Technical Note[1]

International Trends on Hospital Information Systems

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Adoption of Hospital information Systems

1. Information and communication technologies are particularly appropriate in enabling transactional processes carried out by health institutions, care providers, and health programs. ***The imperative for ICT in the health sector is concrete and essentially driven by the operational requirements of healthcare services and organizations***—of which there are many in terms of national models, institutional formats, and governance—all functioning in an environment characterized by shifting demographic, epidemiological, economic, and political determinants. Information systems, communications, and collaborative work have been increasingly employed to support the delivery, accessibility, and quality of ***direct healthcare activities***, the proficient ***operation and management of health organizations***, the ***monitoring and evaluation of operations and outcomes***, and the ***strategic planning of health systems***.

2. Since the ***early 60's***, computer systems were adopted by public, academic, and private healthcare organizations in developed countries for the support of operations. Those led to the progressive ***automation of libraries; business offices; the management of physical assets, stocks, and patient administrative data; instrumentation and diagnostic equipment; and the implementation of departmental systems***, initially in the clinical laboratory and later in many clinical care areas and support services. ***By 2005, 23.9% of physicians were using some form of Electronic Health Record (EHR) in outpatient settings and 5% of hospitals used computerized order systems; in 2008 about 30% of U.S. physicians were using EHR, while the adoption rate was around 60% for Germany and nearly 100% in the U.K., The Netherlands, Australia, and New Zealand***.

3. The ***experience with HIS environments is reasonably good but not excellent***, and true HIS success stories are not common. One of the apparent difficulties is that the ***typical HIS does not regard communication among clinical users as its core mission***, even though repeated studies of information needs and practice patterns show that ***communication is the leading cost in today's health care environment***.

4. ***Older implementations frequently suffer from problems arising from system developed in different platforms acquired from different vendors since an important aspect of HIS is the need for integration***. Often, different hospital departments implemented their own stand-alone legacy proprietary systems that do not communicate with each other, e.g., Clinical Laboratory and Pharmacy systems, areas that were the earliest to adopt

[1] This Technical Note is based on a review of the literature on Hospital Information Systems in developed countries conducted in January 2010.

computerized systems. This led to ***duplicate data kept in separate databases, creating redundant work to enter the data multiple times resulting in errors and inconsistencies due to lack of synchronization***. When a newly deployed system is introduced, e.g., a physician order entry (CPOE) system, it will become much less effective and efficient if it does not communicate electronically with the pharmacy system that would process the medication orders—***redundant data entry*** can be greatly reduced using a well-designed integrated system. Increased efficiency leaves more time for direct care professionals to spend on patient care and ***decreased workload of manual clerical operations***.

5. Healthcare interventions and processes occur in ***complex and segmented markets that include growing client expectations, communities of practice, evidence-based decision support, consumer-oriented information, health promotion demands, and the desire to control costs while increasing access, coverage and service quality***. Those determinants and needs require ***enhanced service management efficiency and strategic alliance models that replace traditional organizational arrangements which require demand forecasting and rapid response.*** There is a growing need for ***professional continuing education and ways to improve customer satisfaction***.

   New developments aim at systems that:

   - Increase emphasis on the ***social aspects of healthcare***,
   - Provide better ***integration of diverse data*** to allow organization-wide communication and workflow management,
   - Incorporate features such as:
     (a) emphasis on ***data quality by ensuring that committed health professionals are involved in the capture of primary data,***
     (b) ***seamless support and tracking of patient-related data,***
     (c) ***integrated resource utilization and tracking,***
     (d) ***ensure the gathering, presentation, and auditing of data from multiple sources in formats that are meaningful to decision-makers***.
   - Take advantage of ***advanced ICT architectures, powerful database management systems, and the availability of user-run report generator tools and Business Intelligence (BI) applications*** for ad-hoc database queries.

6. Most of the experience with health ICT originates from the ***United States, Europe, Canada, and Japan***. For the last 30 years, hospital information systems (HISs) have been recognized as ***essential to the operation and management of resources, planning, facility operations, and clinical care***.

