Hospital and Health Information Systems — Current Perspectives
Contribution of the IMIA Health Information Systems Working Group

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Summary

Objective: To celebrate over 30 years of health information systems' (HIS) evolution by bringing together pioneers in the field, members of the next generation of leaders, and government officials from several developing nations in Africa to discuss the past, present, and future of HISs.

Methods: Participants gathered in Le Franschhoek, South Africa for a 2 ½ day working conference consisting of scientific presentations followed by several concurrent breakout sessions. A small writing group prepared draft statements representing their positions on various topics of discussion which were circulated and revised by the entire group.

Results: Many new tools, techniques and technologies were described and discussed in great detail. Interestingly, all of the key themes identified in the first HIS meeting held over 30 years ago are still of vital importance today: Patient Centered design, Clinical User Support, Real-time Education, Human-computer Factors and Measuring Clinical User Performance, Meaningful use.

Conclusions: As we continue to work to develop next-generation HISs, we must remember the lessons of the past as we strive to develop the solutions for tomorrow.

Keywords

Hospital information system, medical informatics; nursing informatics, public health informatics, computers

Introduction

In 1979, the first HIS working conference was held in Capetown South Africa. As a result of that conference the International Medical Informatics Association (IMIA) created a working group on hospital information systems (HIS). That working group organized a series of working conferences (*Nijmegen, Gottingen, Durham, Heidelberg, Oeiras)* of which the proceedings have been published.

Just before Medinfo 2010, from September 10-12, the HIS WG organized a conference in conjunction with Medinfo to address the topic of health information systems, past and future. Bringing together the pioneers and new talents to pave the way to the future, merging visions of yesterday and of tomorrow, is a unique opportunity to address the challenges of the future with the wisdom and experience of the past.

This most recent conference was held in Franschhoek, near Capetown under the organizational leadership of John Tresling and his team, and the Program committee, co-chaired by Ab Bakker and Christian Lovis and their committee. This paper is a short summary of the working conference presentations, in order to share our findings, more than 30 years after the first working conference In a sense, we have come full circle, back to South Africa: HEALTH INFORMATION SYSTEMS: 30 YEARS OF EVOLUTION.

Back to the Future

In 1979, the first IMIA Working Conference on HIS identified five key elements for clinical systems: Patient Centered, Clinical User Support, Real-time Education, Human-computer Factors and Measuring Clinical User Performance [1]. Nearly 20 years later, the Institute of Medicine (IOM) issued its report that stated "to improve quality in health care, health care professionals (HCP) need to interact effectively and efficiently with the health IT systems" [2]. Now, over 30 years after the original HIS meeting, with few exceptions such as the physicians in Finland,

most health professionals still do not use available health IT systems, because, in some cases, those systems fail to offer clear added-value. The recent USA's National Academy of Science study concluded that the current health IT efforts may actually set back the vision of 21st century health care [3].

To meet the key elements so well stated in the first HIS Working Conference, we believe that a cognitive support system must be established where clinicians and patients make their decisions, most importantly at the point of care (POC). This Smarter POC system:

- knows and uses your context; where you are, what patient you are seeing, what set of tasks you need to perform – based on locally relevant outcomes and measures;
- supports all the coordination and scheduling tasks that you and staff must 'orchestrate' for your patients;
- is customized based upon what you enter, what you need to see and what you do - to closely replicate patterns of reasoning.

The Smarter POC system described below has other key attributes, namely:

- It anticipates the clinician's needs -

has data, information and knowledge before you need it;

- It understands your context-dependent workflow;
- It hides all the complexity of underlying health IT systems with simplicity ('magical' IT).

The fusion of efficient, best clinical practices and patient information at the point of care will directly support improved quality of care, and produce cost savings that have not been realized by current health IT systems. "Savings" and "improved quality of care" can never be realized if clinicians will not or cannot enter the data.

A conceptual architecture for this Smarter POC system has been described [3], which has three main components. The *Context / Task Manager* monitors its user's activity to determine context, uses models of user's tasks and current/expected context to anticipate activities, tasks and data/information that will be required to support the user's activities. An *Information Broker* (IB) component serves as the data/information cache and the connection point to external systems. It also has a suite of analytic engines that monitor

the efficacy and efficiency of user and system tasks versus clinical and system outcomes to continuously enhance best practices and system performance. A *User Interface Manager* component presents relevant data, information and medical knowledge to clinicians and gathers data from them in an unobtrusive manner.

