Chapter 14
Informatics Education in Low-Resource Settings

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Abstract Developing countries have the burden of acute and chronic diseases with the greatest health disparities. There is also a shortfall of more than four million healthcare workers worldwide, and the proportion is higher in less economically viable countries where the lack of proper trained healthcare workers is also compromised by the migration and departure of skilled personnel together with a frail infrastructure and a shortage of resources that cannot provide a proper scenario for an adequate healthcare system that will fulfill the population needs. The need for both technology infrastructure and individuals who have the skills to develop these systems is great,

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but so are the challenges in developing the needed workforce who are well-trained in informatics. This chapter describes the current informatics education efforts in three regions: Latin America, Sub-Saharan Africa and the Asia-Pacific region. The description of specific healthcare informatics education programs, the educational methods used and the challenges encountered are explored.

Developing countries have the burden of acute and chronic diseases with the greatest health disparities. There is also a shortfall of more than four million healthcare workers worldwide, and the proportion is higher in less economically viable countries where the lack of proper trained healthcare workers is also compromised by the migration and departure of skilled personnel together with a frail infrastructure and a shortage of resources that cannot provide a proper scenario for an adequate healthcare system that will fulfill the population needs [1].

e-Health has been defined by the World Health Organization as a broad term for the combined use in the healthcare sector of electronic information and communication technology for clinical, educational, research and administrative purposes, both at the local site and at a distance [2].

Capacity building has been defined by the United Nations Development Program as "the creation of an enabling environment with appropriate policy and legal frameworks, institutional development, including community participation, human resources development and strengthening of managerial systems" [3].

e-Health applications can be of great use in building capacity in countries by making a bridge between what is known in healthcare and how to translate it to the proper care not only at an individual level but also in healthcare institutions. In order to implement effective e-Health systems that can achieve national and regional healthcare goals that reduce the burden of acute and chronic diseases there is a need for solid pillars that will assure the persistence of the systems over time. This ambitious endeavor requires leadership and a properly trained workforce that can focus on projects that will have successful completion [2].

e-Health applications and health information systems have been shown to benefit healthcare in developed countries. Although the health disparities are a challenge for proper access of the population to healthcare in developing countries, a recent systematic review on evaluations of e-Health implementations in developing countries showed that the availability of systems that made healthcare institutions interoperable and provided monitoring of the medication cycle from ordering to patients' compliance were also successful [4].

As we mentioned before, one of the challenges to implementing e-Health is the lack of a well-trained professional workforce that can design, initiate, implement and lead projects. This workforce needs to understand healthcare, information and communication technology, as well as the organizational challenges involved in the implementation of e-Health.

Health informatics is the scientific discipline that provides the basics for e-Health since it applies information using information and communication technologies to help improve individual health, healthcare and public health. Health informatics

education has been available worldwide for several decades, mainly in developed countries. In the last 15 years there are scattered educational initiatives in developing countries. The lack of a biomedical informatics education and research infrastructure in the developing economies still remains as a major barrier both to the development of health informatics as a discipline and to the sustainability of the implemented e-Health solutions [1, 5, 6].

In 2008 the Rockefeller Foundation hosted a conference called "Making the e-Health Connection: Global Partnerships, Local Solutions", that gathered experts to help in the definition a new agenda to expand globally the use of e-Health. The chapter on capacity building that is part of the Report "From Silos to Systems" defined a vision that included three objectives [1]:

- Create an international network of e-Health informatics practice, education, training, policy and research;
- Educate government leaders about the importance of e-Health capacity and informatics to national health and economic development goals, cultivating and sustaining support for e-Health capacity and informatics activities;
- Develop a blueprint for initiating and executing activities in resource poor countries to rapidly create e-Health initiatives.

There have been different educational initiatives in Health Informatics that have been successful in developing countries. In this chapter we will describe the different experiences in health informatics education in three regions that include developing countries: Sub Saharan Africa, Latin America and Asia-Pacific. We will illustrate lessons that may have applicability to other countries that are trying to develop informatics programs.

Sub-Saharan Africa

Sub-Saharan Africa has a disproportionate burden of disease and an extreme shortage of health workers [7] as it "… has 24 % of the burden (of diseases) but only 3 % of health workers commanding less than 1 % of world health expenditure. The exodus of skilled professionals in the midst of so much unmet health need places Africa at the epicenter of the global health workforce crisis" [8]. In order to fulfill a minimum requirement of 23 health professionals per 100,000 people, an estimated 820,000 supplementary health workers are required in Sub-Saharan Africa [8]. The healthcare systems are challenged by increasing cost of care and suffer from fragmentation, weak information systems, lack of good governance, financial constraints [9] and a deficit of trained human resources. Furthermore, educational inequality is widely recognized as a factor impairing the development of a country [10, 11] and negatively influencing GDP growth.

Even though strong evidence is still lacking, information and communication technologies (ICTs) have the potential to provide innovative approaches for alleviating these problems, as ICT can help to overcome geographical barriers, increase

access to healthcare services, train healthcare professionals through distance education and provide the possibility of collaborative healthcare in remote locations.

The Global Observatory for e-Health, conducted a survey on e-Health activities in 112 countries in 2009 [12, 13], which showed that, even though there is a substantial implemented number of telemedical solutions most of them remain either in the pilot or informal stage of development and are not institutionalized.

