Determining Health Informatics Workforce Needs in Developing Economies

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Summary

Despite unprecedented advances in science and technology for health in the developed world, the developing economies are increasingly left behind. One way to bring these advances to these economies is through the use of information and communication technology (ICT), also known as eHealth. The reach of ICT, both via Internet access and mobile phones, is increasing substantially[1]. Additional solutions will involve advancing education for workers[2] and building science capacity.[3] Indeed, a number of initiatives in many countries have been undertaken.[4] Some successful programs have involved partnerships with academic centers in developed countries[5].

Part of the solution to advancing ICT for health care in developing economies will be to provide ICT applications and education for their optimal use. There are many questions to answer, and a sub-question to them all is what lessons can be learned from ICT and eHealth in the developed world? Among these questions are:

- What are the profiles (i.e., training, competencies) for the workforce needed to lead eHealth projects?

- What are the valid methods for quantifying workforce needs in developing countries?

- How can we account for and be respectful of variations in local perspectives (culture, language, health care systems, existing resources, etc.) in developing countries?

In developed economies there is increasing evidence that ICT can improve the quality and safety of health care while reducing its cost.[6, 7] There is also growing evidence for the value that a well-trained ICT workforce can offer.[8] A growing number of educational programs are emerging to meet the need to train such individuals, from graduate education[9] to shorter courses, such as the AMIA 10x10 initiative.[10, 11]

Certainly, any approach to assessing the needs for ICT knowledge and workforce development must focus on the needs of different individuals in the health care system of these countries. This includes:

- Citizens/patients – basic health literacy, use of technology for improving health and interacting with health care and public health systems;

- Health care and public health professionals – use of ICT to improve care, interact with citizens/patients, and obtain education;

- Health ICT (informatics) professionals – development, implementation, and evaluation of ICT to improve health, health care, and public health;

- Health leaders and policymakers – optimal decision making for investment and usage of health ICT.

How do we determine the needs and solutions? The process must be data-driven, using existing research capabilities. As needs will likely differ among countries, cultures, and political and economic factors, the solutions may differ by country or region. There must be a meeting of the minds among those familiar with understanding of local health priorities as well as ICT capacity and of those who are familiar with ICT and what solutions have been found to be most effective in these settings. From this will emerge solutions for appropriate ICT implementation and education of stakeholders, including the ICT workforce.

Three areas related to determining health informatics workforce needs in developing economies are discussed: eHealth applications that are most prominent in developing economies and their barriers, including workforce; what is

known about workforce and capacity in developed economies; and a framework for further research and educational program development in this area.

eHealth Applications in Developing Economies

Developing countries have radically different health problems among each other and compared to developed ones. Some of them (such as in sub-Saharan Africa) face the rising crisis of HIV, multidrug-resistant tuberculosis, and malaria, while others have a similar epidemiologic profile to developed countries, where chronic conditions, such as hypertension, diabetes, cardiovascular disease, and cancer are more prevalent. In many of these countries, infant mortality continues to be a challenge.

In order to build eHealth applications, according to the World Health Organization (WHO) Global Observatory for eHealth, there needs to be foundation and enabling policies, such as governance, policy, funding, infrastructure, support of cultural diversity, interoperability, and capacity building.[12] Regardless of the different priorities defined, and foundation and enabling policies each country has developed, resource allocation is always more difficult than in developing economies, and health care information systems have been primarily focused on the need of aggregate statistics for governmental or funding agencies.[13] Despite this, provision of information to the general public and to health care providers is growing steadily.[12]

In many instances eHealth applications are developed in order to address country, provincial, or organizational needs, such as in Chile,[14] where there is an ongoing Digital Health Agenda that includes integration platforms, an electronic medical record, a balanced scorecard, and teleconsulting facilities. In other countries such as Nigeria, the launch of eHealth as part of e-Government is described as an integral component in building ICT infrastructure for the health sector. However, other political priorities, insufficient funding, and inadequate technical support pose significant challenges in this country.[12]