The built-in business intelligence and analytic tools provide clinicians and managers with the "*What's Been Done*" view versus the "*What Should be Done*" view, based on context and outcomes. This near real-time feedback loop simultaneously provides analyses for informed decisions about: what is best for "my" patients; what is best for our community, our state and our nation (population-level); and best practices. The Smarter POC system enables a clinician-specific and continuously-adapting practice. Thus, the Smarter POC system enables a continuous feedback of outcomes, cost and benefit directly to the point of care - where treatment decisions are made by the clinician and the health care consumer.

Hospitals – the Moving Target

HIS have been installed since the early 1960's to serve traditional hospital environments. One needs to remember that at that time, the hospital system, its structures, and functions, as well as its health professionals, had been driven mainly by the evolution of scientific medicine at the end of the 19th century. Still today, most university cities keep their first "hospital campus" – typically built in brick in Pavilion style. The teaching hospitals became domes of medicine – with famous examples like the old building of the Johns Hopkins Campus in Baltimore, with a statue of Christ blessing the visitors.

The dominating role of hospitals fell at the WHO conference of Alma Ata 1978 (Declaration of Alma-Ata, International Conference on Primary Health Care, Alma-Ata, USSR, 6-12 September 1978), when the focus shifted to
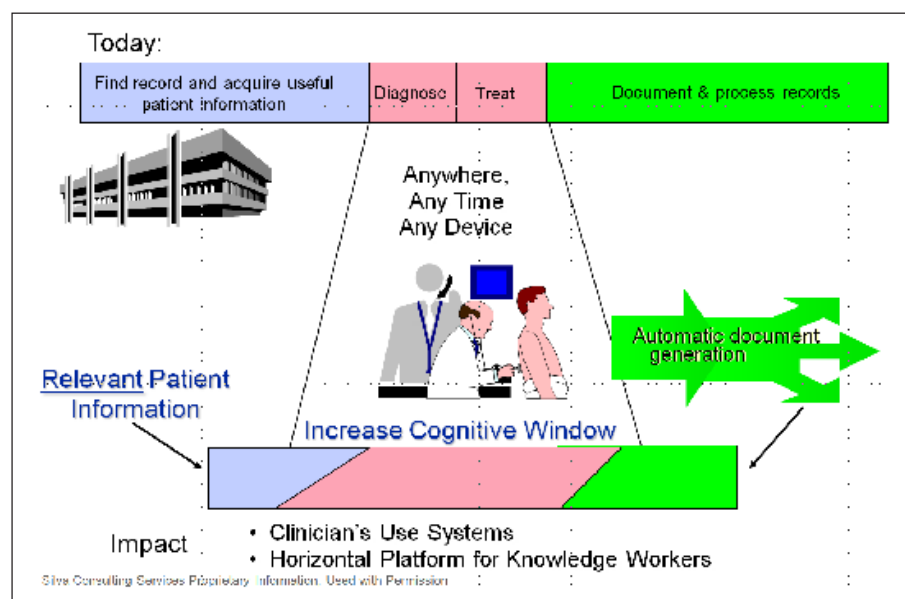

Fig. 1 Changing how clinicians work

ambulatory care. Since then, many hospitals have faced physical size reductions (for example, the huge hospital institutions in the southern hemisphere (e.g. Groote Schuur Hospital, Cape Town; Hospital das Clínicas, São Paolo). The introduction of DRG (Diagnostically Related Groups) billing systems accelerated this process.

Since that time many different ambulatory systems and structures have been established internationally, some of which wereoptimized around the principlesof "managed care", others focusing on health staff development, by introducing new concepts of health professionals. At the same time, the quality of the ambulatory system has been improved so much that the need for hospitals is further diminishing (as in Denmark).

In the new decade, another development was born: the home of the citizen or patient is developed to the "third health center", besides ambulatory and inpatient care (e.g. Session on this issue at the Atlantic Economic Conference, Athens, March 2011).

In the process, the focus of health management slowly reemerges in the form of a widely distributed infrastructure, far away from the domes of more than a hundred years ago.

The international success of the early HIS solutions was rooted in the simplicity of the processes at that time (e.g. Stockholm County System, exported to many places – also to Groote Schuur and Hospital das Clínicas in the 1970s). At the end of the 1970's, the next generation of HIS used a different software technology and was much more adaptable to the changing needs of hospitals (e.g. SMS, firstly in Europe at the Mater Misericordiae Hospital, Dublin).The latter stemmed from a massive sub-specialisation, which started in the 1960's, and in the interim has reached such a degree that even the huge teaching hospitals are currently focusing on subsets of the possible treatment spectrum.

