litigation resulting from an inaccessible site. Fifteen websites of e-health providers were analyzed for the six years before and two years since the commencement of the Target litigation. Results suggest that accessibility of sites has showed significant improvement since the Target case began. A comparison with a benchmark group of companies with a reputation for corporate social responsibility revealed marked differences between the e-health providers and the top CSR companies.

The information and communication technologies (ICTs) field is expanding rapidly and affecting several domains of mankind, as for example healthcare. Therefore, ICTs can act as an enabler or a provider these fields through telemedicine. Consequently, promoting a human centred and ethical approach is the primary challenge concerning ICT healthcare innovation. Simultaneously, can we deter- or at least discourage- innovation that serves malicious ends, or that causes serious threats to humanity? Chapter 15, *The Human Centered Approach to Bionanotechnology in Telemedicine: Ethical Considerations*, discusses the relationship between ICT evolution and healthcare, particularly concerning a specific correlated research fields: bionanotechnology and telemedicine. For that, authors focus in its applications, and sort of ethical and moral dilemmas encompasses.

Chapter 16, *Online Communication and Healthcare: The Diffusion of Health-Related Virtual Communities*, describes and analyses health-related virtual communities, which soon found their diffusion on the Internet. The chapter mainly focuses on those communities whose members are primarily or exclusively patients, exchanging online information and support, on a peer-to-peer base. It analyses their peculiarities, showing how they match users’ profile, desired and needs, providing them several benefits, despite initial concerns about their growth. Besides, the chapter identifies the nature and motives of the daily exchange happening among health related virtual communities’ members, and the peculiarities of their text-based communication, in terms of contents and style. In the last part, some implications for health organizations are identified.
After the Second World War democratization, information technology and globalization changed healthcare. Democratization made that the clients, from an object of treatment by professionals, became active participants in taking care of health. Globalization brought the free marketplace closer to choices clients made for services. Information technology accelerated the way knowledge was accumulated and communicated by medical sciences, medical practitioners and clients. In research studies indications are found that healthcare facilitated by information technology (E-health) improved the care. However the evidence was not quite strong, also because the used research designs were not always suited for E-health. An overview of research designs presented in Chapter 17, *A Client Perspective on E-Health Illustrated with an Example from The Netherlands*, leads to the conclusion that action-research is more suited for E-health, particularly when clients are taking serious as partners in healthcare. An example of action-research in mental healthcare in the Netherlands illustrates this. It also shows that a partnership between professionals and clients can be beneficial for both actors.

Chapter 18, *Empirical Evidence of Resistance to the Implementation of Electronic Prescription in Brazil*, discusses the main causes for the unsuccessful implementation of an electronic prescription system in a general hospital – from an explanatory-exploratory case study standpoint – adopting resistance to information systems as its theoretical background. In the case under analysis, the study shows that the main motives for resistance to the system were: lack of training of the physicians; the age of the physicians; problems with the design and safety of the system; inadequate technological infrastructure; the employment relationship of the physicians; and the interference of the system with the power and autonomy of the physicians. The chapter concludes that the intra-organizational context of the hospitals must be analyzed in a systemic way in order to understand fully how the system will be accepted and used by its main potential users, namely physicians.

The healthcare system in many countries is undergoing change, with the most important drivers behind this being: to improve the quality of the healthcare system, reduce the increase in costs and cope with a shortage of professional staff. These trends are influenced by the increase of chronic diseases across all ages and the aging society. Chapter 19, *A View of Health Information Exchange: Towards a Digital Health Community*, presents trends within the changing healthcare system, the concept of a care cycle and the need for Health Information Exchange (HIE). The role that HIE can play and the potential benefits for the stakeholders involved is also discussed, as well as some possible approaches to HIE and a description of the functionality of important components like electronic health record systems and personal health record systems. For optimal support to care givers and patients, access to data alone is not sufficient, but should be supplemented with advanced applications that can advise care professionals, support their working procedures and processes and support collaboration within multi-disciplinary care teams. The importance of interoperability is shown and followed by a vision of the future “Digital Health Community”, with two examples that are presented in detail, one from a patient’s point of view, the other from a care giver’s. Finally the chapter lists potential building blocks which can be part of such a “Digital Health Community”.