Some solutions are developed at the regional level. If we analyze the case of Uruguay, although there are a series of projects addressing country or local needs, there are other systems coming from regional cooperation: for example, the use of the perinatal information system covers almost 100% of births. This system was developed at the Latin American Center for Perinatology (www.clap.ops-oms.org) and is used across Latin America and the Caribbean.[15] Regardless of how well each Latin-American country is performing in perinatal health, there are always opportunities for improvement at the hospital, provincial, or country level that can be detected by this information system. Also, regarding information access, the role of BIREME (www.bireme.org) has been important in Uruguay as well as in the Latin-American region.[16]

ICT has been increasingly integrated into health systems since 2000. According to the WHO, the use of ICT in health is not merely about technology, but is a means to reach a series of desired outcomes across the entire health system. ICT can offer to developing economies an opportunity to introduce many improvements in health service delivery, as well as overall developmental goals that have an impact on health.[17]

The implementation of health ICT in developing economies has been hampered by traditional obstacles: poor infrastructure, lack of resources, and insufficient political commitment and support. This can be summarized as the "Four Cs:" connectivity, cost, capacity, and culture.[18] This implies that in the developing economies, ICT still has not reached its full potential because there is not an enabling environment that promotes eHealth through means of policies and implementation. As such, the infrastructure needed has not reached completely the health care sector and there is a lack of knowledge and skills in the workforce.

A recent report from the WHO describes that there is a relationship determined between eHealth and country income groups, and this is shown by the relationship that high- and upper-middle-income groups of countries are more advanced in their eHealth development than those in the lower-middle- and low-income groups.[12] The final conclusion is that the underdeveloped world needs to be supported and stimulated so as not to be left behind in this rapidly emerging age of eHealth.

Since the economic situation in a country can determine its adoption of eHealth, we reviewed five countries from the global south (Chile and Uruguay from Latin America, Nigeria and Zambia from Africa, and Thailand from Southeast Asia) and compare them to the United States on the following indicators (Table 1):

- Gross Domestic Product (GDP) in US$[19]

- Expenditure on health care as percentage of GDP[20]
- Expenditure on health care in US$[20]
- Per capita total expenditure on health care US$[20]
- Internet users per 100 people[19]

Table 1 - Indicators from five countries from selected developing economies and the United States.

Country	GDP in million U.S.$ (2005)	Expenditure on health care as percentage of GDP (2005)	Expenditure on health care in million U.S.$ (2005)	Per capita total expenditure on health care U.S.$ (2005)	Internet users per 100 people (2005)
Chile	118,908	5.4	6,421	397	28
Nigeria	98,565	3.9	3,844	27	4
Thailand	176,222	3.5	6,167	98	12
United States	12,397,900	15.2	1,884,480	6350	67
Uruguay	16,615	8.1	1,345	404	20
Zambia	7,271	5.6	407	36	3

ICT has been touted as a cost-saving solution in health care and the general recommendation is that 1%-3% of a budget should be devoted to this area. As shown in Table 1, developing economies have between 15 and 235 times less expenditure per capita devoted to healthcare in comparison with the United States.

In developing economies, there are constraints for the implementation of ICT in healthcare, including the cost of providing access to the less privileged having in mind that is not possible to provide access to all the population, this is shown by the fact that 20 of the world's largest developing nations contribute only about 27% to the global IT market of U.S. $750 billion and less than 5% of the world's population is connected to the Internet. Another issue to bear in mind is that the cost of implementing ICT is not only about the software and hardware needed but the infrastructure and human resources needed for the long-term maintenance of these projects.

In order to improve health care delivery in developing countries, there is a bigger need for equitable distribution of available resources to all areas of the health system than there is for technology. This makes it difficult for the governments of developing countries to determine their investment priorities, because health care in developing countries aims to privilege health care priorities with demonstrated high cost-effectiveness. The low budget available per person devoted to health care determines that in order to take advantage of the "cost opportunity" for some decision makers, ICT is not a priority in the choice. We have to consider that in low-income scenarios with fewer resources, the creation of information systems that facilitate the planning of the health care system can give a differential value to demonstrate the impact of applications.

Characteristics of Health Care Organizations and the Implementation of ICT

Health care organizations have been classified by Henry Mintzberg as "professional bureaucracies" that are characterized for the particular service they provide, where two cultures with different perspectives and professional competencies coexist and are not always aligned: one coming from clinical function, and the other from the business and support functions.