The traditional hospital systems have lost their application target. At the HIS conference in Franschhoek it became

apparent that most of the systems currently installed do not support modern process-oriented care and knowledge driven decision-support. Industry has started to undergo a profound change in concepts and architectures underlying HIS in order to support highly heterogeneous needs and requirements in a very fast evolving field. As a consequence, HIS system development, as well as system management, have become a nightmare to industry, hospital managers, and CIOs. It has become extremely difficult to run current HIS as cost-efficient infrastructures in the hospital environment. The landscape is too fragmented for simple solutions, and ambulatory and home services often require linking and information management via personalized super-institutional health records (see Section "Adaptable health information services for transformation of health services").

If we look into the future, it may well be that the business case of HIS will be a different one. HIS will simply focus on institutional management, while patient-oriented health systems will manage the promotion, prevention, care, and rehabilitation processes in an individualized health world. It is expected that the next decade will see the first software solutions for such environments.

Architectures: Why It Matters

Hospital information systems are progressively extending their coverage in all parts of the hospitals:
- Increasingly complex clinical information systems (CIS), with extended functionalities for each type of use and care provider;
- Support for process-oriented care, workflows and complex decision-support;
- Complete informational integration of all needs: logistics of care, including supplies, human resources, technical resources; billing; clini-

cal research; public health;
- Institution-wide management of resources and optimized planning;
- Proactive clinical and administrative management, based on real-time whiteboards and predictive systems;
- Collaborative care, across intra-hospital boundaries and beyond hospital walls;
- New types of services to customers and patients, such as patient portals and access to patient record, reminders, added-value services, decision support;
- Connection with other care providers; with mobile health, ambient assisted living, and more.

This evolution brings monolithic, proprietary and non-interoperable systems to its knees, despite the seemingly easy procurement tradition of such systems. The industry is slowly turning to highly componentized products, using service oriented architectures. Componentization is broaching what was often considered to be monolithic sub-systems, such as computerized order entry or nursing documentation systems. Thus, several components are required to build a CPOE, and thereby allow greater flexibility. This approach may lead to circumstances in which developers concentrate on small, highly efficient components, which can be assembled to create complete clinical or HIS "à la carte" [4, 5, 6]. The usual problem in the HIS market is that numerous adaptations are required to comply with specific needs, thus making old-fashioned monolithic approaches complex and expensive to maintain. Migration to flexible, highly interoperable components and IT services will lead to the creation of a new market. This marketplace will become highly flexible and adaptable, with higher rates of adoption, and with cost-efficient maintenance and development. However, this implies clear and strong architectures; it also requires the extended use of interoperability standards, including semantics [7]. Furthermore, such

marketplace increases governance requirements on local level and requires strict enforcement of contracts and architectural rules for each hospital or healthcare network.

Governance and Economics

A HIS is not a project with an end. It starts, but then implicitly continues forever. Successful deployments require strong leadership at the highest level of governance, usually through the existence or creation of a "Chief Medical Information Officer". Information management is crucial for the institution. In order to improve patient safety, efficient processes must be able to answer to the increasing economic pressures and competitive markets. It has been estimated that investment in the domain should stabilize around 5% of the overall budget and on the long-term. Current literature shows that there is a clear return-on-investment when the HIS is a high level system (according to HIMSS EMRAM staging), but that satisfactory return on investment occurs only after 5-10 years [8]. So, one can say a) strong governance and b) clinical leadership, c) long-term investment ind) highly inter-operable systems are key factors for success [9]. In addition, most studies show that many hospitals underestimate the needs for internal resources, such as parameterization, consensus building, and change management.

One of the most important challenges is to get a strong understanding of leadership of the importance of clinical information management, at the cornerstone of the care delivery industry. The high complexity of clinical information management, from system architecture to semantic interoperability; from culture change to human factors; from direct investments to patient outcome; from supply chain management to billing; requires strong competencies and leadership.

Nursing Informatics and HIS: Value Resources to Enhance Care Delivery

Nursing Informatics science and practice integratenursing, its information and knowledge and their management with information and communication technologies (ICT) to promote the health care of people, families and communities worldwide(www.imiani.org).