Section 3: Organizational and Business Aspects

This section includes nine chapters devoted to the analysis and discussion of the organization, management, methodologies, tools and approaches related with e-health and Telemedicine solutions implementation and deployment.

Health-care information systems (HCIS) intervene in medical reasoning and function. In a continuously changing environment health-care professionals find themselves overwhelmed with fast pacing advances
both in information technology (IT) and in medical practice. Use of evidence-based medicine (EBM) is flourishing and the coupling between HCIS and EBM opens new frontiers for both. Yet the problems that relate to HCIS development and implementation remain the same. The problems of today have been problems of yesterday and are likely to stay, or evolve, in the future. Chapter 20, Organizational Implementation of Health-Care Information Systems, takes the reader to a journey around the factors that are involved in HCIS development and implementation. Discussion is mostly non-technical and focuses on organization and individual readiness to adopt HCIS technology in the workplace. Discussion formalizes to a concrete framework, which is accompanied by a formal statistical methodology on how to apply the framework in practice. The proposed framework integrates existing formal models related to technology readiness and acceptance, EBM, organization climate and computer knowledge and skills.

Nowadays there are a myriad of e-health services. Due to their innovative character, these services often lack systematization raising difficulties when selecting, implementing or evaluating an e-health service. The purpose of Chapter 21, E-Health Strategic Planning: Defining the E-Health Service’s Portfolio, is to introduce the reader to different types of e-health services and to providing guidelines for the development of a strategic plan for e-health. The authors present a list of sixteen e-health services’ types discussing their main potentials, features and requirements and characterising them according to a multi-dimensional attributes model. This classification model groups e-health services in order to perform case studies analysis and benchmarks between services inside each group. The authors also discuss the processes of planning, selecting, implementing and evaluating e-health services, based on their perspectives and on a review of existing literature, identifying major problems and purposing guidelines.

Information services, medical decision support systems and telemedicine are becoming important tools for medical professionals and also people who are interested in health related information. Medical decision support aims at providing healthcare professionals with therapy guidelines directly at the point of care. Telemedicine is the use of modern information and communication technologies (ICT) for the provision of clinical care to individuals at a distance and transmission of information to provide that care. Chapter 22, Medical Informatics: Preventive Medicine Applications via Telemedicine, presents an integrated view of the medical informatics and preventive medicine applications via telemedicine. It intends to assist people in gaining a better understanding of the technological perspectives in e-health and telemedicine and preventive medicine applications.

While knowledge management (KM) is becoming an established discipline with many applications and techniques, its adoption in health care has been challenging. Though, the health care sector relies heavily on knowledge and evidence based medicine is expected to be implemented in daily health care activities; besides, delivery of care replies on cooperation of several partners that need to exchange their knowledge in order to provide quality of care. In public health decision is mainly based on data and a shift is needed towards evidence based decision making. It is obvious that health care can profit from many advantages that KM can provide. Nevertheless, several challenges are ahead, some are proper to KM and other particular to the health care field. Chapter 23, Knowledge Management in Healthcare, overviews KM, its methods and techniques, and provides and insight into health care current challenges and needs, discusses applications of KM in health care and provide some future perspectives for KM in health care.

Health care organization management needs modelling techniques that allows explaining and managing it as the real world itself. This similarity between real world and model represents the key of success. Chapter 24, Information System for Management of Organization and Its Activity, offers a hierarchical representation model and with different model views of the health care organizations, allowing being applied the business integration architecture, it is a way to transfer the organization approaches from the Industrial world to the Health Care world. To reach this aim it is necessary to represent all the activities
performed by a health care organization with the process map, linking the map with the structures of the organization that connects the different map points (resource-operation), developing the organization model. It is necessary that the decision making rules are implemented in the organization model to include in it the “intelligence”. The decision making rules to reach the organization rules are the Planning and Operation control system, and though it can be integrated the goals, activity and resources.

