Ubiquitous Health and Medical Informatics: The Ubiquity 2.0 Trend and Beyond

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**Section 1 Background**

**Chapter 1**

Identifying the Emerging e-Health Technologies: To Ubiquity 2.0 and Beyond

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This chapter introduced the concept of ubiquity 2.0 trend as the roadmap for e-health improvements and differentiated it from the traditional ubiquity trend or what is called ubiquity 1.0. The ubiquity 2.0 trend is an evolving concept for achieving interoperability based on the new and emerging technologies like ubiquitous computing, Web 2.0, Web-Oriented Architectures and cloud computing. This chapter also highlights the security challenges and the emerging web-oriented identity management technologies to provide a single, common user credential that is trusted, secure, and widely supported across the Web and among various healthcare enterprises.

**Section 2 Research Issues**

**Chapter 2**

Semantic Interoperability: Issue of Standardizing Medical Vocabularies

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This chapter argues that the semantic interoperability is the key to achieving global interoperability in healthcare information technology. The benefits are tremendous, however, there are many barriers to achieving semantic interoperability. Key among these is the resolution of the many issues relating to...
the terminologies used in defining, describing and documenting healthcare. The terminologies conflict and overlap; the granularity is not sufficiently rich for direct clinical use; there are gaps that prevent an exhaustive set; there are major variances in cost and accessibility; and no one appears eager or willing to make the ultimate decisions required to solve the problem. This chapter defines and describes the purpose and characteristics of the major terminologies in use in healthcare today. Terminology sets are compared in purpose, form and content. Finally a proposed solution is presented based on a global master metadictionary of data elements with a rich set of attributes including names that may come from existing controlled terminologies, precise definitions to remove ambiguity in use, and complete value sets of possible values. The focus is on data elements because data elements are the basic unit of data interchange.

Chapter 3
Personal Health Records: Status-Quo and Future Perspectives...

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This chapter suggests the open source solution as a valid solution for patient personal health records interoperability. A Personal Health Record (PHR) is a private and secure digital record that is created, managed, and owned by an individual, and contains the owner’s relevant health information. The benefits of PHRs have not yet been widely realized due to several significant challenges in their adoption, including the need for privacy, security, and interoperability, and the lack of accepted standards. Although many players in the healthcare arena are beginning to offer partial solutions, none have adequately addressed the full range of challenges. The adoption of PHRs can be significantly accelerated by the development of Open Source software that enables an individual to collect, create, organize, and manage his or her own private and secure PHR, using a standardized format and controlled vocabulary.

Chapter 4
A Framework for Privacy Assurance and Ubiquitous Knowledge Discovery in Health 2.0

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This chapter argues that knowledge discovery is a critical component in improving healthcare. There are a number of issues which must be addressed before knowledge discovery can be leveraged effectively and ubiquitously in Health 2.0. Health care data is very sensitive in nature so privacy and security of personal data must be protected. Regulatory compliance must also be addressed if cooperative sharing of data is to be facilitated to ensure that relevant legislation and policies of individual health care organizations are respected. Finally, interoperability and data quality must be addressed in any framework for knowledge discovery on the Internet. In this chapter, we lay out a framework for ubiquitous knowledge discovery in Health 2.0 based on a combination of architecture and process. Emerging Internet standards and specifications for defining a Circle of Trust, in which data is shared but identity and personal information are protected, are used to define an enabling architecture for knowledge discovery. Within that context, a step-by-step process for knowledge discovery is defined and illustrated using a scenario related to analyzing the correlation between emergency room visits and adverse effects of prescription drugs. The process we define is arrived at by reviewing an existing standards-based process, CRISP-DM, and extending it to address the new context of Health 2.0.
Chapter 5
A Semantic Model to Address Health Questions to Professionals in Healthcare
Social Networks
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In this chapter a social network is described, where users can formulate healthcare questions that are automatically classified under concepts of a medical ontology and assigned to experts of each topic. These questions are then answered by healthcare expert physicians. Our proposal includes a semantic classification method that provides the automatic classification of questions by means of a medical ontology, based on the tags used to annotate them, and the previously classified questions. The proposal includes an ontological model that represents the questions, the assigned tags, the answers, the physicians, and the medical concepts.