7. Dating from the mid-1990s there are well-documented studies that demonstrate that ICT enhance productivity in prominent industries, including wholesale, retail, and services. Similarly, following the introduction of ICT ***significant productivity improvement has been corroborated in the health sector of developed countries*** with significant positive changes in the:

   - Professional ***productivity and efficiency*** of interventions;
   - ***Quality of care*** and ***reduction in medical errors***;
   - Improving ***access to knowledge*** bases and the expansion of ***evidence based reasoning***;

- Enabling ***standardized information exchange and communication***;
- Extending the ***scope and coverage of healthcare interventions***;
- ***Empowering consumers and patients***;
- Bringing about the establishment of ***new relationships between patients and health professionals***;
- The ***education of health personnel and citizens***;
- Making ***healthcare more equitable***.

8. At present, nearly every hospital in the ***United States*** has at least some form of HIS, at a minimum level supporting general financial and transactional administrative tasks. ***In 2004, about $25.8 billion was spent on hospital information technology*** and ***web-based applications are expanding rapidly***. Major providers, such as the Cleveland Clinic and the Kaiser-Permanente Healthcare system in the U.S., have developed distributed systems deploying incremental approaches to gathering clinical data, particularly across different organizations and locations.

9. Impact studies have demonstrated ***significant value of the system in preventing adverse events and in saving costs, particularly for medications***. As an example, the U.S. Veterans Health Administration implemented what is likely the largest integrated healthcare information system in the United States using a client-server architecture. The Veterans Health Information Systems and Technology Architecture (VistA), provides technology infrastructure to about 1,300 care facilities, including hospitals and medical centers, outpatient facilities, and long-term care centers linking workstations and personal computers using software that is accessed via a graphical user interface.

10. Although most hospitals in ***Europe*** have some kind of information system in place, only a ***few have fully integrated and functional hospital information systems solutions*** installed. In the ***European Union***, the development of ICT was conducted since the ***mid-80's mostly under the aegis of the Advanced Informatics in Medicine (AIM) Initiative*** a multidisciplinary, multi-professional partnership dedicated to providing digital based solutions to the problems encountered in modern health care delivery.

11. Establishment of the ***AIM Initiative was driven by the realization that the healthcare sector was introducing ICT tools without adequate research and coordination – this left the sector fragmented and with a great variety of incompatible applications***. Managerial and clinical systems were developed from scratch at local or institutional level or bought from vendors without much consideration for the impending unification of the European healthcare systems. ***Research funding has supported health ICT to the tune of EUR 500 million since the early 1990s***, with total investment through co-financing being around twice that amount. Many of today's success stories are the product of that research. All this has helped to create a new health informatics industry with a turnover of EUR 11 billion. Estimates suggest that ***by 2010 up to 5% of health budgets will be invested in information systems and related services***.

12. ***The European Community AIM initiative seeks to encourage research and development in areas beyond the scope of any one country, or where the expertise of several countries could usefully come together***. The Initiative is organized in Framework Programs lasting 2 to 4 years, has hundreds of partners and participants and funds selected projects in a great number of application areas ranging from primary care, medical records,

coding standards, and decision support systems to instrumentation, multimedia workstations, and security and data protection.

13. ***AIM is based on a strong academic research infrastructure of experienced scientists and clinicians and close collaboration with the industry for technology transfer***—the Initiative appreciates that to secure maximum advantage from scarce research resources, attention must be paid to the ***potential commercial exploitation of products and welcomes collaborative arrangements with industry*** especially those in the healthcare sector.

14. The ***main challenges identified in the European Union "2005 e-Health Action Plan"*** is to improve health and healthcare through the use of information and communications technologies at a ***stable or lower cost, and to reduce waiting times and errors***. The goal of the action plan is the creation of a "European e-Health Area" and identifies practical steps to achieve this by developing electronic systems for health records, patient identifiers and health cards, and the faster rollout of high speed internet access for health systems to allow the full potential of heath ICT to be delivered becoming the norm among the healthcare profession, patients and the general population by the end of the decade.

15. ***By end of 2005, each European Union Member State developed a national or regional roadmap for the sector***. The action plan proposed that the Member States agree by the end of 2006 on a ***common approach to patient identifiers and the definition of interoperability standards for health data messages and electronic health records*** taking into account best practices, relevant standardization efforts, and developments in areas, such as the European Health Insurance Card and identity management for European citizens. Under the action plan, a ***collaborative approach to supporting and boosting investment was undertaken among Member States***. This standardization effort will be followed by the deployment of health information networks based on fixed and wireless broadband and mobile infrastructures and grid technologies. Considerable investment is required for the development or modernization of systems and services. Major efforts are currently underway to establish health information networks. ***By the end of 2008 the majority of European health organizations established online services such as teleconsultation (second medical opinion), e-prescriptions, e-referral, telemonitoring and telecare (remote monitoring of patients in their own homes)***. Between 2004 and 2010 the European Commission published biennial studies on the progress made in implementing health ICT applications.