Wheeled mobility and seating interventions have been considered one of the most important assistive technology devices in the field of rehabilitation. Telerehabilitation (TR) is an emerging field that has the potential to complement the current in-person assessment to select an appropriate wheeled mobility and seating device in underserved areas. Currently there are limited means for stakeholders to access comprehensive, reliable, monitored, and up-to-date information relative to wheeled mobility and seating devices including performance, coverage criteria, or research evidence as to their benefits and short-comings. The aim of Chapter 25, Remote Wheelchair Selection: Supporting Wheeled Mobility and Seating Device Stakeholder’s Decision in Telerehabilitation, is to review the current research works related to TR, wheelchair coverage policy issues, and the modern remote wheelchair selection paradigm. As an outcome of the ongoing-research of the authors, the Remote Wheelchair Selection Advisor (RWS-A) system, a knowledge-based decision support system to enhance TR processes, is also introduced in this chapter.

Chapter 26, Rhetoric of Private Healthcare Offers Presented to SMEs over the Internet, aims at determining through a rhetorical analysis the extent in which private medical services are offered to small and medium enterprises over the Internet. The multidisciplinary approach to e-health systems is stressed. Authors present a short description of contemporary changes in health care – client relation as well as the Internet influence on human activity, particularly focused on virtualization of SME and new challenges for medical practice and the medical services market. Rhetorical approach as research methodology is described at length. Subsequently, online offers of four international private medical companies are undergo analysis: two operating in Taiwan and two operating in Poland. Cases from countries of different culture, dissimilar health care systems, a different role of small and medium enterprises and a different level of technology and information systems have been chosen for comparison. The research shows how Internet offers reflect classical rhetorical structures and cultural diversity on the rhetorical level. Internet as e-health medium, from the rhetorical perspective, seems to be still used in very traditional, mainly profit-oriented way.

Ensuring interoperability across different healthcare providers becomes an important issue with a potentially large return on investment (ROI) potential when multiple healthcare providers are collaborating in an e-health system. In cross-context communications, the same information can be expressed by means of different types or values. Chapter 27, An Interoperable Cross-Context Architecture to Manage Distributed Personal E-Health Information, proposes a new architecture for cross-context identity management in the e-health application domain, aiming to improve interoperability between healthcare providers when context-specific information, such as patients’ identifiers, is transferred from one context to another. Furthermore, an algorithm for issuing and converting context-specific identifiers, based on cryptographic techniques, is presented. How the proposed cross-context interoperability service can be integrated in a real-word e-health system is explained with a use case scenario.

Cardiotocography (CTG) is widely used for antenatal monitoring and assessment of fetal well-being. CTG measurement methods based on the phonocardiographic principle and a home-monitoring system utilizing low-cost devices for data acquisition have been proposed and implemented by our research group. Assessment and storage of the recordings are carried out in medical centers, and their calculation capacity is no longer enough to evaluate the ever-increasing amount of incoming data on the constantly growing number of different assessment methods. In Chapter 28, A Proposed Scalable Environment for
Medical Data Processing and Evaluation, the authors propose a new method to create an easily scalable environment based on a P2P principle to share the workload and data between medical centres, while also representing a framework for discovering new correlations between evaluation method results and symptoms of fetal diseases.

Section 4: Ongoing Projects and Applications / Project Results

This section describes ongoing e-health and Telemedicine projects and applications, reports results of research results and draw recommendations, in a collection of fifteen chapters.

Nowadays many surgical procedures are still carried out based on the skills and manual dexterity of each surgeon. The complexity and variability of the operations, the difficulty of sharing and transferring the acquired knowledge, and the problems for surgeons to train in a realistic context, make up a very complex scenario. In this sense, Virtual Reality (VR) provide supporting for surgical training and planning. VR permits modeling, simulation and visualization techniques using 3-D, anatomical predictive models, and are based on realistic models of tissues and organs. The usage of these technologies as a support for surgical planning results in a reduction of the uncertainty in the surgical process, a decrease in the risks for the patients, as well as an improvement of the results. Chapter 29, Virtual Reality for Supporting Surgical Planning, presents a case of study of a Virtual Reality tool for supporting surgical planning, called VirSSPA, that has been already successfully applied in the University Hospital “Virgen del Rocio” (Seville-Spain).

