Key challenges facing healthcare providers today include an aging population, demanding patients, medical errors and rising costs. These challenges are now being addressed through the application of practical solutions to operational problems and the development of more responsive and efficient health policy using eHealth techniques. This timely book overviews the development of eHealth from a number of perspectives including historical, policy and social viewpoints, and describes the current state of play in terms of eHealth research and the development of innovative ICT systems and services that process, integrate and use all relevant biomedical information for improving health knowledge. It also provides the reader with up-to-date knowledge of the eHealth practices related to prevention, diagnosis, treatment, and personalisation of health care in a number of jurisdictions around the world.

A commonly accepted definition of eHealth 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” (Eysenbach 2001).

eHealth thus describes the application of information and communications technologies (ICT) across the whole range of functions that affect the health sector, from the doctor to the hospital manager, via nurses, data processing specialists, social security administrators and - of course - the patient. Thus eHealth is one of the most rapidly growing areas in health today; use of the Internet and other developments in eHealth is playing an increasing role in consumer health behaviour, and in the delivery of health services. Accessing health information is one of the main uses at present of Internet-based eHealth techniques.

National health services are investing significant resources in the development of programs which will bring profound changes to the organisation and delivery of healthcare, including shared electronic records, electronic prescribing and electronic booking of appointments, and ultimately a much more intimate practitioner-patient relationship. The rate of change and innovation in this area is such that research efforts have so far lagged behind and little work has been carried out to investigate the impact of eHealth developments on public health and health services. This book is designed to remedy that situation.

For our purposes in this book eHealth is therefore best examined in terms of its social as well as technical ramifications, and especially its political and economic (or political economy) contexts at and between different service levels, including the local, the regional and the global. However, only very limited systematic research has been carried out to inform eHealth policy and practice in this sense. It was one of the objectives of this book to address this deficiency.
CHAPTER OVERVIEW

Chapter 1 develops an integrated view of telemedicine and biotelemetry applications. The objective of the chapter is coherent with the objective of the book, which includes techniques in the biomedical knowledge management. Telemedicine is the use of modern telecommunications and information technologies for the provision of clinical care to individuals at a distance and the transmission of information to provide that care. The medical systems infrastructure underpinning this form of medicine, consisting of the equipment and processes used to acquire and present clinical information and to store and retrieve data are explained in detail. An investigation of telemedicine applications in various fields is presented and the likely enormous impact of telemedicine systems on the future of medicine is discussed. For example, bioelectric and physiological variables could be measured by biotelemetry systems. Developing a biotelemetry system and the principal operation of such a system are presented, and its components and the telemetry types are explained. The author suggests that the content of the chapter will assist the medical sector and the general reader in gaining a better understanding of the techniques in the telemedicine and biotelemetry applications.

Chapter 2 shows that there is a treasure trove of hidden information in the textual and narrative data of medical records that can be deciphered by text-mining techniques. The information provided by these methods can provide a basis for medical artificial intelligence and help support or improve clinical decision making by medical doctors. In this paper the authors extend previous work in an effort to extract meaningful information from free text medical records. The chapter discusses a methodology for the analysis of medical records using some statistical analysis and the Kohonen Self-Organizing Map (SOM). The medical data derive from about 700 pediatric patients’ radiology department records where CT (Computed Tomography) scanning was used as part of a diagnostic exploration. The patients underwent CT scanning (single and multiple) throughout a one-year period in 2004 at the Nagasaki University Medical Hospital. This approach led to a model based on SOM clusters and statistical analysis which may suggest a strategy for limiting CT scan requests. This is important because radiation at levels ordinarily used for CT scanning may pose significant health risks especially to children.

Chapter 3 documents how the proliferation of Internet and Information Technologies (IIT) has led to many innovations in the healthcare industry. Among such innovations are the Electronic Medication Administration Record (eMAR) and the Bedside Medication Verification (BMV), both of which have been widely implemented by hospitals around the world. In this regard, the goal of this chapter is three-fold. It first describes the underlying work-flow utilized in these systems by comparing it with traditional methods of medication administration. Then it investigates the adoption and implementation of eMAR and BMV in hospitals in the United States, the conversion from traditional medication administration to eMAR documentation, and how utilization of eMAR and BMV can promote patient safety. The chapter concludes with the exploration of future trends in medication administration through the utilization of eMAR and BMV, and highlights future research directions in the field.