In Africa, e-Health is considered a possible solution for the previously described challenges, but there are few people trained in e-Health [7]. Very few postgraduate telemedicine-training programs are established internationally and only one is in Africa [14]. The International Medical Informatics Association (IMIA) Working Group on "Health Informatics for Development" recognized the need for training manpower in developing countries in medical informatics as early as their first meeting in 1983, and emphasized the importance of health informatics in the African continent at their first international conference on Health Informatics in Africa (HELINA) in 1993 [15]. Considering advancements in technology and their application in the health sector in Africa it is essential to understand that "technology gives us tools, but it does not provide us with the wisdom and the skill to use them [16]". To be able to use these tools and to achieve a sustainable development, which depends on a skilled workforce to implement, use, support and maintain e-Health [7], establishing programs, and training human resources in the domain of e-Health in Africa is essential [16–19]. This requires opportunities for informatics training, university partnerships and development of human resources covering all sectors of e-Health [1, 7]. Health informatics education can be implemented as an educational program for supporting healthcare professionals, who need this training to manage health data and information in their job, or as educational programs to support an e-Health strategy that aims to train experts that can plan, deploy and assess e-Health applications [9].

Health Informatics Education Programs in Sub-Saharan Africa

Several health informatics education programs have been established in Sub-Saharan Africa, mostly in South and East Africa.

Walter Sisulu and Winchester University Program (CHIRAD in South Africa)

The Walter Sisulu University offers, in conjunction with Winchester University in England, coursework for a Masters in Health Informatics. The emphasis of this program is for students to "learn the necessary knowledge, skills and understanding of the personal behaviors needed to identify the opportunities and drivers for change, select the appropriate information and communication technologies, involve perceived beneficiaries, identify the prospective benefits and successfully plan, implement and evaluate the impact of change." The qualification is yet to be registered and accredited by the South African authorities [20].

The Regional East African Center for Health Informatics (REACH-Informatics)

REACH-Informatics in Kenya recently established in collaboration with the Indiana and Moi Universities Schools of Medicine and the global informatics leadership of the Regenstrief Institute, a two-year medical informatics post-doctoral fellowship program with the aim of training fellows to implement and use health information technology to enhance research and improve healthcare quality, efficiency, and outcomes [21].

Masters of Health Informatics in Rwanda

The Regional e-Health Center of Excellence (REHCE) is hosted by the Kigali Health Institute (KHI) [22], which is a public higher learning institution established by the government of Rwanda in 1996. The KHI is committed to be a centre of excellence in training and development of health professionals and to train and improve the capacity of health workers. The REHCE offers a Master of Science in Health Informatics that aims at training highly competent health personnel in health informatics; providing in-service short courses for continuous professional development; introducing e-Health technologies in all medical and health curricula; assisting in e-learning health programs in Rwanda; collaborating with the National University of Rwanda (NUR), schools of public health, teaching hospitals and other reference hospitals in telehealth implementation; conducting health research in health informatics; and developing new training programs in e-Health.

The Nelson R. Mandela School of Medicine Telehealth Department

The Nelson R. Mandela School of Medicine (NRMSM) created an academic department of telehealth in 2002, aimed at establishing and running postgraduate academic programs in both medical informatics and telemedicine, facilitating e-learning within the medical school, assisting the Department of Health (DOH) in establishing and running telemedicine programs and conducting international outreach through e-Health [7].

Applied Projects Leading to the Creation of Centers of Excellence in Low–Resource Settings

For a health informatics program in Africa to be successful it is necessary to incorporate the local context. It is not sufficient to just re-produce an existing course or program, but it needs to be adapted to the local needs, context and culture. In French-speaking Africa, health informatics education results from the deployment of applied projects in e-Health, telemedicine or public health. These projects create a demand for local skilled professionals, thus generating enough activity and

momentum to enable the creation of dedicated structures for training, education, and research. Eventually, these centers of expertise will be included in universities.

Réseau en Afrique Francophone pour la Télémédecine (RAFT) and the Jinou Program

The RAFT network [23], launched in 2001, primarily aims at de-isolating healthcare professionals that work in remote settings, through distance education and access to tele-expertise. Active in 18 Sub-Saharan African countries and more than 150 hospitals, and based on a predominantly South-South collaboration scheme (i.e., collaboration among developing countries), its scope has been extended to include the training of medical specialists in various fields, including medical informatics.

This extension, the RAFT–Jinou program, is based on the continent-wide sharing of expertise in various medical specialties: professors from French-speaking universities will each contribute by teaching a number of e-courses, which are organized in a structured curriculum for each specialty. The courses are taught with support from the RAFT infrastructure and tools. The RAFT-Jinou model has demonstrated that scarce human resources can collectively build capacity in a collaborative training approach, and serves as an inspiration for the development of a geographically-distributed Master in Health Informatics in French speaking Africa, promoted by a professionals in Cameroon, Mali, Burkina Faso, Niger, and Guinea.

Centre d'Expertise et de Recherche en Télémédecine et E-santé (CERTES)

Initially developed in collaboration with the RAFT network, the Malian Medical Information and Communication Network (REIMICOM) established CERTES in Mali after 10 years of applied projects development. Staffed with a dozen healthcare and IT professionals, the CERTES is in charge of training healthcare professionals to use health IT tools, to provide operational support for telemedicine activities and health information systems deployment, and to run research projects financed by competitive funds. Strongly linked with the Department of Public Health at Bamako University, it will contribute to the creation of a health informatics master's program and graduated its first group of MD students in 2012. CERTES is a good example of a bottom-up approach at developing a critical mass of Health Informatics activities, which in turn helps to organize and support a formal training program.

Multilateral Capacity Building

The Health Informatics Building Blocks (HIBBs) Project

As described in Chap. 13, The American Medical Informatics Association (AMIA) created the HIBBs project with initial funding from the Rockefeller Foundation as part of its Global Health Informatics Partnership (GHIP) [24]. The goals of this

project are to coordinate and provide distance learning and education in informatics and to collect, create, test and deploy appropriate informatics training content. The open-source content is delivered in a modular approach, can be used alone or as part of a larger curriculum, and provides knowledge and skills on health information use and management. The HIBBs modules have been designed to be portable, reusable, and adaptable to local needs.