In the last decade, developed and developing countries have unsuccessfully been fighting the so called new world syndrome or the epidemic of 21st century. Nutritional misbehaviours in so called developed countries are causing significant social and economic damages, reflected in considerable growth of chronic diseases, morbidity and death. The phenomenon has been traditionally felt in aged populations, but a significant increase has also been detected more recently in young populations. Chapter 30, Nutritional Monitoring and Advising Information System for Health Care Support, presents a proposal to tackle theses serious problems related to nutrition by the means of information and communication technology tools. NutriMe is presented as a new nutritional monitoring and advising system to help individuals to monitor and correct their behaviours. NutriMe is also proposed as the main component for a public national observatory on nutritional profiles for public health and medical analysis purposes.

Information and Communication Technology (ICT) are today seen as a catalyst for change in the way work is carried out. Over the past decade there have been a number of studies examining both the decision-making behind ICT adoption (the driving forces for adoption) as well as the perceived benefits from that adoption. However, no studies have attempted to determine, or indeed map whether emphasis given to specific driving forces have manifested in differing perceptions of perceived benefits. The purpose of Chapter 31, Associations Between Driving Forces to Adopt ICT and Benefits Derived from that Adoption in Medical Practices in Australia, is to examine whether emphasis on particular driving forces for ICT adoption are associated with the perception of particular benefits. A study was undertaken amongst 198 Australian General Practitioners. Results suggest that greater emphasis on improving communications gives rise to higher perceived benefits both in terms of communications and practice effectiveness, while emphasis on other drivers does not significantly alter the perception of benefits derived from adoption.

Telemedicine or the use of ICT for medical diagnosis and patient care is an innovative method of health service delivery. It offers opportunities and challenges for clinicians, consumers and health care organizations. In British Columbia, specialized oncology health care services are provided to cancer
patients at one of the five Regional Cancer Centers of the B.C. Cancer Agency (BCCA). The burden and stress of travel for rural patients as well as the increasing demand for specialized cancer care services prompted us to explore telemedicine as an alternative health service delivery method for these patients.

Chapter 32, *Improving Access to Oncology Care for Individuals and Families Through Telehealth*, outlines a research study undertaken in partnership with the Vancouver Island Health Authority (VIHA), Provincial Services Health Authority (PHSA) and the University of British Columbia. Implementation and sustainability of a telehealth program requires an examination of organizational, health care system and technical readiness. Barriers to uptake include human factors and infrastructure requirements.

Chapter 33, *An Evidence-Based E-Health Agenda: A Rural Perspective*, introduces the reader to the diminishing health services in rural Australia and highlights eHealth as the potential ‘leveller’ for rural health settings. Initially, eHealth is defined in context and eHealth stakeholders and their current contribution to eHealth within the Australian health system are identified. Then it resumes by outlining the feasibility of a nursing eHealth agenda in rural Australia in light of examined barriers and enablers. A future trends section reviews the findings and suggests potential course of action and further opportunities for research. It concludes by suggesting that care must be taken in considering the myriad number of factors that can support or hinder the development of a successful eHealth agenda for Australian rural health context.

Within the broader field of eHealth, a new sub-specialization is emerging from the dramatic uptake of mobile phones throughout the world, namely mHealth. mHealth is characterized by the use of a broad range of mobile information and communication technologies including mobile phones, personal digital assistants, and remote medical devices and sensors to support medical and public health efforts. Mobile technologies serve as an extension of existing health information and telemedicine systems as well as stand-alone support systems for health professionals and individuals within the general public.

Chapter 34, *Opportunities and Challenges of Integrating mHealth Applications into Rural Health Initiatives in Africa*, highlights the developments and trends within mHealth and how the integration of mobile technology has been used to support the Millennium Villages Project. Each of the Millennium Villages, which serve populations ranging from 5,000 to 55,000 people, are located in ten countries throughout Africa, and they have been established to illustrate how targeted interventions valued at approximately $110 USD per capita can be used to achieve the Millennium Development Goals.