The advent of ICT inthe nursing profession has brought resources to innovate, improve, and redesign the way nursing care is provided. The decision for planning and delivering nursing care is always based on the available information about what is needed to support the patient care. The more specific information available to sustain clinical decisions, the better care can be delivered to the patient/client. Consequently, information systems are fundamental tools to sustain clinical decisions, in order to provide better care to the patient/client {10, 11, 12].

Nurses have been at the forefront of implementing information systems within hospitals and clinical practices to ensure that the software programs are fully integrated into nursing workflows [2]. However, a major issue facing nursing is that some information systems appear to require more complicated entry processes, and that these processes detract from direct patient care. It has been estimated that one medical prescription generates twenty nursing actions; ICT must be interactive, easy touse and not bring more work to the care settings.

The nature of changes on the healthcare systems require that nurses and allied professionals be prepared for leading and managing, either the redesign ofnursing care delivery or the assumption of new roles and positions at the global health sector [3]. Technology adoption is a process not a product. If integration is not considered as a fundamental aspect of the initial design the end product will be complicated and not a useable solution. Integration among systems also depends on the integration among health care professionals, and between providers and patients.

Considering that: (a) there is no adequate and sufficiently comprehensive solution to cover all nursing needs for ICT; (b) more innovative solutions are required to address complex problems of nursing care delivery; (c) nurses must participate on changing process, providing expertise, and knowledge to the planning, managing, education and care delivery; (d) sharing knowledge, experiences and information is a faster manner to achieve solutions and insight strategies for investments and resources applications, some suggestions are:

- Nurses must be involved in the planning, design, selection or development, implementation, and evaluation of any health care application that will be in their environment;
- Support selecting systems that fit the workflow of nurses. Thus, information systems must not require nurses to adapt their workflow to the system;
- When evaluating an information system, select a system that can be customized to the practice of nursing in the environment. Without this you will not be able to make changes that are needed for better patient care;
- Nurses are the primary educators of patients worldwide and they are the translators of information and knowledge from the health care system or from the internet to consumers. This role will only continue to grow in the future;
- Select systems that have a behavioral component. It means: selecting a system that presents information in an easy way to understand and an easy manner to deal with.

All ICT resources currently developed, as the main goal, must provide humanized care that means to be connected, engaged and integrated enough to the patient to establish real bonds that can give better indication to translate patient's expression into information to better design nursing care delivery.

Evaluation of Healthcare Information Systems

Lessons from the Past

Evaluation of HIS has been discussed at various workshops in the last decade. In 2002 evaluation was discussed during the HIS working conference in Heidelberg [13]. In 2003, a workshop specifically dedicated to evaluation of HIS was held in Innsbruck. This workshop developed the "Declaration of Innsbruck", stressing that evaluation of IT interventions in health care require the same rigor as any other intervention in healthcare [14]. As a result of this workshop the IMIA and EFMI working groups have developed guidelines for reporting of evaluation studies in health informatics (STARE-HI, adopted as an official document of IMIA) [15] and are working on guidelines for good evaluation practice in health informatics (GEP-HI) [16].

During the Franschhoek workshop it became apparent that evaluation tends to be consumed by the academic HIS community and not by healthcare decision makers. It seems that there is a disconnect between what is known about HIS from evaluation studies and what is done in practice. There seems to be no evidence-based decision making with respect to the procurement, implementation and use of HIS in clinical practice.

The Agenda for the Next Decade

During the discussions at Franschhoek the following topics emerged for future activities and developments:

- Implementation of a HIS is not a daily activity. Managers may implement a HIS only once or twice in their professional career. Hence there is a need to make results of evaluation studies of implementations available for the various stakeholders beyond academia as to share the experience and to develop good implementation practice that can be applied in practice;

- Attention should be paid to the development of HIS that support their evaluation. A HIS should provide details about the interaction of the user and the system as to support the evaluation of the usage, short cuts, bad practice, shortcomings etc.
- New evaluation approaches are needed to address emerging technologies like social networks and the semantic web. Also the new European Medical Device Directive requires that systems are evaluated to demonstrate that they do not compromise patient safety. A platform is needed to promote the exchange and development of these new evaluation methodologies.

Does Computerization Lead to Harmful Incidents?