In the developed world the main focus has been put on the business process. This perspective has brought along many difficulties when trying to improve efficiency and quality, because the clinical process was not correctly taken into account. On one side, health care professionals are well aware of the "product" that is being provided and the most efficient way of doing it. These professionals usually work with an individual point of view and with autonomy in decision making, similarly to the way they handle their patients. The structure of work process in the health industry is based on handoffs from professional to professional. On the other side, administrative management professionals have a similar culture to others working in economic settings. These professionals seek ways to improve quality and efficiency but sometimes find barriers because many decisions are decided in the clinical arena. This situation tends to be worse when the project of the health information system (HIS) is confused with the ICT project and the business project. There is a need to find a relationship between clinical and business strategies so as to define how ICT will be used in health care organizations.

In the past, and especially in developed countries, health care organizations have pursued narrowly defined ICT strategies, mainly

focusing on the business functions and administrative tasks. This has resulted in the implementation of technology without consideration of the need to change the clinical process. The ICT systems that were developed for that objective had a logic and vocabulary based on these functions. In comparison with the administrative area, the clinical area had a later development of information systems, and this can be attributed to an increased complexity of the task and the tradition and culture of health care professionals to resist standardized information architecture. The application of information to clinical processes was developed by medical informatics. These applications helped through the creation of standard vocabularies and integrated databases.

The strategic organization planning must include a HIS plan that includes the business plan and the clinical information system, and both of them must be aligned with the strategic planning of the health system. HIS can be the result of the union of three components: information systems (IS), ICT, and information management (IM). IS refers to the entire information structure, and it includes the personnel, processes, and objects used to record and store patient information. ICT refers to the hardware and software used to perform specific functions. Finally, IM refers to the use of information and knowledge for different needs. The strategy of HIS defines the specific tasks that IS and ICT need to perform and how the applications should be managed.

Information strategy should be created after a thorough enterprise analysis, where HIS can support or enhance the current clinical, business, and support practices. Health informatics provides very important tools because it can understand and help with the integration of the clinical area with the business area. In other words, the HIS is the result of the combination of both areas through strategic planning. A health care organization's information strategy will define how communication and interaction will occur for goals and objectives to be accomplished, and it will assign responsibilities to IS, ICT, and IM components. The correct definition of the organizational strategy, including both clinical and administrative functions, will define the HIS.

In developing economies the slow acceptance of ICT by HIS should be seen as an advantage, and the knowledge acquired from the experiences in the developed world should be used in order to define a more efficient and better degree of acceptance. Maybe the most appropriate for each health care organization, region, or country would

be to have strategic planning of the health system and based on it define a business plan and clinical information system for the creation of a HIS that concurs with the strategy. For this task there is a need to generate and prepare human resources in IS, ICT, and IM for the success of the project.

What We Know About HIT Workforce in the Developed World

Despite the growing adoption of health information technology (HIT) in the developed world, there are still barriers to its optimal use. These include a mismatch of return on investment between those who pay and those who benefit, challenges to workflow in clinical settings, lack of standards and interoperability, and concerns about privacy and confidentiality.[21, 22] Another barrier, less publicized but increasingly recognized, is the lack of characterization of the workforce and its training needed to most effectively implement HIT systems.[9, 23, 24] Most research assessing the HIT workforce has looked only at specific settings or professional groups.

The most comprehensive assessments of the HIT workforce was carried out in England.[25] This analysis estimated the employment of 25,000 full-time equivalents (FTEs) out of 1.3 million workers in National Health Service (NHS). This equated to the employment of about one information technology (IT) staff per 52 non-IT workers. The workers were found to be distributed among information and communication technology staff (37%), health records staff (26%), information management staff (18%), knowledge management staff (9%), senior managers (7%), and clinical informatics staff (3%).

Studies done in the United States (US) have generally focused on one group in the workforce, such as IT or health information management (HIM) professionals. For IT staff, Gartner Research assessed IT staff in integrated delivery systems of varying size.[26] Among 85 such organizations studied, there was a consistent finding of about one IT staff per 56 non-IT employees, which was similar to the ratio noted above in England. The major roles for IT staff were listed as programmer/analyst (51%), support (28%), telecommunications (16%).