AFRICA BUILD

AFRICA BUILD [25] is an EU-funded project (2011–2014) aspiring to improve capacity for health research and education in Africa with the main objective to promote health research, education and practice in Africa. This is expected to be achieved through the creation of centers of excellence, by using IT, e-learning and knowledge sharing through Web-enabled virtual communities. The project includes a custom-designed collaborative platform to foster education, training and knowledge sharing between virtual communities of African researchers. The action is expected to promote African health scientists along with their institutions, and research networks, in order to create a sustainable and attractive research landscape for health research in Africa, but also aims at building capacity for medical informatics. The African participants are strongly integrated in the development of the platform and tools, and some of the courses taught are in the field of medical informatics.

The International Society for Telemedicine and e-Health's (ISfTeH) Basic Telemedicine Training Program

The ISfTeH [26] developed a basic, modular and adaptable course in Telemedicine that is delivered face to face. The curriculum covers introduction to computers; ethics and law in telemedicine; setting up venues; basic telemedicine skills; basic skills in the use of email and digital photography; practical use of store and forward telemedicine; teleeducation; and telemedicine and homecare. The training program was taught in 2009 to groups of physicians in several hospitals, and has been modified afterwards based on the participants' feedback [14].

Challenges Ahead

These examples illustrate the potential benefits of e-Health, but to develop its full potential strategic commitment, organizational changes and a harmonization of activities in e-Health, telemedicine and implementation are required on a national level with specific attention to the education of medical informatics professionals, as they are the basic foundation for the successful implementation and development of any e-Health project. Two groups of medical informatics professionals need to be qualified: healthcare professionals that are trained using e-Health applications and

tools, and professionals that are able to support and carry out e-Health projects, and develop tools. The survey of the Global Observatory for e-Health [27] concluded that many African countries do not have a national e-Health strategy, yet an increasing number of countries in Africa are establishing a national e-Health strategy. The e-Health Strategy Toolkit, which has been developed by the WHO and the International Telecommunications Union (ITU) [28] is expected to accelerate this development. Furthermore the African Union is highlighting the need to harmonize telemedicine and e-Health activities in Africa [7].

The potential of low-cost wireless telecommunication access technologies for health education, ICT enabled care processes, public health activities, business and community development in Africa is emphasized by the ITU and others [29–32]. In the absence of fixed line networks and hardware, infrastructure challenges remain important, consequently mobile phones and related technologies like the General Packet Radio Service (GPRS) and wireless technologies are expected to be increasingly used for accessing the Internet [29].

There is no single e-Health solution that fits all. For e-Health to develop its full potential in Africa, solutions and applications have to be developed and deployed based on real needs, fostering innovative ideas and combinations of existing and new technologies. Capacity should be developed at different scales and across all sectors of e-Health, moving from vertical silos to widely-connected systems, by facilitating the evolution and development of infrastructure for existing centers of excellence, and establishing North–South (between developed and developing countries) as well as South-South collaborative networks of excellence [1], based on models of successful implementations [33].

Latin America

There are 21 countries that vary greatly in size, wealth and population that form the Latin American región. In what follows, this grouping of countries was done according to the sharing of a common language (mainly Spanish, Portuguese and French).

Latin America is widely known as the world's top unequal region. The public health challenges the region faces are due to the acute socioeconomic inequalities, along with gender, racial, and sexual discrimination, and the world's highest income disparities. It has been said about the region that 35 % of the region's population lives in poverty, and 21 % of the residents do not have access to healthcare services [34].

Also the current healthcare challenges that the Latin American states face are the growing burden of non-communicable chronic diseases which the Pan American Health Organization (PAHO) reported had become the "greatest cause of premature death and morbidity in Latin America and the Caribbean". In addition, infectious diseases continue to cause death in the region, and outbreaks of dengue and yellow fever are on the rise [34–37].

In the region healthcare is underfinanced leading to deficiencies mainly in basic care that should be granted to all the population. It has also been described as having

an inefficient allocation of the limited resources available and there is no proper coordination between all the stakeholders, leading to effort duplication and resource wastage. The current situation needs to be addressed in order to provide equity in the provision of healthcare services with efficient management and perceived quality by the population [38].

Inequalities persist in the access to healthcare services due to different causes that challenge the possibility of getting timely and high quality healthcare when needed. Among the different factors that compromise proper healthcare are the lack of qualified human resources and proper infrastructure, together with lack of technology, equipment and drugs due to the low income situation that many areas of the region face. Since there are limited financial resources to support healthcare, qualified healthcare professionals seek work opportunities in urban areas within the country leading to a concentration of the most highly trained health personnel in urban areas or abroad. There is also a severe shortage of nurses in many countries (on average less than five nurses/10,000 pop) [35, 39].

Given the challenges facing the healthcare sector in the region, e-Health should have great potential for Latin America. e-Health could propel and lead to a more equitable, effective and efficient way to improve access, provide timely care and help in cost reduction to ensure more effective diagnosis and treatment. WHO's second global e-Health survey was completed by some countries of the Latin American region. The main results show that 45 % of the respondents had an e-Health strategy together with 36 % having a telemedicine policy. Eighty-two percent (82 %) also declared that they were investing in IT and software; including pilot projects in e-Health and 63 % in digital literacy for the proper use of these technologies. eLearning initiatives were used as a teaching tool for healthcare by 82 % of the respondents while 91 % acknowledged using distance learning to train health professionals. PAHO also conducted a recent study to determine the existence of e-Health initiatives in the Americas region. The survey showed that 68 % of 19 members considered e-Health a priority on their national agendas, while 47 % indicated having policies or strategies for the use of ICTs within the health sector [40, 41].

Despite the results of the survey, e-Health initiatives, both public and private, have been small-scale projects that were not properly included in public health and e-Health strategies. However the use of IT in the health sector continues to grow and is slowly driving changes in the way the population interacts with healthcare.