<u>Design characteristics of modern HIS</u>

16. ***Computing power and data storage capacity has grown in many orders of magnitude at the same time that the technological infrastructure cost was reduced in an inverse order***. Those advance, associated with the ***diffusion of fast software development tools, new database management systems, graphical user interfaces, and the ubiquity of interactive communications and networks*** has made possible novel applications oriented to ***functional interconnection of professionals, the integration of clinical care processes, and extensive clinical decision support***. These applications can achieve the efficient delivery of information and services, including remote monitoring and direct care, and emphasize direct physician interaction.

17. ***Modifications and combinations of technology architectures are common*** in many existing deployments as, for example, the use of client-server technology with mainframe systems and the addition of wireless technology and personal digital assistants (PDAs) to supplement the core computing functionality. ***In considering the optimal architecture for a hospital, many factors are taken into account such as size of the institution, desired scope and sophistication of the application, ICT budget, and anticipated level of user community involvement***.

18. Among leading digital technologies, ***Internet-based ICT solutions have brought the greatest impact and they are rapidly changing the way health organizations, providers, care plans, payers, regulators, and consumers, access information, acquire health products and services, deliver care, and communicate with each other***.

19. Current developments in the ***health systems of developed countries are particularly concerned on how to deal with the short life cycle of explicit evidence-based knowledge, capturing and sharing the tacit knowledge of health professionals, safety, confidentiality (personal data protection), and regulatory concerns***.

20. ***New health ICT applications*** support models of care that move away from the reactive delivery of care to a more proactive management approach of the health status of individuals and population groups—this expanded view of health ICT has been promoted by the ICT industry, professionals, and development agencies as the final stage in ***bringing online the entire healthcare system*** and oriented to:

    - ***Economies of speed associated to economies of scale***;
    - ***Modularity and standardization of basic components (reuse)***;
    - Information systems ***centered on clients***;
    - ***Communication among professionals***;
    - Integration of the ***clinical care process management***;
    - ***Standardization of patient records and provider communications*** across multiple provider organizations;
    - Delivering ***network-based health information and services***, including remote monitoring and direct care;
    - ***Convenience to end-users and clients***;
    - Focused on ***quality and accountability***.

21. ***Service-oriented Architecture (SOA)*** during the phases of systems development and integration and the deployment of SOA-based architecture provides services and web-based applications that can be used within multiple business domains and different organizational units using different implementation languages and platforms. Rather than defining application interfaces SOA defines the interface in terms of protocols and functionality.

22. Hospitals can use a ***variety of configurations for HIS implementation depending on business needs and budgetary constraints***. Options run from off-site (remote) processing using private or public networks by a contracted service provider whereby an ***application service provider (ASP)*** hosts a proprietary application on their servers or upload the application to the consumer device, to ***turnkey systems*** where development requirement is minimal with limited customization of the system still possible, or—at the other end of the

spectrum—deploy ***in-house or contracted systems development*** where both customizability and resource use is high. Costs, development time, and project risks are higher with the latter option.

23. The ***operational requirements of teaching hospitals*** are not different than those of large general hospitals but they have some ***distinguishing features related to their role in education, training and research which requires expanded application functionalities***. ***Integrated HIS have been deployed with success in many academic tertiary-care hospitals providing nearly all clinical, administrative, and financial computing services***. Clinical modules of those systems commonly include a very wide range of data and applications, comprising results communication, longitudinal medical records, order entry, critical pathway management, facility dynamic scheduling, critical event detection and automatic alerts, generation of automated summaries and out-of-limit reports, and online reference to knowledge bases and protocols of care.