Chapter 6
An Integrated System for E-Medicine (E-Health, Telemedicine and Medical Expert Systems)
Ivan Chorbev, Ss. Cyril and Methodius University, Republic of Macedonia
Boban Joksimoski, European University, Republic of Macedonia

This chapter presents an overview of an integrated system for eMedicine that is implemented in the Republic of Macedonia. The system contains advanced medical information systems, various telemedicine services supported by modern telecommunication technologies, and decision support modules. The telemedicine services use wireless broadband technologies (WiMAX, 3G, Wi-Fi). A significant part of the chapter presents a web based medical expert system that performs self training using a heuristic rule induction algorithm. The data inserted by medical personnel while using the e-medicine system is subsequently used for additional learning. The system is trained using a hybrid heuristic algorithm for induction of classification rules that we developed. The SA Tabu Miner algorithm (Simulated Annealing and Tabu Search based Data Miner) is inspired by both research on heuristic optimization algorithms and rule induction data mining concepts and principles.

Chapter 7
Web 2.0 Approaches for Active, Collaborative Learning in Medicine and Health
Eleni Kaldoudi, Democritus University of Thrace, Greece
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This chapter elaborates on the potential of Web 2.0 for active and, potentially, effective learning in medicine and in health and reviews current practices and emerging advances in the field. Discussion focuses on current and emerging applications that fully exploit the potential of Web 2.0. Finally, the envisaged merit of merging with Web 3.0 technologies is also discussed.
Chapter 8
Integrating Medicinal Learning Objects with Daily Duties

Juha Puustjärvi, Helsinki University of Technology, Finland
Leena Puustjärvi, The Pharmacy of Kaivopuisto, Finland

This chapter analyzes the relevant medicinal instructions such as medicinal learning objects and considers three complementary ways for the dissemination of medicinal instructions: (i) by providing keyword-based searching, (ii) by providing ontology-based searching, and (iii) by automatic integration of medicinal instructions to employers’ day-to-day work tasks. The integration can be based either on the similarity of the metadata descriptions of the tasks and learning objects, or on the ontology which specifies the relationships of the tasks and instructions. The authors argue that integration is most preferable as medicinal instructions are provided just-in-time and tailored to their specific needs.

Chapter 9
Personal Health Information in the Age of Ubiquitous Health

David Wiljer, University Health Network, Canada
Sara Urowitz, University Health Network, Canada
Erin Jones, University Health Network, Canada

This chapter explores the essential issues of ubiquitous health information (UHI), beginning with its origins in the explosion of health information and the advent of new technologies. Challenges of UHI include privacy issues, change management, and the lack of basic infrastructure. However, benefits for patients include improvements in access to information, communication with providers, prescription renewals, medication tracking, and the ability to self-manage their conditions. Benefits at the organizational level include increased patient satisfaction, continuity of care, changes in costing models and improved standardization of care as organizations streamline processes to address this change in clinical practice.

Chapter 10
Healthcare Collaborative Framework Based on Web 2.0, Grid Computing and SOA

Wail M. Omar, Sohar University, Sultanate of Oman

This chapter highlights the role of grid computing as the basic architecture for supporting enterprise healthcare applications through offering massive resources through collaborative framework that is offering power computing, storage devices, and services. Grid computing along with Web 2.0 technologies provides a robust model for deploying, discovering, invoking, and integrating resources in open standard format. This chapter proposes a Service Oriented Architecture (SOA) as a model for managing the mixing between Web 2.0 and grid computing technologies. SOA for Web 2.0 and Grid Computing (SOAW2G) are used throughout this chapter to offer a fabric for e-health applications.
Chapter 11
An Agent-Based Architecture to Ubiquitous Health
Daniel Ruiz Fernández, University of Alicante, Spain

The chapter introduces a multi-agent architecture as a framework for the implementation of healthcare decentralization. It is intended to provide the capability to implement a global distribution of healthcare, even reaching the patient's home, workplace or holiday hotel. This is a distributed architecture which is flexible to implement new functionalities and accessible from anywhere. The architecture defines different types of agents and their interactions.