PAHO has developed an e-Health Strategy and Plan of Action (2012–2017) that aims to help the sustainable development of the Latin American countries' healthcare systems [41]. e-Health will be a means of improving healthcare access and quality, based on the use of IT, the development of digital literacy together with access to the scientific literature. This strategy will help health information access that is considered a basic right of the people to be informed and to have equitable access to healthcare. The strategy addresses different topics related to e-Health such as electronic health records, telemedicine, mobile health and interoperability, but specifically regarding education the Strategic Area 4 refers to knowledge management, digital literacy, and education in information and communication technologies as key elements for ensuring the quality of care, health promotion, and disease

prevention activities, guaranteeing training and better access to information in an equitable manner. This has the potential to promote education activities in health informatics for the region [42, 43].

It is widely recognized that e-Health is a useful tool that can enhance the competencies of the healthcare workforce to support patient care, making well-trained professionals in this area of expertise a key need. Although there have been training programs in health informatics in developed countries for over 40 years, in the Latin American region only a few countries have developed initiatives for formal training in the discipline. These programs have included short courses, certificate and masters programs. QUIPU, The Andean Global Health Informatics Research and Training Center, surveyed 142 experts from 11 countries of the region (mainly from Perú) as to their needs for informatics training. The top ranked courses in a scale from 1 to 5 were related to medical informatics: introduction to biomedical informatics (score 4.41); data representation and databases (4.29); mobile health (4.26); and security, confidentiality and privacy (4.25). The research topics that were considered as a priority were: Evaluation of Health Information Systems; Policy in Health Informatics; Interoperability and Standards; Evidence-based Decision Making in Informatics; Rural Telemedicine; Mobile Health; Electronic Health Records; Sequence Analysis and Gene Finding; Tele-education; and Cost-effectiveness Analysis in Biomedical Informatics. These results could help to define the competencies and the structure of training programs for the region but as of the middle of 2013 there were no education programs that have addressed these results [44].

Health Informatics Education Programs in Latin America

Several health informatics education programs have been developed in the region; below some of the published experiences are described.

Argentina

Hospital Italiano de Buenos Aires Medical Medical Informatics Residency Training Program Spanish Version of AMIA's OHSU 10×10 Course

Hospital Italiano de Buenos Aires (HIBA) is a non-profit healthcare academic center founded in 1853, in 1998 HIBA decided to implement a Healthcare Information System (HIS) called "ITALICA" developed as an in-house project that currently handles all the information related to healthcare both clinical and administrative, from its capture to its analysis. As part of the project, the Department of Health Informatics was created in 2001, at the same time a postgraduate education program was created. The medical informatics residency is a 4-year program that has been accredited by the national authorities that aims to train physicians to be a major factor in e-Health and to work as a "bridge" between healthcare and IT. The training

curriculum includes healthcare (two years in internal medicine), computer science, healthcare information systems, electronic health records management, epidemiology, knowledge-based databases for clinical terminology and standards, biostatistics and decision making theory. The graduates of the residency program are currently working on different e-Health projects in Argentina and Chile as Chief Medical Information Officers (CMIOs) at healthcare facilities coordinating development and implementation of health information systems and working at the health ministry level helping in the creation of a national e-Health agenda [45].

The Department of Health Informatics at Hospital Italiano also developed other courses for digital literacy oriented to information retrieval and computer literacy, and helped in the creation of an HL7 introductory course. A collaboration with Oregon Health & Science University's Department of Medical Informatics and Clinical Epidemiology allowed the regional adaptation of AMIA's 10× 10 in 2006 (see Chap. 8 for additional detail). The initial course was a Spanish translation of the 10 one-week units. After the initial experience and feedback from the students, the course has been adapted to better meet regional needs (for example characteristics of healthcare in the region and public health informatics topics were added. Security and privacy issues such as HIPAA – the Health Insurance Portability and Accountability Act, are not addressed since HIPAA only applies in the U.S.). Currently it is entitled Introductory Course to Health Information Systems and has 15 modules that are delivered in 16 weeks with topics that address the needs of health informatics in the region. Through December 2012 more than 1,000 students have taken the course from all over Latin America, and more than 80 % (850 students) are active in the field of Health Informatics. This experience provided basic training for healthcare professionals in medical informatics in Latin America in their own language. The course has been well-accepted by users across the region. This could represent a model for disseminating knowledge of medical informatics across other languages and cultures [45, 46].

Brazil

Open University of the Unified Health System Health Informatics Education

In Brazil the Open University of the Unified Health System was launched as an e-learning endeavor in the context of the National Telehealth Program. This project mainly promotes the production of distance healthcare courses for the country so that healthcare professionals in many states experience the potential of new teaching technologies that include web conferences and courses that use simulators, organic modeling and animations as part of the training experience.

The Ministry of Health has supported the production of didactic material within the program, which addresses the ongoing training and education needs of healthcare employees working in the area of health, offering distance postgraduate and university extension courses to professionals. It also has a public collection of educational materials that are available free of charge on the Web [47].

In Brazil, education in nursing informatics was the first focus for informatics training. It was promoted by the development of nursing education programs with nursing informatics topics in the curriculum.

A program financed by the Fogarty International Center started in 1999 and funded the creation of 10 onsite health informatics courses in Brazil, which were subsequently made available on the Internet and CD-ROM, together with regular medical informatics courses taught yearly in the U.S. at Harvard University initially and currently taught in conjunction with the University of California San Diego. Several regions of Brazil were reached during the development and implementation of this training program and by 2003 over 1,700 healthcare professionals were trained. The program has continued and currently training is provided to all healthcare personnel. Different courses were added to the offering such as: Introduction to health informatics; computer-aided instruction; electronic medical records; clinical systems; telecommunications and network infrastructures to support healthcare, homecare, biosignals, and images in medicine; hospital information systems; and decision support systems. This program has the potential to be expanded since an important project entitled RUTE (Red Universitaria de Telemedicina – University Network of Telemedicine), is being coordinated by the National Network of Teaching and Research. The National Program of Telehealth Care currently integrates academic teaching institutions with nearly 60 healthcare facilities and hundreds of primary care clinics throughout the country promoting improved access to healthcare, health information and training for individuals that live in regions that are remote and difficult to reach. In 2006 it started with 19 university hospitals and currently 158 institutions have benefited by RUTE and nearly 400 health institutions are involved in online virtual events [48, 49].