24. Information and communication technologies are a powerful tool for ***extending educational opportunities, both formal and non-formal***, and used in the ***professional education and training of health professionals***. They are especially important in delivering ***continuing education and access to new knowledge*** to:

    - Previously ***underserved constituencies*** such as physicians and nurses in remote areas—groups traditionally unable to remain abreast of new developments and keep up with the health sciences growing need for lifelong learning – or those with constraints of time and financial resources to enroll in campus-based refresher courses or attend professional meetings.
    - Respond to the increasing ***demand for higher education and the need for quality assurance and professional certification, especially in developing countries***, being in many instances the only viable solution provided such technologies are properly mastered and the necessary investments made, in hardware and software as well as in human skill and training;

25. ***Anytime, anywhere***—one defining feature of public networks allows access to:

    - ***Asynchronous learning programs***, or learning characterized by a time lag between the delivery of instruction and its reception by learners. Online course materials, for example, may be accessed 24 hours a day, 7 days a week. ICT-based educational delivery also dispenses with the need for all learners and the instructor to be in one physical location.
    - Other modalities, using ***synchronous technologies*** such as teleconferencing enable interactive instruction to be received simultaneously by multiple, geographically dispersed learners.
    - Access ***remote knowledge bases and learning resources***. Teachers and learners no longer have to rely solely on printed books and other materials in physical media housed in libraries.
    - Access to ***resource persons, mentors, experts, researchers, and professionals***.

26. Large-scale surveys carried out over a ten year period with distance education tutors at the UK Open University, a leader in distance education, have shown results that were gradual rather than revolutionary. ***Behavioral changes are required from teachers and students*** and ICT-mediated technology requires ***courseware materials and student evaluation***

formats prepared and delivered in totally different ways than the traditional classroom modality. There remains much to be done in terms of exploiting ICT for rich pedagogical use, improved forms of teaching and learning, and for serving learners in different target groups.

HIS and the organization

27. ***The development and implementation of HIS, especially advanced systems, is a daunting task***. The ***main obstacles are organizational and cultural rather than technological***. When implementing a HIS, especially sophisticated system using clinical rules, a ***variety of stakeholders need to participate in the development and implementation***.

28. These stakeholders include senior management, ICT staff, vendors, and the user community such as physicians, nurses, and support service professionals. In particular, the ***users need to feel that they own the system***. Some health centers have used a two-committee approach. The first committee would be an ***advisory or steering committee composed of senior executives and other strategic decision makers*** responsible for the overall planning process of development and implementation, communicating and promoting the intended benefits of the system to end-users, ensuring that the system is well-designed with user input in mind, and developing a plan for user training. The second group would be a ***stakeholder group made up of prospective users of the system*** charged with the job of bringing in significant input into the development and implementation process including content and features, GUIs, integration with other departments, relationship of workflow to system implementation, testing parameters, and other aspects.

29. ***Ownership helps to ensure buy-in from the various stakeholders***. Without physician and nursing personnel advocacy or at least acceptance of the system a successful implementation is nearly impossible. ***Physician buy-in to the system is of critical importance***. If clinicians perceive the HIS as primarily targeted toward the needs of hospital management or believe that physician opinions are not appropriately acknowledged during the development process, they may resist participating in user groups and resist using the system once up and running.

HIS, efficiency, and quality

30. One of the promises of HIS is to ***increase efficiency and effectiveness of healthcare by avoiding duplicative or unnecessary diagnostic or therapeutic interventions, through enhanced communication possibilities between healthcare providers***. Enhancing quality of care is achieved by:

    - ***Benchmarking and comparative analysis*** between different providers;
    - Enabling ***standardized information exchange*** and ***communication between healthcare facilities, levels of care, and caregivers***;
    - Making the ***knowledge bases and personal electronic records accessible at the point-of-care***;
    - Opening new opportunities for ***patient-centered applications***;
    - The ***education and training of health professionals*** through online sources (continuing education) and ***consumers*** (health education, tailored preventive information).

31. ***Although a HIS is intended to support rather than dictate work processes ICT deployment leads to a unique opportunity to improve work processes***. Through different administrative and clinical departments the mere fact of working together on system issues leads to improved interdepartmental communication and better understanding of common issues and the organization as a whole, e.g., data needs will be identified that will provide the means to improve care quality and for monitoring required by management and regulators. The ***introduction of automation compels the reassessment of work processes that must be changed*** to accommodate system impacts.