With the increasing penetration of computerization in healthcare, there are also increasing reports of incidents [17, 18]. The problems found and reported can be grouped in the following domains:

- Technical aspects, such as bugs, or data loss, downtimes, and more. These address reliability, integrity, performance and availability of both the infrastructure and the software;
- Interoperability, that is the ability of various subsystems to exchange information in a meaningful manner to support higher order processes;
- Governance, such as means for care providers education; deployment strategy, overall leadership of the project, including change management;
- System knowledge, that is the creation and the management of the knowledge in the system. This includes acquisition forms, decision-support, order sets, etc.

However, there are strong arguments to state that providing strong clinical leadership, with a good technical environ-

ment and specific adaptation of systems, order sets and knowledge to meet the local requirements does lead to a reduction of harmful incidents [19]. Unfortunately, the introduction of CIS is too often seen as an IT project, and the need for clinical specialists (physicians, nurses, etc.) trained in medical informatics and clinical informatics is under-estimated. A good regulation framework, spanning education and the required competences on the user side, as well as reliability, interoperability and integrity on the technical side are needed to increase the safety of the global process of information technologies in healthcare.

HIS Solutions for eQuality Monitoring

Healthcare quality is an important issue worldwide. The deployment of fully automated electronic quality monitoring systems (*e*Quality) is one promising method for improving the value of healthcare [20, 21]. This requires clinical data from electronic health records, which traditionally have contained a small proportion of fixed field data (often obtained from pick lists) and larger quantities of free text [22]. Some EHRs only store images of handwritten or typed notes (e.g. faxed in data). These practices have made it difficult to extract and use electronic health record data for secondary purposes [23]. The iNLP system, which has a recall of 99.7% and a precision of 99.8% for clinical problems, was expanded from supporting only English to also supporting French language clinical records [23]. Multi-lingual intelligent natural language processing has the potential to make interoperable records from disparate regions and cultures. In a recent French-English study of such a natural language processor, we found an initial agreement of 72.2%, which shows promise for this lofty goal. Our study shows that multi-

lingual natural language processing is feasible and can lead to promising results. Improvements to synonymy and the translation of the EHR would lead to greater specification of common problem statements.

These purposes can be categorized into assistance with the practice of medicine, research and education. The practice of medicine can employ EHR knowledge at the point of care in the form of alerts and expert advice for the clinician, the patient or their family (care givers). Ideally these systems could learn from the outcomes associated with the population of patients cared for by a given provider. Research stands to gain substantially by employing EHR data for secondary uses. These can and will range from more intelligent study design where the impact on recruitment can be tested as we add additional criteria to either the inclusion or exclusion criteria for the study.

In the future, we will employ data-driven recruitment that will assure that a much higher percentage of participants screened for recruitment to a clinical trial will qualify for that trial. For retrospective trials, we will be able to produce fully automated studies and complete trials in minutes rather than years. For prospective studies, we will be able to track a much broader set of clinical outcomes and more cost-effective solutions.For education, real time learning systems will be updated with the results of clinical practice and based on best outcomes and will be able to educate all physicians in a practice area with information learned from anyone's practice. This continuous learning environment will advance the quality of practice available to all patients.

In order for this dream to become a reality, systems require a common data infrastructure in which all clinical data is represented. This first requires defining the formalism, and then requires a method for encoding the clinical data recorded during the normal clinical care workflow into this common representation schema. To be usable, the formalism must represent the data at the

same level of granularity as is recorded in routine clinical practice.

Hospital Information Systems must be learning environments in which the knowledge gained from each case is recorded, analyzed, shared and utilized internally, nationally and internationally to improve all patient care. We live in a global civil society and we must strive to improve the health of people worldwide.

The Importance of Community-Level Interoperability in Hospital Information Systems

During the last decades, the provision of healthcare services has increased its fragmentation across space, time and specialty boundaries. Services that were once provided by a single physician are now often managed by an ever-increasing number of specialists. Too often, this is a scenario requiring coordination which is not always successful. Likewise, the shift from the in-patient hospital setting to the outpatient ambulatory care setting, while providing medical and economic advantages, has also contributed to widening the communication gap between providers caring for one given patient. Paradoxically, in our modern connected world, patients or their next of kin often serve as information intermediaries amongst healthcare providers. Finally, the multiplication of specialties and subspecialties adds to the confusion as each of them often come with their own terminologies, informational structures and professional standards.