Chapter 12
Semantic Web Architecture to Provide E-Health Content and Services
Mahmood Tara, Mashad University of Medical Sciences, Iran

This chapter is aimed at introducing the Semantic Web and Web Services Architectures for e-health users and professionals. In particular, the chapter focuses on the current and prospective (or practical and potential) contributions of the Semantic Web technologies in providing e-Health content and services to its potential users worldwide.

Section 3
Management Issues

Chapter 13
Mobile Virtual Communities in Healthcare: The Chronic Disease Management Case
Christo El Morr, York University, Canada

This chapter explores the ways in which mobility within virtual communities can play an important role in facing the current and future healthcare challenges. The chapter suggests that mobile VCs (MVCs) can help patients with chronic disease to self-manage their health. The chapter shows the many advantages of this approach, particularly in terms of enhanced healthcare delivery and reduced healthcare cost, also the chapter discusses the challenges that this approach faces.

Chapter 14
Privacy Enhancing Technologies in Electronic Health Records
Christian Stingl, Carinthia University of Applied Sciences, Austria
Daniel Slamanig, Carinthia University of Applied Sciences, Austria

This chapter provides a security analysis of Electronic Healthcare Records (EHR) systems and discuss the basic and enhanced security requirements and finally introduces levels of security to classify EHR systems.
Chapter 15
Privacy-Based Multiagent Brokering Architecture for Ubiquitous Healthcare Systems
AbdulMutalib Masaud-Wahaishi, United Arab Emirates University, UAE
Hamada Ghenniwa, University of Western Ontario, Canada

This chapter presents a privacy-based multi-agent brokering architecture that supports different privacy degrees. Unlike traditional approaches, the brokering is viewed as a set of services in which the brokering role is further classified into several sub-roles each with a specific architecture and interaction protocol that is appropriate to support a required privacy degree. To put the formulation in practice, a prototype of the proposed architecture has been implemented to support information-gathering capabilities in healthcare environments using FIPA complaint platform (JADE).

Chapter 16
Managing E-Health in the Age of Web 2.0: The Impact on E-Health Evaluation
Benjamin Hughes, ESADE, Spain

This chapter aims to critically examine the issues associated with use of Web 2.0 technologies in healthcare. The chapter concludes that Web 2.0 will enhance e-Health applications and provides an improved management from a policy perspective.

Chapter 17
Academic Family Health Teams: Collaborative Lessons from the Far Flung North
David Topps, Northern Ontario School of Medicine, Canada

This chapter describes approaches taken and lessons learned while developing the informatics infrastructure to support interprofessional practice at with the Northern Ontario School of Medicine. Moreover, it describes how common procedures and software tools can benefit from a Web 2.0 approach, comparing commercial and open-source aspects of possible solutions.

Section 4
Applications

Chapter 18
The K4Care Platform: Design and Implementation
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Antonio Moreno, Universitat Rovira i Virgili, Spain
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This chapter describes the technological challenges faced during the design and implementation of the K4Care system, an agent-based Web-accessible platform that helps medical practitioners to deliver Home Care services in an efficient way. The system incorporates a Knowledge Layer, with an explicit
representation of the required medico-organizational knowledge. The administrative and care actions are performed by the coordinated operation of intelligent agents, that represent the human users of the system. Users can access the platform by means of a Web interface. Several Web 2.0 technologies have been used in order to provide a rich interaction, putting special care on connecting the Web browser with the multi-agent system in an efficient manner. An intermediate Data Abstraction Layer has been incorporated in order to allow agents to transparently retrieve the appropriate knowledge when needed. The separation of the knowledge from its actual use has allowed the development of a very dynamic, flexible and adaptable system. The platform also includes several techniques to personalize the interaction with the user both from the visual and functional points of view.