More recently, Hersh and Wright used the HIMSS Analytics Database (derived from the Dorenfest IDHS+ Database™, http://www.himssanalytics.com) to analyze hospital IT staff. This database contains self-reported data from about 5,000 US hospitals,

including elements such as number of beds, total staff FTE, total IT FTE (as well as broken down by major IT job categories), applications, and the vendors used for those applications. A recent addition to the HIMSS Analytics Database is the EMR Adoption Model™, which scores hospitals on eight stages to creating a paperless record environment[27] (see Figure 1). "Advanced" HIT is generally assumed to be Stage 4, which includes computerized physician order entry (CPOE) and other forms of clinical decision support that have been shown to be associated with improvements in the quality and safety of health care.[6]

Hersh and Wright found the overall IT staffing ratio to be 0.142 IT FTE per hospital bed. Extrapolating to all hospitals beds in the United States, this suggests a total current hospital IT workforce size of 108,390 FTE. They also found that average IT staffing ratios varied based on an EMR Adoption Model score. Figure 1 shows the average staffing ratio for each of the stages (there are currently no hospitals in the United States at adoption Stage 7). Average staffing ratios generally increased with adoption score, but hospitals at Stage 4 had a higher average staffing ratio than hospitals at Stages 5 or 6. If all hospitals in the US were operating at the same staffing ratios as Stage 6 hospitals (0.196 IT FTE per bed), a total of 149,174 IT FTE would be needed to provide coverage – an increase of 40,784 FTE.

Also assessed have been HIM professionals, finding that the primary work setting for these individuals was hospital inpatient (53.4%), hospital outpatient (7.8%), physician office/clinic (7.2%), and consulting firm (4.2%).[28] For those

involved in electronic health record (EHR) implementation, two-thirds were on the planning team and half were on implementation team. Study respondents indicated that the largest need for more education was in the areas of IT, legal and regulatory issues, reimbursement methodologies, and health care information systems.

No studies have quantified numbers of biomedical informatics (BMI) professionals, although some studies have qualitatively assessed certain types, such as Chief Medical Information Officers.[29, 30] The value of BMI professionals is also hinted at in the context of studies showing flawed implementations of HIT leading to adverse clinical outcomes,[31] which may have been preventable with application of known best practices from informatics,[32] and other analyses showing that most of the benefits from HIT have been limited to small numbers of institutions with highly advanced informatics programs[6]. Others have documented the importance of "special people" in successful HIT implementations.[33]

One additional workforce study has focused on a specific HIT application, estimating the workforce necessary to deploy a Nationwide Health Information Network (NHIN) in the U.S.[34] For a five-year implementation time frame, there would be an estimated need for 7,600 FTEs for installation of EHRs for 400,000 practicing physicians who do not currently have them, 28,600 FTEs for the 4,000 hospitals that do not have EHRs, and 420 FTEs to implement the infrastructure to connect the network.

Stage 7	Medical record fully electronic; CDO able to contribute to EHR as byproduct of EMR
Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), full R-PACS
Stage 5	Closed loop medication administration
Stage 4	CPOE, CDSS (clinical protocols)
Stage 3	Clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology
Stage 2	CDR, CMV, CDSS inference engine, may have Document Imaging
Stage 1	Ancillaries – Lab, Rad, Pharmacy – All Installed
Stage 0	All Three Ancillaries Not Installed

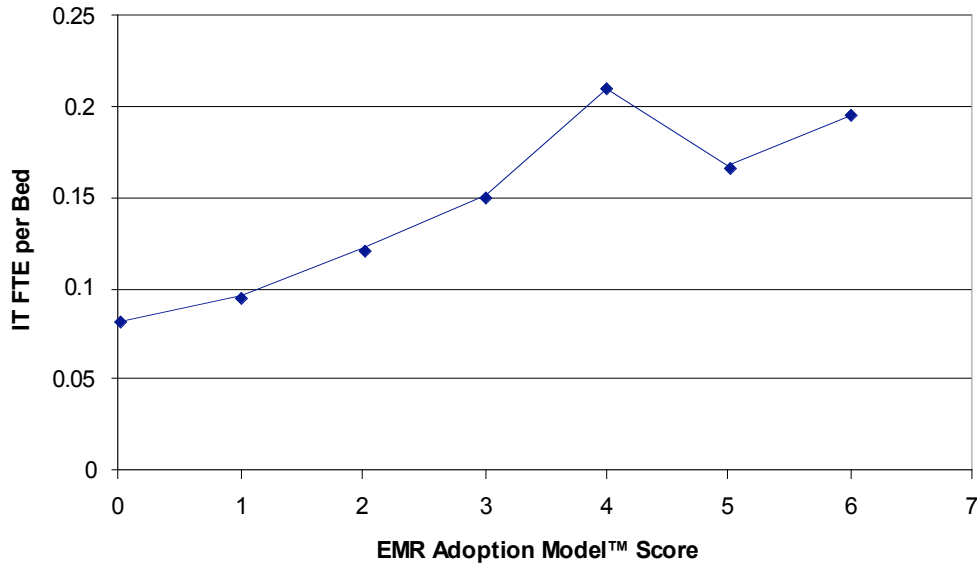**Figure 1** – Description of stages for the EMR Adoption Model.[27]