One conclusion that has clearly emerged from the IMIA Working Conference on HIS meeting in Le Franschhoek is the lack of substantial progress in the realm of HIS. As noted by Silva and Ball in their opening review, most of the problems afflicting HIS in 1979 still persist in 2010. An excessive focus on intra-hospital connectivity, as opposed to the more real-

istic scenario of healthcare provision across wide spatial, temporal and professional boundaries which exceed the single hospital may well be one of the causes of this lack of progress, and future design of HIS should probably consider this issue with greater attention. While the world is becoming increasingly networked at an astounding speed, such networks are physical rather than conceptual. Installed HIS are still centered on single hospitals or healthcare providing corporations, and transfers of complete medical records between providers remain few and far between.

Aside from security restraints, which sometimes become so stringent that they end up by hindering the possibility of transfer, HIS developers and providers have not adopted common standards of terminology and information structures. In that sense, the approach adopted by the medical imaging industry with DICOM is an example to be followed, and hopefully the HIS industry will follow suit through widespread adoption of openEHR or similar approaches.

The science of economics has taught us the importance of *network externalities*, also known as the *network effect*, the basic notion of which is the desirability to choose systems widely used by others. Whereas it is probably not possible (nor desirable) to have a sole provider of HIS in any given community, network externalities may be achieved by standardization. Extended adoption of common standards guarantee minimum levels of quality and safety (by setting them and making them compulsory), reduces exploratory costs and training efforts by reducing the variety of minimally differentiated products, and assure the proper operation of inter-application interfaces by establishing common information models. Thanks to the advent of the Internet and initiatives such as HL7, inter-application communication is now possible. There is still, nevertheless, work to do in the realm of adoption of common conceptual structures. If this goal

is attained, the promise of better healthcare through advanced HIS will then come to being.

Adaptable Health Information Services for Transformation of Health Services

In previous IMIA HIS working conferences in 2002 and 2006, *pathways to open architectures* have been discussed in the context of promoting *adaptability* of Health Information Systems, which is required to support continuous changes in healthcare, and transition of HIS from hospitals to wider context of health information systems. The socio-technical HIS landscape is increasingly facing pressure for rapid adaptation to new medical knowledge, treatments and investigations as well as changing organizational and networked service models. Advances of new technologies as well as suitable features of novel systems development approaches must be combined to support these needs in HIS development within hospitals but above all in healthcare networks.

People-centered (as titled by WHO) and *preventive* healthcare, the increasing need for *quality assurance* and *evidence-based care*, increasing *competition*and *customer choice*as well as new paradigms such as *molecular and genetic computing* are central healthcare trends affecting HIS development [24]. Meaningful *exchange of health information* to support the *continuity of care* across patient journeys through *networked health services [24, 25]*, support for *dynamic workflow systems* in healthcareand large-scale initiatives to support *personal health records [26]* are but some examples of re-thinking the delivery of healthcare services enabled by HISs. Over their lifecycle, such initiatives require *adaptability* from technologies, architectures and development methods [24]. A prominent driver is the transition of the socio-

technical development context *from systems development to services development [27]*. This service approach especially promotes customer needs, evolution and co-production of value by providers and customers which have also been emphasized for the transformation of healthcare. These drivers and trends are also reflected in *development methods* and related academic work which is increasingly published in information systems and service literature in addition to medical informatics.

In this context, the design of HISs has to evolve *from containers of data to the components of socio-technical network [26]*. Trustworthiness, flexibility, governance and traceability require architectural design [24] in addition to user-centered design needed to ensure adoption [26]. These requirements are supported by advances in *model-based* and *services-oriented* systems development [24, 27]. On the other hand, local flexibility and autonomy must be combined with agreement on *standards and semantics* for semantic interoperability and processability [7] (see section *"The importance of community-level interoperability in Hospital Information Systems"*). Combining knowledge of "mainstream" IS research with medical informatics in fields, such as technology-based knowledge management and designing systems as services [27] provide considerable potential for supporting the transformation of healthcare. Knowledge creation, capture, transfer and application applied to clinical processes and for patient-centered knowledge management applications [25] require the development and governance of adaptable and reusable health information services.

Gathering evidence on support for transformation is complicated by the fact that lifecycles of services, architectures, models and development approaches outlive individual projects or applications. As an example, the solutions for ePrescription and eBooking architectures and interfaces, together with personal health information management tools and related certification

requirements must co-exist and be continuously developed in national and local HIS architectures in Finland after the completion of each initial development project.