Currently the Brazilian Society of Health Informatics is working on the development of proTICS – Professionalization Program in Information Technology and Communication in Health – that aims to promote and encourage the creation of new undergraduate and postgraduate courses in health informatics and also will collaborate with the definition of the minimum content and quality criteria so that the accreditation of this course occurs in proTICS, thus obtaining official recognition from the national academic society.

Chile

In Chile Health Informatics training initiatives are diverse and have been motivated by the need to implement e-Health projects in different settings.

Since 2011 the Heidelberg Center for Latin America together with the School of Medicine of Universidad de Chile have developed a collaborative Masters in Biomedical Informatics. This program has two specializations: the first will focus on health informatics, with an emphasis on health information management, and the second will focus on bioinformatics and biomedical image processing, with emphasis on information processing and complex computational and statistical techniques.

The Center for Health Informatics of the Universidad Central de Chile also offers graduate certificate programs on Medical and Nursing Informatics, Standards, Evidence and Decision Making in Public Health and Project Management in Health Informatics. At a tertiary non-university level, a technical program of undergraduate training in biomedical informatics has been created at the Professional Institute and Technical Training Center DuocUC. It is a four-year program and the graduates become Biomedical Informatics Technologists. This offering is quite innovative since most of the programs in the region only focus on healthcare professionals.

Colombia

Health Informatics in the Universidad de Antioquia, Universidad de Cauca and Universidad Javeriana

The Universidad de Antioquia has a Master of Biomedical Sciences with emphasis in medical informatics, which is currently offered exclusively to health professionals. The program includes in its curriculum introduction to health informatics, telemedicine, knowledge representation, and user interfaces design for e-Health. The University also has a graduate certificate program in medical informatics in collaboration with the Center for Health Sciences at the University of Texas in Houston.

The University of Cauca educational offering consists of a MSc and PhD program in Telematics Engineering, both of which have an area of research in e-Health. This program is offered exclusively to engineering professionals, and is developed in collaboration with e-Health Competence Center Regensburg in Germany, which has a department that is responsible for basic and domain-related research, education and other academic obligations in the telehealth field. The Universidad Javeriana and Pittsburgh University have received funding to develop the ENRICH project: "Enhancing Research and Informatics Capacity for Health Information in Colombia" This project aims to build capacity in health informatics with an emphasis on clinical research. The University of Pittsburgh will help in the creation of an integrated program to train researchers in health informatics and advanced research methods that will address the healthcare needs of Colombia. Different courses will be delivered locally in the form of workshops/seminars on clinical information systems, clinical terminologies, bioinformatics, database management bio-surveillance and clinical research methodology [50, 51].

Cuba

In Cuba there has been local development and implementation of e-Health projects but there has not been enough evidence published in the scientific literature to determine the details. The government created a Telematic Network for Health in Cuba, known as INFOMED that coordinates most of the projects which have mainly been used to deliver training activities through e-learning [52].

Mexico

Most of the formal training in health informatics in Mexico is at the undergraduate level. The School of Medicine at the Universidad Nacional Autonoma de Mexico is one of the largest medical schools in Latin America, with more than 7,000 undergraduate students and was created in the sixteenth century.

The undergraduate program underwent a major revision in 2008 and health informatics courses were added as core requirements in 2011. A Department of Biomedical Informatics was created and two one-semester courses were developed and delivered in a blended learning mode. The courses include basic health informatics content areas such as medical databases, electronic health records, telemedicine, medical decision-making and clinical reasoning. Nearly 1,200 students took the courses and evaluated the program positively [53].

Other universities also have undergraduate courses on biomedical informatics at their School of Medicine at Universidad de Veracruz, Universidad La Salle University, Universidad Panamericana and Universidad Anahuac. The Instituto Politécnico Nacional that provides training in engineering disciplines also delivers a health informatics course as part of their Biomedical Engineering program at the Unidad Profesional Interdisciplinaria de Biotecnología.

Perú

AMAUTA Global Training in Health Informatics
QUIPU Andean Global Health Informatics Research and Training Center

AMAUTA is a Quechua word that describes a person of great wisdom, one who knows and who teaches. The AMAUTA Global Training in Health Informatics program was developed in 1999 between two Peruvian and a U.S. university (Universidad Peruana Cayetano Heredia, University of San Marcos of Peru and the University of Washington) to train Peruvian healthcare professionals in health informatics. The program consisted of training individuals and providing the initial steps to develop a local training program. The collaboration developed short course offerings locally to identify needs and collaborators and potential trainees. There was also the possibility of postgraduate training in informatics for the local universities' faculty. The program has increased the availability of health informatics applications, knowledge about data collection methods, access to scientific resources, and geographic information systems for monitoring disease incidence and outbreaks, and bioinformatics training [50, 54].

Universidad Peruana Cayetano Heredia also received funding in 2009 to develop a health informatics training project entitled QUIPU (which means knot in Quechua, and is an ancient system used by the Incas in the Andes to record and distribute information). The objective of QUIPU is to promote research and training for biomedical informatics professionals and global health. QUIPU seeks to become a Center of Excellence of the highest quality in the Andean region by developing and implementing opportunities for biomedical informatics training, short and long

term, in the Andean region. It will engage new researchers in the Andean region for research in health informatics and promote the expansion of a research network in the Andean region, promoting South-South cooperation and partnering with universities in developed countries [55].