Chapter 35, *Web Based Learning Environment for Medical Education: E-Fer, a Practical Tool for Diagnosis and Treatment of Chronic Wounds*, describes the relevance of learning environments supported by ICT, followed by a conceptualization of the Virtual Learning Environments, highlighting their overall advantages, more specifically those in the field of medical education. Special attention is also paid to some learning methodologies and strategies and their applicability. Before describing the e-fer, as Web based learning system, authors introduce some practical examples of the use of ICT in medical education. The chapter demonstrates the importance of this training platform for the diagnosis and treatment of chronic wounds, with a description of its functionalities, as well as its characteristics such as case based learning and game based learning. The chapter also presents research projects currently in progress, based on the e-fer, in areas such as the impact of the content adaptive model in learning processes, cost estimate as a result of non-training and the build up of communities of practice.

Authors of Chapter 36, *Conservation of Information (COI): Geospatial and Operational Developments in E-Health and Telemedicine for Virtual and Rural Communities*, review Telemedicine and eHealth from an organizational perspective. To evaluate their effectiveness, they review organizational and system theory along with field and laboratory results. Theory of the conservation of information (COI) provides the means to study tradeoffs across space and over time as Telemedicine and eHealth management make operational decisions for virtual communities users. Presenting three case studies,
Chapter 37, *ICTs and Family Physicians Human Capital Upgrading: Delightful Chimera or Harsh Reality?*, provides a quantitative assessment of ICTs role in General Practitioners (GPs) medical daily practice and scientific performance, focusing on the Portuguese underexplored context, where the Health Sector has been under pressure for wide and profound reforms. These reforms have been extensively relying on ICTs, namely on the Internet. Based on the responses of 342 GPs, authors concluded that 94% uses the Internet and 57% agrees that the Internet is essential to their medical daily practice. GPs tend to use the Internet mainly for professional purposes. Data shows that the Internet for the respondent GPs has a critical role on updating and improving their professional knowledge basis. They recognise, however, that the vast majority of GPs lack specific and general training in ICT-related technologies. Such training handicap uncovers that a large part of Portuguese GPs may be unable to reap the benefits of ICTs in their daily medical practice.

Health care providers, first responders and law enforcement professionals face serious safety issues when they find themselves exposed to health-threatening incidents on the job. According to Chapter 38, *Hotline for Exposure to Occupational Hazards*, rapid, reliable and documented guidance by specially-trained medical personnel is essential to the safety of the exposed person and their contacts. Florida Hospital Centre Care and FONEMED, an accredited medical call centre, offer a 24X7 Hotline to provide counselling to employees who sustain an occupational exposure. Paper-based systems proved inadequate to handle sophisticated protocols using the compliance guidelines of the U.S. Department of Health & Human Services and Centres for Disease Control. Therefore, they developed advanced information technology for Registered Nurses to process the protocols, obtain source information, fully document all calls and transmit the reports immediately to the treating health care provider and other concerned parties. Nurses have immediate access to advice from on-call occupational medicine physicians for unusual environmental exposures, pandemic or bioterrorism issues.

According to previsions, Spanish population over 65 years old will soon be an important fraction. For the EU region, old-age dependency ratios will more than double in 2000 to 2050, decreasing, at the same time, the ratio of persons of working age to every elderly people. These data show the need for some helping technologies that make possible to deal with this scenario. One of the possibilities explored is the use of some kind of Intelligence at home. Chapter 39, *MIMO: Multi-Agents System for Personal Health Monitoring*, describes the current status of the Ambient Intelligence initiatives that link multi-agent technologies with personal monitoring for health and wellbeing, exploring various enabling technologies based on environmental intelligence, by means of which the user interacts with his or her home in various scenarios. All this possibilities are intended to satisfy the objective of home assistance and wellbeing, and it fits well within Ambient Assisted Living Joint Programme (AAL - “Ambient Assisted Living,” 2008) partly funded by the European Commission. The chapter describes this technology on a Personal Health Monitor integrated with the Multi-Agent System for home environments created by Telefónica I+D in cooperation with the Departamento de Informática y Automática of the University of Salamanca and the Computer Science Department of the University of Valladolid, Spain.