Approaches such as individual empowerment through personal systems need to be integrated with new incentives and service delivery models [26]. Metrics and key performance indicators for quality measurement of information systems [24] have to be integrated with evaluations throughout different phases of technology life cycle [25]. Thus, further research is needed on flexibility and traceability supported by service- and model-driven approaches throughout the *extended lifecycle of requirements*. Evidence of benefits and best practices, which is also emphasized by service systems approach [27], must be continuously gathered and evaluated by HIS initiatives (see Section *"Evaluation of Healthcare Information Systems"*) to support the successful implementation and adoption of HIS in a given socio-technical context [25].

Translational Strategies for introducing Health IT and Standards into Developing Countries

The introduction of healthcare IT standards into resource-challenged environments is a complicated one. Representatives from developed nations are often eager to deposit their complex, technically-demanding solutions into countries that are ill-suited to manage and maintain those gifts. Often, the capabilities are single-purpose (such as for AIDS epidemiology), and fail to account for the general needs of the population. Such countries are left with technology and infrastructure that they are neither technically able to maintain nor sufficiently staffed to reuse for other healthcare requirements.

Matching healthcare standards and architecture to the business and human requirements of the populace is one effective solution. Nonetheless, providing the technical infrastructure must be preceded by the development of healthcare IT capacity and manpower. In the developed world, we have a sorry history of leaving solutions behind that cannot be maintained or customized to real needs. In addition, for nations with tiny healthcare budgets, the notions of IT requirements are often mismatched with the viewpoint of the government agencies we hope to support.

Typically, we envision IT superhighways in an environment in which most citizens walk. Nonetheless, fundamental demands for the primary capabilities of interoperability and reuse include an architectural framework, as well as standards for transport, structured vocabulary, security (and privacy), and quality and decision support. All of this would be incomplete without the essential metrics to evaluate the efficacy and safety of the system. If all of this were given free of charge, there would still be the needs for implementation, training and maintenance. Most importantly, the technology leadership of the developed world must find the means to train the nation's citizenry to perform these indispensible tasks.

In both developed and economically challenged countries, there is a growing body of evidence that has established the cost-benefit ratios of deploying standards and standardized infrastructure. In particular, this approach reduces implementation times, alleviates some training requirements, decreases maintenance costs, and improves quality. In most well-established environments, this improves healthcare delivery and helps to control the spiral of healthcare expenditures.

At the same time, the leadership has unavoidable policy demands. These must be addressed before technology can be implemented and governance can be established. To provide a reasonable assurance for the success of any stand-ardized system, the leadership must strike a balance between fragmentation and integrated solutions, between realm localization and local development, and between all-at-once installation and Incrementalism. Finally, no approach can be successful without the metrics to evaluate milestones and endpoints, and the critical ability to celebrate small successes.

Like any mission critical project, defects should be identified and gaps recognized and remedied. There is a long and storied legacy of such behavior to help direct any new endeavor. Countless publications have documented the triumphs and the tragedies. We must recognize that when we bring everyone (certainly all of our stakeholders) to the table, we will need a really big table. The changes that we enable must be sustainable and be consistent with the public and policy needs of governments and the people they govern. We must never lose sight of the fact that this process is about the people not about the systems. I am always reminded of the small sign that nonetheless held an important spot in the medical library. It read, "First, do no harm."

ICT to Improve Health in Developing Nations: Is this the Right Solution?

A recurring question arose during discussions of exciting reports of new applications and findings, coupled with thoughtful reminisces of past accomplishments and difficult lessons learned.Participants asked "What is the role of information and communications technology (ICT) research and development (R&D) in improving the health of people in the developing world?"

While the field of ICT R&D has clearly made tremendous strides over the past 30 years, it is equally apparent from recent attempts to evaluate wide-spread ICT adoption efforts on a large scale that we still have much to learn. Slight improvements in widespread healthcare quality and population health, often mediocre at best, raise many questions about the wisdom of the World Health Organization's (WHO) recent admonition regarding universal adoption of our still early, experimental attempts to implement, so-called, "state-of-the-art" ICT within the existing healthcare delivery systems around the world [28].

During the conference we had many discussions regarding the opportunities of the biomedical informatics community to help our colleagues in the developing nations.

1. *Share the scientific literature, our knowledge, and experiences regarding what works, what doesn't, and why.* The combination of PubMed (http://www.pubmed.gov) and its links to freely available, full-text journal articles, coupled with Google Scholar (http://scholar.google.com/), provide an enormous resource for governments and individuals around the world. We must continue to publish our successes, failures, and lessons learned.