Uruguay

In Uruguay the training in health informatics was initiated at the postgraduate level for the Federación Médica del Interior (FEMI). The intent was to start a health information system project that aimed to exchange and analyze clinical and administrative information at a national level. Twenty-three healthcare institutions across the country form FEMI, together with a tertiary referral center in the capital city of Montevideo. FEMI provides healthcare services to over 650,000 people nationwide (approximately 20 % of the population). The strategy was to train an interdisciplinary group at each of the institutions that would include a physician, who would act as Chief Medical Officer, an information system professional and a medical records technician. A total of 128 professionals were trained through online and in person sessions in Uruguay and Argentina, the topics addressed were health informatics project management, electronic medical record systems, human error prevention through system redesign, coding systems, health information standards, and data warehouses [56].

Recommendations for Addressing the Challenges

The World Health Organization has stated that in this century healthcare expectations need to be met through improved access to high quality resources for most of the world's population [57]. And there is also a strong recommendation at the regional level by PAHO to use e-Health as a strategic tool in the planning and development of healthcare actions [41].

The development of e-Learning modalities can help to address these recommendations by providing communication, knowledge acquisition, and access to knowledge to any person, in any place and at any time. e-Learning can help as an educational approach for large numbers of trainees since it can respond efficiently to the current needs for high quality universal education, and it is a suitable and viable resource for keeping people informed of the most up-to-date knowledge in healthcare and health informatics [47].

We have seen that many training projects were developed through cooperation between developed and less-developed countries. The most difficult and limited resource is local trained experts and a workforce that has skills in the development and implementation of e-Health applications. This situation is worse in developing economies that rely on foreign personnel who are available for a limited time, while a constant and local presence is needed so that these projects can evolve and

narrow the "digital divide" by building e-Health training programs that address these local needs. To develop these partnerships there are different areas that need to be evaluated prior to a formal cooperation agreement: priority assessment, technology evaluation and selection criteria, implementation issues, emerging technologies linking patients and providers, access to knowledge databases, consumer health informatics. In developing countries, capacity building in health informatics can be used to address capacity shortages, by providing electronic information and training, especially in rural and underserved areas. There is a need for robust clinical data to address local healthcare needs, which are different from those in developed countries, due to cultural differences, political and economic factors, etc. Although the burden of chronic diseases is similar to developed economies, infectious diseases and malnutrition are still great public health challenges. These issues make it essential to find local solutions.

Individual capacities of the local workforce need to be evaluated and these capacities can be strengthened if the workforce profiles of future leaders of e-Health projects are correctly identified, if the size and composition of the workforce needed is determined according to the local needs and the current perspectives are taken into account such as language, the healthcare system and available resources. The training should be oriented to e-Health projects that can strengthen health as shown by the benefits achieved after a successful implementation of the project. In order to promote successful projects they need to be clearly stated and described in sufficient detail. The planners also need to expand their vision beyond the local involvement to all the future or current stakeholders from the managerial and operational areas. The PAHO e-Health Strategy and Plan of Action launched in 2012 has been adopted by most of the countries of the region so we hope that in a near future training programs will emerge that address capacity building as part of incorporating e-Health into all of the Latin American countries [5, 38].

Asia-Pacific

For this discussion the Asia-Pacific is defined as the group of countries along the eastern Pacific rim, including most of what is often called East Asia, Southeast Asia and Australasia.

The Asia-Pacific includes a heterogeneous group of countries that covers a great swath of territory and encompasses a massive population. The group members frequently have little in common other than geography. The region is highly diverse in almost all aspects, including racially, culturally, and economically as well as in religion, governance and healthcare systems. This wide diversity makes it extremely difficult to try to describe succinctly any aspect of this region, and certainly the area of health informatics development is no different.

Some of the more developed countries and territories in the region, such as Australia, Hong Kong, Japan, Korea, New Zealand, Singapore and Taiwan already have a long history of significant health informatics development. Australia launched

the Personally Controlled Electronic Health Records system in 2012 as a national electronic records sharing system [58]. Hong Kong deployed the Clinical Management System, an interoperable EMR for all the 41 public hospitals and 121 associated clinics in Hong Kong [59] and is currently developing an electronic health record program for the whole of Hong Kong [60].

A recent study in Korea found 100 % adoption of CPOE at tertiary hospitals and a 77 % adoption of EMRs [61]. In Japan more than 62 % of major hospitals have an electronic medical record installed [62]. New Zealand is well known for the high rate of EMR adoption, particularly in the primary care sector [63]. Singapore launched the first phase of the National Electronic Health Record (NEHR) in 2011 to consolidate health records between various sectors of care [64]. In Taiwan the "Taiwan Electronic Medical Record Template" (TMT) interoperability standard has been developed to form the basis of the future National Healthcare Information Project (NHIP) [65, 66].

For these more experienced nations, Health Informatics and e-Health development is already firmly on the policy agenda. However even for the other countries in the region health informatics and health IT are seen as strategic imperatives to enable more effective, efficient delivery of better quality healthcare to their populations, and countries such as China, Malaysia and Thailand have also made significant strides in their e-Health journeys.

Health Informatics Education Programs in Asia-Pacific

This brief discussion will not attempt to provide a comprehensive review of all the health informatics education programs in Asia-Pacific. Instead we will try to illustrate the situation through three case studies.

Hong Kong

Hong Kong has taken a somewhat non-traditional approach to Health Informatics education. The Hong Kong Polytechnic University has a Department of Health Technology and Informatics, specializing in Medical Laboratory Science and Medical Imaging, which represents the only dedicated tertiary department teaching Health Informatics related material. More general health informatics education programs have been offered, such as the Postgraduate Diploma in e-Health Informatics taught by the University of Hong Kong School of Professional and Continuing Education, and the "Applied Clinical Informatics" distance learning course which is a collaborative venture between the Hong Kong Society for Medical Informatics, the Hong Kong Polytechnic University and is being recognized as an i10 × 10 course (the international variation of the AMIA 10 × 10 program).