Chapter 19
Electronic Environments for Integrated Care Management: Case of Depression Treatment
Matic Meglič, UP PINT, Slovenia
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This chapter provides a basic overview of care process management and active patient engagement principles. It builds upon these principles to describe in more detail the way information and communication technology can provide support for these activities. It later discusses effects on cost efficiency and quality of care. The authors specify care models suitable for ICT support, specific process support characteristics related to health care, standards and communication devices to be used to work with these environments. For practical purposes the chapter provides a description of development and implementation of such an environment to support treatment of patients with depression.

Chapter 20
Building Virtual Communities for Health Promotion: Emerging Best Practices through an Analysis of the International Health Challenge & Related Literature in Second Life
Sameer Siddiqi, University of Houston, USA
Rebecca E. Lee, University of Houston, USA

This chapter introduces a virtual reality approach for building virtual communities for health promotion using Second Life. Such approach allows health educators, researchers, and practitioners (ERPs) to engage students, participants, and patients through innovative and uniquely rewarding methods. The technology’s value lies in its access to non-traditional participant pools, novel forms of social interaction, and cost-effective improvements to existing methods. These benefits are built on key Web 2.0 principles, namely social networking, community synthesis, and collaborative content generation. In light of ongoing dynamic development of virtual platforms, advancements in networking and immersion technology, and sustained consumer interest, the appeal of these environments will likely increase. Linden Lab’s Second Life (SL), a widely recognized and heavily populated MUVE, illustrates the technology’s broad spectrum of possibilities through the documented efforts of early adopters involved in health promotion, research, and therapy. However, ERPs must be mindful of the medium’s complexities, technological and social parameters, and weaknesses before considering development within virtual worlds (in-world). As these environments operate independently of the real world in some aspects, knowledge of gathering and creating relevant in-world and real-world resources, attracting and retaining project interest, and addressing common obstacles is essential. Through an analysis of the Texas Obesity Research Center at...
the University of Houston’s International Health Challenge in SL and the documented findings of past and existing health-related programs in SL, we seek to provide best practices to overcome these challenges and establish realistic parameters for program design and implementation.

Chapter 21
Dynamic Business Processes and Virtual Communities in Wireless eHealth Environments

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Constantinos Mourlas, National & Kapodistrian University of Athens, Greece
George Samaras, University of Cyprus, Cyprus
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This chapter discusses the features needed to incorporate the Computer Supported Collaborative Work (CSCW) for e-health applications (e.g. dynamic creation of medical virtual teams, dynamic workflows and the automatic triggered events upon time expiration). In this respect and having in mind the new Web 2.0 characteristics, a set of new features applied to the proposed system (DITIS). Furthermore, an extensive evaluation of the system is presented, supporting the need for such enhancement.

Chapter 22
Digital Pathology and Virtual Microscopy Integration in E-Health Records

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This chapter introduces a method for integrating Digital pathology and Virtual Microscopy at the format of the Electronic Healthcare Records. Digital pathology allows information sharing for diagnosis, biomedical research and education. It follows the previous efforts made in radiology and clinical laboratory. Virtual microscopy resulting in digital slides is an outreaching technology that is facilitating the shift to digital in anatomic pathology. Limiting factors in the expansion of virtual microscopy are formidable storage dimension, scanning speed, quality of image and cultural change. Anatomic pathology data and images should be an important part of the patient electronic health records as well as of clinical data warehouses, epidemiological or biomedical research databases and platforms dedicated to translational medicine Integrating anatomic pathology to the “healthcare enterprise” can only be achieved using existing and emerging medical informatics like Digital Imaging and Communications in Medicine (DICOM), Health Level Seven (HL7), and Systematized Nomenclature of Medicine-Clinical Terms (SNOMED CT), following the recommendations of Integrating the Healthcare Enterprise (IHE) Anatomic Pathology technical framework.

Chapter 23
Content-Based Image Retrieval for Digital Mammography

Issam El Naqa, Washington University School of Medicine, USA
Liyang Wei, Hologic, Inc, USA
Yongyi Yang, Illinois Institute of Technology, USA
This chapter reviews recent advances in Content-based image retrieval (CBIR) technology and discusses its expanding role in medical imaging and its particular application to mammography, provides working examples, and highlights the potential opportunities in this field for computer vision research and clinical decision making.