32. ***Measuring efficiency and quality is not easily done***. In 2005, the ***Clinical Information Technology Assessment Tool (CITAT)*** was developed at the Johns Hopkins University School of Medicine and used in cross-sectional study of clinical information technology capabilities in four U.S. hospitals (one large academic hospitals with advanced HIS, a major Veterans Affairs hospital, and two community hospitals with low ICT investment). The study assessed the degree of automation and usability including117 physicians and 4 chief information officers (CIO) using a 68-item survey instrument 4 automation domains (test results, notes and records, order entry, and processes) and usability in 3 domains (effectiveness, ease, and support). By reputation, all four hospitals were considered leaders of quality of care in their region but only the first two were considered national models for health information technology. ***The study was one of the first quantitative, standardized measures of hospital ICT performance***. The tool may be used to generate internal measures of hospital performance, establish regional or national quality benchmarks, and examine the value of hospital-level information technology.

Human resources and HIS

33. Staffing needed for HIS can range from a few employees full-time equivalents (FTEs) per 100 beds for very basic off-site processing systems to 15 or more FTEs per 100 beds for sophisticated systems that attempt to combine several architectures into one system, e.g., combination of client-server systems with mainframe processing. ***Resource use and application customizability tend to go in tandem—the greater the flexibility of the system to meet unique user needs, the greater the cost outlay for capital and additional FTEs required***.

34. People are central in the value-added deployment and utilization of ICT products and services and ***engagement of the human resource is crucial to success***. Frequently, ***challenges found in the deployment of HIS are mostly related to the inevitable changes of work patterns and procedures, increased documentation workload for staff and direct healthcare professionals, and issues of retraining***. Resistance to change is related to professional hierarchy and traditional roles, technophobia, unwillingness to collaborate in recording and exchanging patient data, and mistrust regarding electronic data storage and access control. Physicians also are particularly concerned with issues related to ***physical data security, and confidentiality of patient-related information***.

35. ***Physicians and nurses have natural resistance to change, see direct patient care as their primary responsibility, and have strong negative views on long response times and too many steps to complete a process or work order***. They can create serious obstacles to success. On the other hand, if physicians and nurses believe that the system will help patient care processes or outcomes and streamline their work processes there is an

excellent chance that they will contribute to and develop feel positive feelings about the new system. Particularly, physicians see remote access to medical records from outside offices or homes, along with intuitive, easy-to-use interfaces, as pluses.

36. The introduction of ICT in healthcare ***disrupts traditional structures and work organization***—deployment in a patient care environment requires that health professionals transcend the strict boundaries of their specialized functions and ***acquire a new set of skills that may have been unnecessary in the past. These are mainly related to changing mindsets and attitudes, leadership competencies, systemic thinking, as well as some basic ICT-related technical skills***. Those needs create an additional burden to the already demanding schedule of health professionals.

37. ***To maximize the potential for success, the user community needs liaisons between the ICT staff and the end-users***. Those "super users" often have some previous computing background and can help guide and train others during the implementation process. Having peers involved in leading the training and implementation increases buy-in of key stakeholders. Each hospital department should have at least one super user, and preferably several.

Electronic Health Records (EHRs)

38. ***Common features of an EHR*** include:

- History and physical exam documentation, progress notes, and patient demographics;
- Prescription; ordering diagnostic tests, and treatments, including decision support and automated drug interaction alerts;
- Medication, medication allergy, and events of drug interaction;
- Laboratory results;
- Medical imaging studies including X-rays, CT, MRI, and Nuclear Medicine;
- Clinical practice guidelines (evidence-based) to aid diagnostic and treatment decisions;
- Alerts that can be sent to patients reminding them of appointments and necessary preventive care;
- Linkage to scheduling of appointments and status of claim processing for payment;
- Secure Web-based and wireless technology features allowing provider access to the EHR from remote sites.

39. ***Interconnectivity of systems becomes more important with EHRs than with any other application*** since a patient medical record is used concurrently by health providers of different roles and levels in diverse clinical areas, even physically located in different geographical places. If there are isolated departmental systems without connectivity, redundant data entry occurs detracting from the value of the application.

40. A good quality EHR design includes ***accessibility at the point-of-care*** through bedside terminals, portable workstations, laptops, wireless tablets, hand-held computers, and personal digital assistants (PDAs). The inputs can be uploaded into the computer system after rounds or transmitted immediately to the system. Bedside technology obviates the need to re-enter data from notes after rounds are completed. This improves recall and avoids redundancy in the work process, saving time that can instead be devoted to patient care. In July 2004, the U.S. government strongly advocated for electronic health records (EHR),

including the creation of the Office of the National Coordinator for Health Information Technology to develop a National Health Information Network. In the Health Care Reform presently under discussion in the U.S. Congress the EHR has a prominent role.