The bulk of health informatics education in Hong Kong, however, has been provided as in-service training through positions in the health informatics Team

and Information Technology Services in the Hospital Authority. The development of the Clinical Management System (CMS) and its deployment to all the public hospitals and associated clinics in Hong Kong has offered a unique opportunity to participate in the development and deployment of a very large scale electronic medical records system. Since the CMS was (and continues to be) entirely developed in-house, team members are exposed to a very wide range of health informatics disciplines, from strategic planning to deployment issues, from information architecture to usability, from clinical engagement to technical development. As the Hospital Authority has also been appointed the technical agency for the development of the electronic health record sharing system (eHR) for the whole of Hong Kong, members of the team have also been exposed to issues involved in interoperability and development for and deployment to different sectors of the healthcare system.

This sustained investment in development programs has resulted in a large number of experienced workers in the health informatics industry in Hong Kong and it is anticipated that the demand for such a workforce will increase in the future as the scope of health IT gradually increases and the eHR is deployed to all healthcare sectors.

Singapore

In Singapore, health informatics education falls into two categories – academic and certificate courses.

Academic Course. Since January 2012, health informatics has been offered as an undergraduate module (Course Code IS3250) at the National University of Singapore (NUS). The module runs for one academic semester and comprises 10 weekly lectures each of 90-minutes duration, followed by a 45-minutes forum at which industry speakers are invited to share their "ground experience" with the students. For example, after the lecture on Electronic Medical Records, the forum will feature a speaker from the Singapore Ministry of Health to update students on Singapore's National Electronic Health Record (NEHR) system which was launched in June 2011. Topics include (1) Overview of Health Informatics, (2) Information Systems in Healthcare Enterprises, (3) Computerized Medical Records, (4) Clinical Decision Support, (5) Standards and Interoperability, (6) Confidentiality, Privacy and Security, (7) Infocommunication Advances in Patient Care, (8) Bioinformatics – Biology meets IT, (9) Healthcare Analytics and (10) Pervasive Computing in Healthcare. As a requirement for passing the course, students have to undertake a course project. The final examination of the module comprises three sections – Section I with 20 multiple-choice questions, Section II with 10 short-answer questions and Section III with 1 essay question. Since it was offered in January 2012, IS3250 has been well-subscribed by students with an enrollment of about 60 students for each of its two runs.

Certificate Courses. Singapore also offers the international version of the AMIA-OHSU 10×10 Course through a collaboration between Gateway Consulting, the

American Medical Informatics Association (AMIA) and Oregon Health & Science University (OHSU), USA which started in 2009. The course is the same as the AMIA 10×10 course in the USA with lectures delivered from OHSU via distance-learning. In addition, students are required to participate in the online forums and undertake a Course Project to partially fulfill the course requirements. The course ends with a three-hour, open-book, invigilated examination. Known in Asia as the Gateway to Health Informatics (G2HI) Course, this international version of the AMIA-OHSU i10×10 course has just completed its seventh run and has, so far, trained some 160 healthcare and IT professionals from Singapore, Malaysia, Thailand, the Philippines, Brunei, Vietnam and Saudi Arabia. The course is endorsed by the Infocommunications Authority of Singapore (IDA) under its Hybrid Skills Development Program (HSP). Details of the Gateway to Health Informatics Course are available from http://www.gatewaypl.com/g2hi/index.htm [67].

In January 2012, the NUS Department of Information Systems established a Centre for Health Informatics (CHI) with co-funding from the Infocommunications Development Authority (IDA) of Singapore. A major term of reference for the CHI is to conduct executive training courses on various topics in health informatics for professionals in the healthcare and IT industries. These courses are generally 3-day, short courses comprising lectures, case studies and projects to equip course participants with knowledge and practical skills needed to respond to challenges of the workplace with ideas that are fresh, practical and relevant. Courses that have been offered by the CHI include Introduction to Health Informatics, Managing Healthcare IT Projects, Standards in Health Informatics, Databases in Healthcare Practice and Healthcare Analytics. More details on CHI Courses are available online [68].

Thailand

Formal education in informatics in Thailand can be classified into three levels: a certificate and diploma level, an undergraduate level, and a graduate level. At the certificate and diploma level, short courses in targeted areas of informatics are offered, often targeting individuals with specific roles such as the Chief Information Officers (CIOs) or Chief Medical Informatics Officers (CMIOs), or focusing on a particular field within informatics such as dental informatics. Table 14.1 describes the programs available.

Informatics education at the undergraduate level is mostly incorporated as part of other curricula, targeting undergraduate healthcare professional students, or ICT students with interests in healthcare and health IT. Medical records management and coding study which has been taught by an institute under the Ministry of Public Health as a vocational-level degree has extended to a four-year undergraduate degree. At the graduate level, master of science programs in biomedical and health informatics are offered by a few institutions, and there are also graduate programs in other related areas such as engineering, ICT, or dentistry with informatics-related research work. Table 14.1 lists some of the informatics

academic programs in the country. There are also academic programs in bioinformatics offered in several institutions, forming the country's bioinformatics cluster with support from the National Center for Genetic Engineering and Biotechnology (BIOTEC).