Chapter 4 outlines how Health Level Seven (HL7) and Digital Imaging and Communications in Medicine (DICOM) standards are strongly influencing Electronic Health Records (EHRs) standardization. In this chapter, the authors present a web-based application, TeleOftalWeb 3.2, to store and exchange EHRs in ophthalmology by using HL7 Clinical Document Architecture (CDA) and DICOM standards. EHRs are stored in the native Extensible Markup Language (XML) database, dbXML 2.0. Application architecture is triple-layered with two database servers (MySQL 5.0 and dbXML) and one application server (Tomcat 5.5.9). Physicians can access and retrieve patient medical information and all types of medical images through web browsers. For security, all data transmissions are carried over encrypted Internet connections such as the Secure Sockets Layer (SSL) and Hypertext Transfer Protocol over SSL.
(HTTPS). The application verifies the standards related to privacy and confidentiality. The application is being tested by physicians from the University Institute of Applied Ophthalmobiology (IOBA) in Spain.

Chapter 5 presents an overview and analysis of electronic prescriptions. Medical prescriptions are currently typically handwritten or printed on paper and hand-delivered to pharmacists. Paper-based medical prescription is generating increasing concern as the incidences of prescription errors have been increasing and causing minor to serious problems to patients, including deaths. Most of the problems of paper-based prescription can be avoided by electronic medical prescription, also variously known as electronic prescription, e-prescription, or electronic transmission of prescription. Though the basic concept of e-prescription is simple, e-prescription has not yet been widely adopted, despite advances in information and communication technologies – it is, in fact, just in early stages of adoption in a few countries only. To facilitate wider adoption of e-prescription, several technical and non-technical issues need to be addressed. Beginning with an introduction to e-prescription, the chapter examines various aspects of the e-prescription system, and describes and evaluates various e-prescription models and systems. The chapter then discusses technical and non-technical issues in implementing e-prescription, and concludes with our recommendations.

Chapter 6 shows how some common health methodologies in everyday life are not based on modern scientific knowledge but rather a set of experiences that have established themselves through years of practice. As a good example, there are many forms of alternative medicine, quite popular, however difficult to comprehend by conventional western medicine. The diagnostic and therapeutic methodologies are very different and sometimes unique, compared to that of western medicine. How can these be verified and analyzed through modern scientific methods? The authors present a case study where data-mining was able to fill this gap and provide us with many tools for investigation. Osteopathy is a popular alternative medicine methodology to treat musculoskeletal complaints in Japan. Using data-mining methodologies, it is possible to overcome some of the analytical problems in such an investigation. The authors studied diagnostic records from a very popular osteopathy clinic in Osaka, Japan that included over 30,000 patient visits over 6 years of practice. The data consists of careful measurements of tissue electro-conductivity differences at 5 anatomical positions. Data mining and knowledge discovery algorithms were applied to search for meaningful associations within the patient data elements recorded. This study helped the authors scientifically investigate the diagnostic methodology adopted by the osteopath.

Chapter 7 outlines how, in the wake of continuously escalating healthcare costs, health management in the workplace has gained new momentum as employers strategize how to optimize the health of their workforce while containing healthcare costs and dealing with ethical issues. Gaining acceptance as a viable tool to aid employers is a process called Predictive Modeling. On the surface, Predictive Modeling may contribute significantly to delivering the right interventions to the right person at the right time by identifying high risk individuals, and under-users and over-users of health services. This chapter discusses the ethical principles of non-maleficence, beneficence, justice and autonomy, as well as value judgments and human rights as applied to Predictive Modeling to guide professionals and employers in health management decisions.