Health care applications are technically complex and the software and hardware markets for medical technologies are less mature than for many other fields. Although there should be an interplay between design and the usage of systems, this is often not the case in the health care sector. Currently, information is often bound to a location or institution due to fragmented information systems. Using the notion of asset specificity as a theoretical background, authors of Chapter 40, *Governing Medication Information*: 

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Asset Specificity in the E-Health Context, conducted interviews in the Finnish primary health care system. The interviews were analyzed and examples of real-life situations are provided to guide designers of information systems for the health care sector.

Being diagnosed with breast cancer is a complicated and disruptive experience for many. Apart from the effects of cancer on their physiological state, patients are required to make important life-changing decisions within a short period of time. To most patients, their physicians act as the main source of medical treatment information. While physicians maintain their trusted role as being the key source of medical treatment information, patients find that their physicians do not provide all the answers to their questions. The Internet is a convenient and inexpensive information resource that assists patients and their care-givers in the decision-making process by providing them with answers to queries that come to mind, detailed explanation of medical jargon and cancer treatment options. Due to the limited time that physicians have with their patients and the power imbalance inherent in their possession of medical knowledge, patients and their care-givers turn to the Internet to seek for more detailed information to supplement the medical advice provided by their physicians. Apart from that, the Internet also provides patients with enhanced capacity to engage in constructive discourse with their healthcare providers thereby bringing new issues and concerns to the patient-physician relationship, as discussed in chapter 41, Internet Use and Health Decision Making by Breast Cancer Patients in Malaysia.

Nowadays, Information and Communication Technologies (ICT) are being used in the mental health field to improve the quality of the services provided. Several studies refer both advantages and disadvantages for these practices. Chapter 42 presents e-Therapy as a new way to help people in their life and existing relationships, and there is proven evidence that online therapy helps, for instance, to reduce depression symptoms. It is also seen as a complement of the technological and traditional techniques, to improve the effectiveness and efficiency of the therapeutic process. As a matter of fact, some people tend to be more comfortable with the computer than in face-to-face therapy. Besides patients and physicians, other direct players could be found in this domain, namely, families and caregivers. All players will be directly affected by the use of existing services and thus, a correct assessment of the effectiveness of e-Therapy solutions and studies is required. eSchi is a multimedia portal that enables an e-Therapy setting for schizophrenia patients. Currently under development, the system is described and future trends in the area are depicted.

The healthcare sector has been continuously growing in importance in the past years throughout the entire world, and particularly in most Western countries and the US, where we witness an increase of expenditure in health per capita every year. This is related to many aspects of contemporary society, including an increase in life expectancy, the public demand for a better quality of life and better health services. This must be met with more cost-efficient approaches, and new technology-based solutions for providing health and other services. Chapter 43 contextualizes the utilization of Electronic Marketplaces (e-Marketplaces) for the social and healthcare sectors, how this field has been evolving in recent years, current challenges and trends, and their contribute to society. The authors of the chapter also discuss a pilot project of an e-marketplace for healthcare and social services currently being developed in the Guimarães Municipality, including its goal, definition and implementation, as well as the commercially available enabling technology and tools.

Section 5: Current Development Opportunities and Future Trends

These eleven chapters report challenges, opportunities and trends revealed by ongoing projects and developments.
Chapter 44, *Exploring Personal Healthcare with the Help of Two Large European Framework Programs for Healthcare: MyHeart and HeartCycle*, describes two projects of Personal Healthcare developed under two European Framework programs for Healthcare. Personal Healthcare enables prevention and early diagnosis in daily life and is centred on the patient. There is a need for a new personal healthcare paradigm in the treatment of chronic diseases, that will be achieved by new technologies that are currently explored, e.g. in European Research projects such as MyHeart and HeartCycle. These projects develop technologies and application concepts for the (self) management of chronic diseases in patients’ homes with special emphasis on usability and ease-of-use e.g. wearable sensors and processing units that can even be integrated into the patient’s clothes. These technologies allow empowering patients, fostering self-management and therefore reducing cost, and improving patients’ quality of life.