Figure 2 – IT FTE per Bed vs. EMR Adoption.

Even in the developed world, it is essential to have a more concerted research agenda to better characterize the HIT workforce and its job roles, required competencies, and optimal education. This will not only help HIT leaders implement systems better, but also assist educational programs in determining the best curricula for students training to fill these roles. A major component of this research agenda must include further elaboration of the role of BMI professionals in the success of HIT implementations. It is also imperative for policymakers to address issues of planning and funding for this important barrier to more widespread adoption of HIT.

Framework and Recommendations for Further Research and Educational Program Development

The understanding of health informatics workforce needs in any setting is a challenging task. To understand the needs of a country, or of developing economies in general, is daunting. How can we develop a framework for understanding the workforce and characterizing how to educate and train it? In this section, we develop a framework, with the recognition that gathering the requisite data would be both costly and time-consuming. The likely best approach to moving forward would be highly targeted sampling of specific countries and eHealth applications. We then provide recommendations for moving forward.

The first step in understanding workforce needs is to catalog the types of eHealth applications used in specific countries. In developing economies, this might include basic electronic medical records and telehealth applications. To understand the workforce currently used as well as that ideally required, it would be necessary to visit representative locations where the applications are used. The first type of data will be purely quantitative, such as the size of each organization, its "product" (e.g., health care, public health, commercial software), and its customer base (e.g., patients, the public, purchasers of software). In the case of the hospitals, we would also need to assess the number of patients, number of beds, and other health care measures.

The next step would be to gather data on the sites' HIT organizations. This would not only include the formal organization, but also all who play any sort of role in the provision or support of information or its systems. For example, we would include such individuals as HIM professionals and librarians as well as any clinicians who are involved in HIT support.

The data collection would need to include not only people but also descriptions of their roles. We would need access to organizational charts and would gather data on the individuals within them, such as job responsibilities, level of education, perceived shortcomings of their education, and career pathways. Additional

needs include a discussion with HIT leaders of such organizations about their anticipated future needs for IT applications and gathering data on the types of workers and their desired qualifications.

Of course, gathering research data is not enough. Once we have a good picture of the types of eHealth applications used and workforce to implement required, we will need to develop a plan of action. How can we operationalize this? No single country or region can act alone, nor should they, since standardizing approaches across them will allow achievement of economies of scale as well as sharing of resources and expertise. As such, we recommend the development of partnerships under the aegis of international organizations, such as the International Medical Informatics Association and its Working Group on Education. This should lead to partnerships, not only between developed and developing economies, but also among developing economies. An example of the former is the translation of an in-depth on-line introductory course in biomedical informatics from English into Spanish and its delivery to several hundred individuals across Latin America.[11] An instance of the latter, collaboration between two developing economies, is the participation of around 40 professionals from Uruguay in site visits to Argentinean implementations of clinical information systems, and in courses delivered online by Argentinean experts, as one element of the training strategy for a countrywide implementation of clinical information systems in Uruguay.[35]

Throughout the development of research and educational projects, we will need to remain cognizant of our broader goals and how to achieve them. As we collect data, we will also need to brainstorm on ideas for developing instruments that would allow assessment HIT workforce characteristics and needs of a much larger number of health-related organization. A final step will be fostering the establishment of academic partnerships and centers of excellence in eHealth education and research in developing countries as a critical path for sustainable capacity building, in accordance with local needs.

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