Chapter 8 discusses the role of e-health in creating persistent clinical encounters in order to extend the scope of health care beyond its conventional boundaries by utilizing social networking technology to create what the authors’ term ‘user driven health care’. It points out the necessity to direct the development of health information systems such that they serve as important vehicles between patient and health professional users in communicating and sharing information other than their role in automated alerts and responses. A project is described that plans to create a system of online sharing of health information in a user driven manner that necessarily becomes persistent due to being stored in electronic health records.
Chapter 9 documents how patient image data are increasingly distributed between hospitals using CDs instead of physical films. This introduces problems because different viewers from different vendors are provided, and sometimes viewers are unusable because local software installation is not allowed. In 2004 the incorporation of image data from CDs into the normal workflow of the hospital by using commercially available software to perform patient reconciliation based on the DICOM modality work list was begun. In the years after this initial introduction, a more comprehensive software system was developed which allows for the fast upload of large amounts of patient image data into the normal workflow. Although direct network connection between institutions is currently being developed and deployed, in the next decade CDs will remain to be used and the integration of the data into the normal workflow is a must. The literature shows that other institutions also started to handle CD based media in a similar fashion.

Chapter 10 discusses the role of user-centric and inclusive design methods in healthcare pathways. The rapid uptake of e-health technologies by clinicians and healthcare managers to administer, for example, patient records, has meant that user-centered e-health tools and processes should be adopted to enable those receiving healthcare to become more involved, more proactive in, and more responsible for their own healthcare and its planning. An argument for a user-centered approach as good business practice can also be made. The three case studies described in this chapter are united by a concern for the individual, the end-user, at the heart of healthcare processes, and how design methods, which have a strong emphasis on the consumer or user perspective, can assist the changing requirements for healthcare delivery through an improved, earlier and ongoing engagement with the recipients of healthcare.

Chapter 11 describes a web-based decision support system called TeleDerm that has been developed with the aim of helping general practitioners diagnose skin ailments from a knowledge base while allowing incremental updates of the knowledge base as cases occur. The authors outline the two major challenges in developing the TeleDerm system: developing a general practitioner query process that is easily accessible and building knowledge validation in a case-based reasoning system. The chapter provides a detailed description of approaches to address these problems which involve the use of artificial intelligence classification and reasoning techniques. The system was deployed in a large scale trial in the Eastern Goldfields Health Region of Western Australia and the chapter presents the results and feedback obtained from an evaluation by the general practitioners involved.

Chapter 12 outlines the fundamental user issues identified in the design stage of a Stroke Information System (SIS) for the Hospital Information Management System (HIMS) in the secondary care and above phase of TACMIS (Total Access Care and Medical Information System – see Chapter XXIII). TACMIS is a total, integrated and inclusive healthcare information system design solution reflecting the core ideas of DAITS (Design for Disability, Aging and Access to Inclusive Information Tools, Technologies and Systems); creativity; cutting edge research; and being global. Being a subsystem, HIMS-SIS is developed in alignment with TACMIS, the main system architecture and information system concept, and is designed to allow stakeholders and professions involved within stroke special care unit practice to inform staff from nonmedical professions in order to improve healthcare quality. This may also make improved treatment affordable by many if not all. Finally, initial investigations on how large volumes of patient data could be transformed into useful knowledge using intelligent information processing methodologies are outlined.

Chapter 13 documents how e-health systems and digital libraries deal with human health, requiring fast responses and real-time decision-making. Human intervention can be seen in the whole life cycle of biomedical systems. In fact, relations between patients, nurses, lab technicians, health insurers, and physicians are crucial in such systems, and should be encouraged when necessary. However, there are some issues that affect the successful implementation of such infrastructures. Man-machine interaction
problems are not purely computational and need a deep understanding of human behavior. Many inte-
gerated health knowledge management systems, have employed various knowledgebases and ontologies
as their conceptual backbone to facilitate human-machine communication. Ontologies facilitate sharing
knowledge between human and machine; they try to capture knowledge from a domain of interest; when
the knowledge changes, the definitions will be altered to provide meaningful and valid information. In
this chapter, the authors review and survey the potential issues related to the human factor in an inte-
grated dynamic e-health system composed of several interrelated knowledgebases, bio-ontologies and
digital libraries by looking at different theories in social science, psychology, and cognitive science. The
authors also investigate the potential of some advanced formalisms in the semantic web context such as
employing intelligent agents to assist the human user in dealing with changes.