**Chapter 24**

Feature Evaluation and Classification for Content-Based Medical Image Retrieval System.............. 509

*Ivica Dimitrovski, Ss. Cyril and Methodius University in Skopje, Macedonia*

*Suzana Loskovska, Ss. Cyril and Methodius University in Skopje, Macedonia*

This chapter aims to develop highly flexible web-based system for storage, organization and retrieval of medical images. The developed system besides text and metadata retrieval also supports querying by image to find visually similar images to presented query. Several algorithms and techniques were implemented in the system to support content based retrieval. For efficient and reliable search machine learning techniques were included in the system.

**Chapter 25**

Virtual Reality as an Experiential Tool: The Role of Virtual Worlds in Psychological Interventions .............................................................................................................................. 532

*Alessandra Gorini, Istituto Auxologico Italiano, Italy*

*Andrea Gaggioli, Istituto Auxologico Italiano, Italy*

*Giuseppe Riva, Istituto Auxologico Italiano, Italy*

This chapter illustrates the past and the future of different virtual reality applications for the treatment of psychological disorders. After a brief technical description of the virtual reality systems, the rationale of using virtual reality to treat different psychological disorders, as well as the advantages that the online virtual worlds offer to the promising field of the virtual therapy will be discussed. Finally, the chapter introduces “Interreality”, a personalized immersive e-therapy whose main novelty is a hybrid, closed-loop empowering experience bridging the physical and virtual worlds. The main feature of interreality is a twofold link between the virtual and the real world: (a) behaviour in the physical world influences the experience in the virtual one; (b) behaviour in the virtual world influences the experience in the real one. This is achieved through: (1) 3D Shared Virtual Worlds; (2) Bio and Activity Sensors (From the Real to the Virtual World; (3) Mobile Internet Appliances (From the Virtual to the Real One).

**Chapter 26**

Use of Clinical Simulations to Evaluate the Impact of Health Information Systems and Ubiquitous Computing Devices Upon Health Professional Work................................. 552

*Elizabeth M. Borycki, University of Victoria, Canada*

*Andre W. Kushniruk, University of Victoria, Canada*

This chapter describes an approach to applying clinical simulations to evaluate the impact of health information systems and ubiquitous computing devices on health professional work. The approach allows for an assessment of “cognitive-socio-technical fit” and the ability to modify and improve systems and devices before they are released into widespread use. The application of realistic clinical simulations
is detailed, including the stages of development of such simulations (from creation of representative clinical environments to subject selection and data collection approaches). In order to ensure the success and widespread adoption of ubiquitous computing devices (UCD) it is argued that greater emphasis will need to be placed on ensuring such systems and devices have a high degree of fit with user’s cognitive and work processes.

Chapter 27
Technology and Human Resources Management in Health Care

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Lisa King, University of Western Ontario, Canada
Candace J. Gibson, University of Western Ontario, Canada

This chapter introduces the uses of technology in human resource management and how it can help improve the medical care that health professionals provide to their patients. For instance, technology can be used to maximize communication, collaboration and support between health professionals separated by distance, as well as provide immediate and up-to-date patient care information. ICT can also be used for distance training and education for those facing geographic isolation and provide a medium through which continued education can be maintained for both rural and urban health professionals. However, due to the differences in barriers of ICT use found for each group, such as computer illiteracy, geographic isolation or poor infrastructure, different steps need to be taken in order to ensure the successful implementation and use of information technologies in both urban and rural communities in developed and developing regions across the world.

Section 5
The Future

Chapter 28
Enabling Technologies and Challenges for the Future of Ubiquitous Health:
The Interoperability Framework

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This chapter introduces an interoperability framework as a solution for the challenges facing e-health communities. The proposed interoperability framework identifies citizens, providers, policymakers and researchers. This framework is developed and related to the improvement of understanding, access, trust, discourse, and practice for the purpose of moving toward a high performing healthcare system. Web 2.0 offers great promise as an eHealth platform to synergistically catalyze significant improvements to healthcare delivery, however, caution is advised about uncritical adoption. Barriers to progress and opportunities for advancement are identified and questions for future research are posited.

Compilation of References

About the Contributors

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