41. ***EHR implementations contribute to cost saving***. In a U.S. large east coast hospital it was found that EHRs saved $9,000 to $19,000 annually per physician FTE. This savings was achieved through a decrease in costs for record retrieval, transcription, non-formulary drug ordering, and improvements in billing accuracy. In radiology, storage of digital pictures and the use of a picture archival and communication system significantly decreased the turnaround time for radiology image interpretation — from 72 hours to only 1 hour. However, there is significant front-loading of costs prior to achieving such savings. At the American Health Information Management Association October 2006 conference, panelists suggested that developing, purchasing, and implementing an EHR would cost over $32,000 per physician, with an outlay of $1,200 per physician per month for maintenance. Also, there exists no national norms requiring compatibility between the numerous competing EHR vendor systems,need to communicate with each other. The lack of standardization escalates costs and increased user frustration and ultimately rejection of systems that fail to include desired features and communication with different vendor systems.

HIS and evidence-based decision making

42. Studies have shown health professionals are increasingly using and accepting the Internet paradigm for ***information search and knowledge sharing***. Evidence of this phenomenon is the growth of interactive health communication by which individual consumers, patients, caregivers, and professionals access or transmit health information, receive or provide guidance and support on health-related issues, and relay knowledge. A global survey demonstrated that ***80% of physicians across eleven North American, European, and Asian countries own a computer and regularly access the Internet***.

43. More than 90% of ***U.S. physicians*** are online or intend to be online in the near future. Almost all (95%) said they use the Internet to access disease information an average of 14.7 times per month, 88% reported reading medical journals online, and 86% said they use the Internet to obtain drug information. Of the time spent seeking any information on the Internet, experienced user physicians overall report spending a full 50% of that time seeking medical information. A finding, both surprising and indicative of the general trend toward patient empowerment, is that ***62% of net-connected physicians reported suggesting to patients that medical information could be obtained online***. Almost one-third of U.S. physicians reported that patients coming in for a consultation had brought with them medical or health-related information they had found on the Internet.

44. Four out of five ***European doctors*** have an internet connection, and a quarter of Europeans use the internet to get information about diseases and health matters. These encouraging figures indicate that ICT-supported health systems and services will develop rapidly. An example of the impact of ICT in the capture, dissemination, and decision-making is the role information system played in the initial outbreak of the new influenza strain A (H1N1) in Mexico in 2009. Health officials were able to quickly identify and respond to unusual patterns of illness thanks to Mexico's disease surveillance system, linking units from all around the country. Those findings were quickly detected by the country's health information system, which includes individual medical record keeping and a responsive reporting system.

HIS and health research and education

45. A reliable and continuous supply of scientific research is needed to determine the most effective diagnostic and therapeutic options for particular illnesses and subgroups of patients. ***Integrating ICT-supported research processes into the workflow of clinical information system facilitate communication between clinicians and researchers***. Clinicians, managers, funding agencies, and the civil society can thus have access to information about prospective research being conducted and clinical trials streamlining clinical trial screening and enrollment, and integrating the collection of research data into the clinical workflow. The incorporation of metrics for study feasibility, standardization of clinical coding, case note tracking, administrative interfacing, and better research prioritization and oversight are associated with reduced overall cost and better primary data quality and integrity.

46. Another aspect is the essential role of ICT in the ***dissemination of research findings***. The length of time for the translation of scientific findings into actual patient care has been estimated to take an average of 17 years, by which time the scientific findings may already be outdated. To reduce the diffusion time from scientific study to bedside application, extensive efforts to develop ***evidence-based clinical guidelines and care pathways*** have taken place during the last two decades. Typically, such guidelines are updated every one to three years to take into account the latest scientific evidence. Clinical guidelines are useful for guiding decision-making using algorithms and rules. One of the barriers to implementation of clinical guidelines has been that they are not accessible at the point-of-care. Paper guidelines often require reading on the physician's own time or the provider uses them on the wards only for highly complex cases, if at all. ***Electronic strategies may contribute to an increased use of guidelines through hand-held devices or bedside terminals. Benchmarking and performance tracking allows the comparison of input data to evidence-based clinical guidelines and performance analysis compared to norms or benchmarks.***