Chapter 14 shows how the application of laboratory test results can be used in healthcare manage-
ment that includes screening for disease as well as in making a diagnosis and for monitoring response to
treatment of a known disease. Laboratory test results used in health care management can be qualitative
or quantitative. These cover several disciplines, the four major disciplines being histopathology, haema-
tology, medical microbiology and chemical pathology. Histopathology and medical microbiology are
mainly qualitative assessments, while chemical pathology is predominantly based on quantitative analysis
of chemical constituents in blood or other body fluids. Haematology encompasses both quantitative
and qualitative assessments, the blood cell parameters being quantitative while blood film reports and
bone marrow reports are qualitative. The application of such results to healthcare management includes
screening for disease as well as in making a diagnosis and for monitoring response to treatment of a
known disease. This necessitates the availability of normal ranges to compare with and decide whether
the results are normal or not. Normal means the individual is in a state of good health and a deviation
from normal is interpreted as implying ill-health. Data used in these tests are taken from previous studies
of Sri Lankan Adults carried out from May 2005 to July 2006.

Chapter 15 documents the increasing attention that has been paid by the media and the tourist industry
to what has become known as ‘medical tourism’, sometimes also called ‘health’ or ‘wellness’ tourism.
Before around 2000, these were hardly mentioned by the media at all. However, in one sense, medical
tourism or the combination of medical treatment in a location separate from home-base and aspects of
leisure & recreation has a long history, as some of the information sites on the Internet are eager to point
out. People have been travelling in search of medical treatment for millennia, whether in order to visit
hot springs as in Poland, Hungary or Japan. Why this sudden interest? In this Chapter it is argued that
this is due to a combination of factors: the changing distribution of medical services and technologies,
the growth of interest among both local medical practitioners in different parts of the world and travel
agents, the clever packaging of tourism and medical services as a single product, and the availability of
the Internet both to assemble and to disseminate information on these new products. The chapter covers
the implications of these cases for the future of medical tourism, and its relations both with the medical
and tourism industries.

Chapter 16 shows how e-health systems can be used to communicate the risk of significant infec-
tious diseases such as HIV infection to individuals who are contemplating taking the risk of the personal
behavioral choices they make. Access to an on-line system which communicates this data in a user-
friendly format, can help avoid high-risk behavior by informed individuals who live in different areas
with various levels of risk. We present the case of HIV infection in Japan where many individuals have
voluntarily continued a high-risk behavior because apparently they consider the overall risk of infection
too low to forgo the personal benefits of risky behavior such as more pleasure, less inconvenience, etc.
We discuss how a user friendly e-health system can provide geographical risk data that are extracted
from HIV epidemiological surveillance. This can provide individuals with a rational incentive for be-
behavior change in high-risk areas. It is hoped that such a system helps with the control of not only HIV, but also other agents of disease in situations where individual choices play a significant role in the risk of exposure/disease.

Chapter 17 argues that e-health has the potential to improve the provision of health care and the quality of patient treatment, but it also contains many threats, especially in developing countries where information technologies are generally implemented without any discussion with society. With regard to health information, Brazil is behind some African countries in terms of data recording according to international reports used to publish health care indicators. Most of the hospitals do not have basic information systems for data collection and storage, despite the fact that the country has historically registered very bad health indicators. Moreover, many e-government initiatives, including e-health applications and development are based on the traditional top-down model or market-driven approach to information technology, oriented towards corporate actor interests and health care administration rather than basic population health care needs. This system tends to neglect basic priorities for people lacking education, clean water, food and primary health care.

Chapter 18 outlines the approach to mental health care developed and currently being implemented by Pathways New Zealand for reducing disease risk factors in patients treated for mental health problems. Pathways New Zealand was formed in 1989 following the closure of the major mental service facility for the Waikato-Hauraki Region of New Zealand: Tokonui Hospital. Since that time Pathways has grown to a national level service offering services to its clients ranging from 24-hour supported accommodation, through healthy lifestyles programs, to outcomes based services including patient access to and involvement in the management of their medical and personal history data (ICAN). The author, Pathways Housing Management Coordinator for the Waikato-Hauraki Region, in conjunction with the Waikato Institute of Technology (WINTEC) has developed a holistic system for the treatment of environmentally induced mental illness that includes chemical treatment, exercise programs, self-help training and community support. The results of a two year program of research into the impact of this program are reported on in this chapter, and its suitability for wider adoption discussed. These comments are based on research statistics provided by the Centre for Sports Exercise Science (WINTEC) and Mike Dove, Team Leader Residential, Pathways.