Chapter 45, *Neonatal Monitoring: Current Practice and Future Trends*, focuses on monitoring vital health parameters for a particular group of patients - critically ill newborn infants in neonatal intensive care units (NICU) at hospitals. These neonates are extremely tiny and vulnerable. Thus, health monitoring for the neonates provides crucial parameters for urgent diagnoses and corresponding medical procedures, subsequently increasing the survival rates. Neonatal monitoring is a multidisciplinary area which involves a unique integration of knowledge from medical science, design, technology and social study. In this chapter, we introduce current status and new developments in neonatal monitoring. We present some ongoing research examples of non-invasive neonatal monitoring designed and developed at the department of Industrial Design and the department of Electrical Engineering, Eindhoven University of Technology (TU/e) in collaboration with the department of neonatology, Máxima Medical Center (MMC), Veldhoven, in The Netherlands, including the first prototype smart jacket, a wireless power supply and video signal processing for neonatal monitoring. Challenges and social impacts of non-invasive neonatal monitoring are also discussed.

Chapter 46, *Analyzing and Tracking the Evolution of Rehabilitation Treatment for Patients with Locomotory Deficiencies*, sets up a complex system for the individualized management of mobility recovery for patients with neuromuscular and orthopaedics pathology through interdisciplinary research. Authors’ goal is to aggregate information from multiple hardware devices into a single data acquisition and processing system with direct applicability in the human motility analysis, namely gait analysis. The project combines high performance image acquisition techniques with the acquisition of clinically interpretable data, to develop a database (medical, imaginistic, biomechanical) and develop conceptual models for interpreting the available data, with direct applicability in choosing the adequate treatment and evaluating its efficiency. Since this is a system with an open architecture, authors also address the security of the system, proposing a combination of the conventional smart used for identification with biometric characteristics, namely fingerprints, substantially preventing unauthorised access to the confidential information.

Technological advances in the fields of electronics and computer science have given rise to a considerable increase in the number of physiological parameters available to clinical staff for interpreting a patient’s state. However, owing to the limitations and flaws in current commercial monitoring devices, this has not resulted in a corresponding increase in healthcare quality. Chapter 47, *Current State of Critical Patient Monitoring and Outstanding Challenges*, analyses the reasons why clinical staff are not making full use of information from the monitoring devices currently in use in critical care units; a review is made of the most salient proposals from the scientific literature in order to address the imbalance existing between the amount of data available and the improvement in healthcare; and those problems for which suitable solutions have yet to be found and which have, up until now, hindered the applications of said proposals to clinical routine are analysed.
The adoption of wearable systems in modern patient telemonitoring systems has been considered as a medical challenge towards the established medical practices, aiming at the highest level of quality of life. The current state-of-the-art technologies in wearable computing, wireless telemedical platforms and wireless sensors allow easy and unobtrusive electronic measurement of several vital signals and health conditions regardless the time and the place the patients need a condition monitoring. Certain major milestones to consider in the process of adopting wearable systems, besides the enabling technologies, are the affordability that depends on financial criteria, the adaptability of the overall healthcare sector to the innovative technologies and the conformance of the medical staff to the lifelong learning for vocational training. These aspects are discussed in Chapter 48, *Adoption of Wearable Systems in Modern Patient Telemonitoring Systems*, along with the description of the wearable systems capabilities and reference to their latest popular applications and future trends.

The importance of the analysis, modelling and management of a business process is not restricted to a specific enterprise sector. In the field of health management, as a result of the nature of the service offered, health institutions’ processes are also the basis for decision making which is focused on achieving their objective of providing quality medical assistance. Chapter 49, *Healthcare Process Development with BPMN*, presents the application of business process modelling to the processes of a health sector institution, using the BPMN standard notation, and describes an experience obtained in the creation of the conceptual models of certain hospital processes which can be used as a basis for others in collaboration with hospitals in order to model their processes using BPMN. Hospital processes are highly complex, and their graphical visualization facilitates their management and improvement by means of the understanding and detection of possible failures.

Chapter 50, *Individual and Group Cognitive-Based Therapy Support*, addresses Cognitive Behavioural Therapy (CBT), that is a wide spread method used to deal with an assorted variety of psychological disorders. Associated procedures and techniques are strongly dependent and limited by the use of traditional paper-based artefacts (e.g., questionnaires, thought registries) which pose issues and difficulties for both patients and therapists. As technology is introduced within this process, a large set of opportunities emerges to enhance therapy for all the actors. This chapter presents a comprehensive framework that targets these issues and takes these opportunities by defining new paths that support individual (on the two active therapy roles) and cooperative endeavours spanning through the course of the various activities that therapy requires. Authors detail the tools that compose the framework, illustrating their functionalities and features with a variety of scenarios that validate its significant contribution to the overall therapeutic process.