Despite these educational activities, opportunities lie ahead for informatics education in Thailand. Strengthening the country's informatics education would require a standardized informatics curriculum with a recommended set of competencies that apply international recommendations to the local context. There is no

Table 14.1 Certificate, undergraduate, and graduate health informatics programs

Level	Program & institution	Notes
Certificate and diploma	ICD-10 Basic and Advanced Certificate Programs, Thai Medical Informatics Association	Targets medical coders and health information management professionals.
	Graduate Diploma Program in Biomedical and Health Informatics (International Program), Faculty of Tropical Medicine, Mahidol University	Targeting informatics practitioners, especially those who work in the area of public health.
	Healthcare CIO Certificate Program, Hospital Administration School, Faculty of Medicine Ramathibodi Hospital, Mahidol University	Targets Chief Informatics Officers (CIOs) or IT executives of healthcare organizations.
	Dental Informatics Certificate Program, Institute of Dentistry, Ministry of Public Health	Focusing on dental informatics.
Undergraduate	Bachelor of Science Program in Information and Communication Technology, Faculty of Information and Communication Technology, Mahidol University	First undergraduate ICT or computer science program with informatics contents.
	Doctor of Pharmacy Program in Health Informatics (Pharm.D.), Faculty of Pharmacy, Silpakorn University	Major in health informatics.
	Doctor of Pharmacy Program in Pharmaceutical Sciences (Pharm.D.), Faculty of Pharmaceutical Sciences, Chulalongkorn University.	Pharmacy informatics is a sub-major in the social and administrative pharmacy major.
	Bachelor of Public Health, Kanchanabhishek Institute of Medical and Public Health Technology, Ministry of Public Health	Focusing on health information management and medical coding.
	Bachelor of Nursing Program, Ramathibodi Nursing School, Faculty of Medicine Ramathibodi Hospital, Mahidol University	Nursing informatics a required course for undergraduate students.

Table 14.1 (continued)

Level	Program & institution	Notes
Graduate	Master of Science Program in Health Informatics, Institute of Health Science, Ramkhamhaeng University	First informatics graduate program in Thailand.
	Master of Science Program in Health Informatics (International Program), Faculty of Public Health, Mahidol University	Targeting informatics practitioners, biostatisticians, and data analysts.
	Master of Science Program in Biomedical and Health Informatics (International Program), Faculty of Tropical Medicine, Mahidol University	Targeting informatics practitioners and project managers, especially those who work in the area of public health.
	Master of Pharmacy Program in Health Informatics, Faculty of Pharmacy, Silpakorn University	Targeting pharmacy practitioners.
	Master of Science and Doctor of Philosophy Programs in Social and Administrative Pharmacy (International Program), Faculty of Pharmaceutical Sciences, Chulalongkorn University	Student research in informatics areas exist. Informatics courses available for students who aim to conduct research in informatics or related areas.
	Master of Engineering Program in Industrial Engineering, Faculty of Engineering, Mahidol University	Student research in informatics areas exist.
	Doctor of Philosophy Program in Oral Health Science, Faculty of Dentistry, Thammasat University	Student research in informatics areas exist.

informatics education at the doctoral level, and incorporation of informatics content in the education of health professionals varies greatly. Little local research in the area of informatics education exists. The push for a strengthened informatics workforce is necessary given the exponential growth in the application of informatics and health IT to healthcare. The Thai Medical Informatics Association (TMI) has recently established the Biomedical and Health Informatics Education Special Interest Group which hopes to address some of these issues in the years to come.

Lessons Learned and Future Challenges

All of the countries in the Asia-Pacific will face continued pressure on their healthcare systems resulting from demographic shifts, funding and manpower constraints, improvements in medical technologies and treatments and rising expectations from patients and their families. Health IT and health informatics are seen as key to helping meet some of these challenges but it is clear that the specific needs of healthcare

delivery in the region and the resource constraints in many of the countries mean that local solutions will need to be developed. The Health Informatics education programs discussed above have demonstrated the ability of countries to build up local capacity in health informatics to enable the development of the necessary systems and programs.

There is no doubt that the demand for e-Health and m-Health will only rise throughout the region, and to meet this demand two areas must improve. Firstly, health informatics education programs in the region must be expanded and enhanced. Secondly, regional collaboration should be strengthened. Although the Asia-Pacific Association for Medical Informatics (APAMI) was formed in 1993 to promote health IT [69] more work needs to be done to share and disseminate the work that has already been done in the region to others, especially those countries that are just beginning to address the workforce needs.

Conclusion

Despite the documented benefits, there are still barriers to implement e-Health and one of the most important is the lack of a health IT workforce and the training programs needed to most effectively address the challenges. Although there are different initiatives in different regions and in different countries within the same region, there is still a need to focus on the role of e-Health, health informatics education and capacity building that is critical for improving healthcare quality and efficiency.

There are many opportunities in these regions that offer education in the discipline. In some countries, there are broad and complete dedicated educational programs in health informatics at different levels of education (undergraduate and postgraduate) and for the different healthcare professions (physicians and nurses) that offer specific career paths. In the regions, these programs co-exist with a myriad of offerings that may have some kind of degree, diploma or certificate. Still other countries have not developed successful programs illustrating the disparities in the health informatics training in each of the three regions.

We have reviewed the education experience in three regions that include developing economies, although these regions differ in culture and language they still share the same challenges in the implementation of e-Health. The lack of coordinated projects and “islands” of educational programs and training activities still remain as a barrier, although there is still a need for healthcare practice, education, training, policy and research carried out as a coordinated effort so lessons learned from other experiences worldwide can be leveraged in the efforts carried out locally. The possibility of collaborative partnerships between countries within the same region can improve training opportunities; such partnerships could also work between regions in spite of their cultural differences as globalization continues.

e-health applications are still a promise to improve global health in developing countries. A proper approach to implement e-Health should include needs assessment together with education and formal training opportunities for the healthcare

and health informatics workforce. The local successful experiences could be extended into the region that would be able to scale for a rapid and effective way of dissemination. Such an approach could also promote the creation of academic partnerships and centers of excellence in education and research in developing countries for sustainable capacity building in health informatics.

Key Take-Away Points

- Partnering with existing informatics education programs from other nations such as the U.S. and Europe is a useful approach to start new informatics programs in regions with shortages of informatics educators.
- Programs from outside the region usually have to be adapted to address the local context.
- Educational programs, including informatics education, can often utilize existing telematics/telemedicine/telehealth infrastructure to reach sufficient numbers of participants to make the program viable.
- Collaboration within regions can be an effective way to disseminate successful programs that are tailored to the needs of the region.

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