2. *Provide basic and advanced informatics education using on-line courses, internships, and visiting professors.* Many US and European universities are making available at least a portion of their informatics curricula via the Internet. iTunes University is also becoming a valuable resource. At Health Level 7, the basic training course is provided through e-technologies and distance learning by live instructors in real time around the world, and one in ten students from emerging nations receive free tuition.

3. *Help with basic infrastructure projects:* for example, clean, running water, sewage removal, medication distribution, and reliable electricity. While clearly beyond the expertise of most informaticians, many of the tools and techniques we

regularly employ (e.g., relational databases, project management tools, knowledge elicitation and management) are transferrable. Most importantly, we must remember that any local resources we consume, be they technical, financial, personnel, or even the time and attention of various governmental agencies and officials, could potentially have been used for another, perhaps more beneficial, purpose.

4. ***Continue to conduct health-related ICT R&D experiments in the developed world.*** These experiments should be small-scale, have clear objectives, and require limited local financial support [29]. In addition, everyone involved (i.e., governments, healthcare workers, and subjects)should be provided with clear, concise, easy to read "informed consent" documents that explain the risks of the experiment, including the costs and what other basic infrastructure projects could have been started with the money.

5. **Identify and develop high-quality, easy to use, ICT with minimal, essential functionality** that can be configured and accessed via the Internet. Such remotely managed systems greatly reduce the need for locally-managed, high reliability data centers as well as the need for highly trained local staff to develop and support the applications and computing infrastructure [30].

Information and communications technology has the potential to transform the healthcare delivery systems of nations around the world by increasing its efficiency, quality and safety and eventually improving the health of all people. Unfortunately, implementing current state of the art technologies within existing complex healthcare delivery systems is filled with significant technical, social, management, and financial challenges [31]. Those interested in helping developing nations improve the quality of the healthcare they deliver with the ultimate goal of improv-

ing the health of their populations should precede with caution.

The Quality of Health Information on the Web: a Challenge for Empowering and Informing Citizens

According to the latest statistics from the Internet World Statistics data 2010, nearly 2 billion people in the world use the Internet and health is one of the topics on which this usage has an important impact. The Pew Internet & American Life Project 2010 report on Health topics affirms that 80% of Internet users in the United States looked for health or medical information in 2010 [32]. In Europe, Kummervold et al have identified the same phenomenon [33]. This represents a positive step towards the empowerment of citizens and patients in the access to health information. However, it also creates important challenges in terms of quality of information, privacy, protection of personal health data and the emergence of a new form of hypochondria, *cyberchondria [34]*.

Health On the Net Foundation (HON), an international Non-Governmental organization, promotes the efficient use of the Internet for health purposes and develops a global solution in response to the challenges posed by the usage of new technologies in the health domain [35]. Within its services HON has developed tools in order to help the public identify trustworthy health information and for health information providers to respect fundamental ethical and quality criteria. These services range from user awareness and education to the elaboration of a quality standard for trustworthy health websites:

- The HONcode of Conduct: a set of quality criteria for the development and content of websites that defines the production process of good qual-

ity health information online;
- The HON certification based on the HONcode: free of charge and available to all; not subject to any conflict of interest.
- User tools to guide users reviewing health websites;
- HON certified search engine: searches in a unique database of health related websites currently certified by HON;
- HON is participating in the development of the next generation of health search engine
- KHRESMOI (Khresmoi.eu) which aims to empower and inform citizens. This project funded by the European Union is focused on multilingual research and the analysis of trustworthy health information on the Internet for the public and health professionals.

HON has certified more than 7,500 websites in 34 languages from 102 countries with the HONcode. In 2007, the *Haute Autorité de Santé* (HAS - French National Health Authority) chose HON to be the official organisation certifying health websites in France [36]. Thus, by March 2011 the French population benefits from a pool of 1,300 trustworthy health information certified websites.

Summary

The 30th anniversary of the first HIS conference, recently held in Franschhoek, near Capetown, South Africa, was a huge success. The juxtaposition of the pioneers of the field with the next generation of informatics leaders, along with governmental representatives of several developing nations, created an exciting and instructive dialog. Although many new techniques and technologies were described, all of the key themes identified in the first HIS meeting are still of vital importance today: Patient Centered design, Clinical User Support,

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Real-time Education, Human-computer Factors and Measuring Clinical User Performance. As we continue to work to develop next-generation CIS, we must remember the lessons of the past as we strive to develop the solutions for tomorrow.

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