Communication is a dynamic process that creates and conveys a mutual understanding between two or more people. Since this process is complex and not easily taught, there exist many communication disorders ranging from a physical limitation, such as ALS, to a cognitive language disorder, such as autism. Augmentative and alternative communication systems (AACs) help people with communication disorders by providing them substituted means for communicating. These systems range from non-technical solutions, such as a paper-based PECS (Picture Exchange Communication System), to elaborate technical solutions, such as a plasma picture communication table. Due to the increased attention to AACs, the Worldwide Health Organization (WHO) provides a framework to evaluate effectiveness. Using this framework as a basis, the authors of Chapter 51, *Augmentative and Alternative Communication Technologies*, identified barriers and support factors for AAC effectiveness and subsequently best practices for AAC designs. The chapter includes a case study of adapting a paper-based picture-based communication system to mobile devices using open-source software development for use by children with severe autism.
eOphthalmology can be defined as the use of information and telecommunications technologies (ICT) to provide or support a group of activities related to ophthalmic care. eOphthalmology-based models of assistance can be useful resources to compensate for the increased demand for medical care foreseeable in the near future due to aging of the population and lack of medical specialists. Chapter 52, *E-Health Applications in Ophthalmic Diseases: Ongoing Developments*, presents in detail the models proposed for three important health problems in ophthalmology as screening for diabetic retinopathy and follow-up of glaucoma and age-related macular degeneration. Furthermore, the main advantages of these models and the technologic requirements needed for their implementation are described. Finally, future trends in e-ophthalmology are also addressed.

Clinicians cannot afford to ignore the Internet. Psychological advice, help and treatment for addicts are no exceptions with both counselling and psychotherapy entering the computer age. Chapter 53, *Online Advice, Guidance and Counseling for Problem Gamblers*, overviews the main issues in the area and approaches the discussion acknowledging that online therapy has to be incorporated within the overall framework of the need for clinical assistance. The chapter also provides brief overviews of some websites as illustrative examples of what types of online help and therapy are available. The chapter makes particular reference to online help for problem gamblers and will overviews the only study to date that evaluates the effectiveness of an online help and guidance service for a particular type of addiction (i.e., problem gambling).

Besides formalized work processes, organizations also present work processes that are not a priori formalized and often rely heavily on tacit knowledge and experience distributed among involved actors. The development of Information Systems able to assist such work processes is a challenging task. The traditional approaches for modelling often reveal short in emergent and informal work processes which are hardly elicited in requirements phase. Chapter 54, *Capturing Distributed Contributions to an Informal Work Process: A Hospital Facility Case Study*, focus on the collaborative dimension of an informal work process to develop an information system aiming to improve the outcome work processes and describes how teams shared awareness was used as coordination and control mechanism for a loosely coupled collaboration model. The chapter also reports the implementation of the conceptual approach in a Hospital facility.

**EXPECTATIONS**

This handbook of research offers an exhaustive coverage on the theme, providing researchers, scholars, professionals with some of the most advanced research developments, solutions and implementations on the domain of e-health and Telemedicine in a very comprehensive way.

This way, it is intended to support the academic audience (teachers, researchers and students, mainly of post-graduate studies), healthcare professionals and managers (health specialists, medical doctors, sociologists and administrators), IT professionals and managers (information system developers, information technology solution providers and IS/IT managers) and policy makers of a broad range of sectors (central and local administration, healthcare sector, research and development and education).
We sincerely expect that this work will stimulate further research and development on e-health and Telemedicine issues by healthcare professionals and researchers, academics and doctoral students, IT/IS professionals, policy makers and top managers of healthcare organizations. Simultaneously we expect that these target groups can take full advantage of the increasing new forms of intervention and interaction enabled by e-health and Telemedicine technologies and applications.

The Editors,

Maria Manuela Cruz-Cunha
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