Chapter 19 notes that according to the Australian Department of Health and Aging the adoption of new technologies is crucial in addressing health issues. Currently, wireless technology is used in Australian healthcare with limited scope, addressing specific aspects of quality of service offered to various stakeholders. While prior studies agree that wireless applications have the potential to address the endemic problems of healthcare, very limited information can be found about the determinants of such applications. Therefore, there is a need to identify factors that may assist in the adoption of wireless applications in healthcare and the factors acting as barriers in the uptake of such applications. This chapter reports on a study designed to elicit these factors using a semi structured interview approach and surveys. The study is structured in two specific phases. The first phase involved a semi structured interview with selected healthcare professionals to understand various factors involved in the adoption of wireless applications as applicable to Australian healthcare. The second phase involved administering a survey to generalize the findings of phase one and to capture the views of the wider population.

Chapter 20 shows that sleep problems are frequently witnessed in aged care facilities with a large proportion going undetected. Multiple factors are known to contribute many abnormal sleep/wake patterns for residents. A systematic review conducted by Haesler (2004) provided a guide to the direction of future research into sleep in older adults residing in care facilities. This chapter evaluates the effectiveness of implementing the following evidence based recommendation from Haesler (2004): that Wrist actigraphy currently represents the most accurate objective sleep assessment tool for use in studies of this
phenomenon. Factor analysis was utilized to study the patterns of relationship among many dependent variables, with the goal of discovering something about the nature of the independent variables that affect them. Wrist actigraphy showed a disparity between the actual bed time and wake time. One clear difference detected using the device was the increased detection of sleep during the day.

Chapter 21 focuses on the fact that sleep disorders causing excessive daytime sleepiness are estimated to affect six percent of the population and has traditionally been under diagnosed. Sleep disorders symptoms may lead to an increased likelihood of suffering work and vehicle related accidents as well as affecting the physical and mental well being of the sufferer. A sleep diary documenting sleep hygiene habits over a period of time is an important tool in the diagnoses of sleep disorders. This project was to develop an online sleep diary, bringing benefits of presenting the information earlier to the physician in a format which allows the quick assimilation of information from the diary. The information is also in an electronic format facilitating the transmission to an electronic health record and the building of a database of sleep patterns. An online sleep diary allows a patient to self-monitor their condition allowing them to assess treatment and lifestyle changes on sleep patterns.

Chapter 22 contends that there is growing interest in the way that communication between doctors and patients affects important aspects of patient care and health outcomes. However, there is not much research on quantifying the effect of specific training programmes in communication skills for doctors. The aim of this chapter is to describe a research project that addresses this issue by first asking patients to provide feedback to doctors on their interpersonal skills. A set of training objectives is then discussed with individual doctors based on patient feedback. A training programme is subsequently undertaken by doctors, who are re-assessed by patients to determine the effectiveness of the feedback and training. The results indicate significant improvement on re-measurement. The chapter discusses the reasons for this improvement and the implications for providing personalised interpersonal skills training programs that target those skills that have been specifically identified by patients.

Chapter 23 shows how TACMIS is an inclusive solution to the management of health care and medical information. Its design is based on a detailed process analysis of patient journeys and the pathways of clinical care of stroke patients as they progress from acute care, through rehabilitation to discharge and independent living, often with a residual disability. The findings are the work of a team based in the Discovery Research Laboratory at Ritsumeikan University in Japan. The clinical analysis was conducted at King’s College Hospital in London and in several care institutions for the disabled and the aged in Japan.

Finally, Chapter 24 outlines how Information Technology (IT) applications for medical services in Japan have developed in line with two major national level factors. One is the “E-Japan Project” which was proposed and implemented to revitalize the Japanese economy by introducing IT to a wide range of industries and sectors of the society and by promoting establishment of IT infrastructure. The other is the serious concern over the fast rising healthcare expenses in the face of the rapidly aging society in that country. The first major efforts under this project, therefore, were made for productivity improvement and cost reduction in the health insurance bill claiming procedure and other related fields. These initiatives were followed by the construction of medical information sharing and processing systems first and then later developed further for regional collaborations among medical institutions. Other examples of IT applications in the Japanese medical services are also discussed, notably that which can be found in telemedicine to cope with the currently serious shortage of medical doctors.