HIS and medical error reduction

47. In the U.S., the Institute of Medicine (IOM) has estimated the number of annual deaths from medical error to be 44,000 to 98,000. ***Most errors are the result of communication, transcription, and lack of access to evidence***. Other studies indicate that between 6.5% and 20% of hospitalized patients will experience an ***adverse drug event (ADE)*** during their stay. Both quality and cost of care suffer. The cost for each ADE is estimated to be about $2,000 to $2,500, mainly resulting from longer lengths of stay and the U.S. National Committee on Vital and Health Statistics (NCVHS) reported that about 23,000 hospital patients die annually from injuries linked specifically to the use of medications.

48. ***The U.S. Federal Drug Administration (FDA) estimates that over 500,000 fewer adverse events will occur over the next 20 years, a result of an expected 50% decrease in drug dispensing and administration errors***. The decrease in pain, suffering, and length of stay from drug errors is estimated to result in $93 billion in savings over 20 years. Furthermore, besides the improvement in quality and efficiency of care, avoidance of litigation, decreased malpractice premiums, and reduction in inventory carrying costs will be added benefits accrued from improved information management.

49. ***Manual entry of orders, use of non-standard abbreviations, and poor legibility of orders and chart notes contribute to medical errors***. Since the late 1990s, there has been increasing pressure for hospitals to develop processes to ensure quality of care. The Joint Commission and the Leapfrog Group, a voluntary consortium of large employers, have pushed ***patient safety as a high priority aiming at the reduction of preventable medical mistakes***, encouraging health providers to publicly report their quality and outcomes, and promoting the idea of rewarding professionals and hospitals for improving the quality, safety and affordability of health care. The Leapfrog Group, in particular, highlighted CPOE systems as one of the changes that would most improve patient safety since these systems have the reduction of medical errors as a prime function. State and federal legislatures have also stepped up activity in this regard.

HIS, data security, and privacy of personal data

50. Those are issues are of universal concern and a high-priority stand in many countries. There is a ***growing apprehension regarding the protection of health records against intrusion, unauthorized use, data corruption, intentional or unintentional damage, theft, and fraud***. Health data transmitted over public networks offer unprecedented opportunities for better patient care and community health interventions by facilitating data exchange among professionals but pose new challenges to confidentiality.

51. Given the ***sensitive nature of healthcare information***, and the high degree of health professionals ***dependence on trustworthy records***, the issues of ***reliability*** (data residing in the electronic health record are accurate and remains accurate), ***security*** (owner and users of the electronic health record can control data transmission and storage), and ***privacy*** (subject of data can control their use and dissemination) are of particular significance and must be clearly and effectively addressed by health and health-related organizations and professionals groups. Reliability, security, and privacy have been accomplished by the implementation of a number of ***preventive and protective policies, digital signature certification, and proactive actions*** that address the areas of physical protection, data integrity, access to information resources, and protection against unauthorized disclosure of information.

Cost-benefit of HIS

52. ***Beneficial effects of HIS deployment on healthcare costs*** consider:

- Reduction in ***labor costs*** mainly by improvements of manual or clerical tasks and streamlining the workflow processes of clinicians with productivity gains been demonstrated in the order of 10%;
- Reductions in the need for ***equipment and supplies*** by standardization and better inventory management;
- Increased ***revenue generation*** by improved charge capture and elimination of lost charges along with a decrease in outstanding days of receivables, which can improve revenue generation, with charge revenue increases that have been shown to amount to 10% to 30% over a previous manual system;
- Improved ***employee satisfaction*** once they go over the top of the learning curve with gains in productivity;

- Improvements in ***LOS and healthcare charges per admission*** leading to a contractual advantage with payors;
- Reduced costs of ***"at-risk" reimbursement*** (high cost conditions or procedures) patient cases in capitation, per diem, and case rates (as is the case with the Ministry of Health SUS payments), since reduced resource utilization can lead directly to more relative revenue;
- Although hard to quantify financially, ***quality of care improvements***, especially if publicized outside the hospital, may lead increased service utilization and reduction in medical errors that increase LOS and complications.

53. Depending on the ***institutional category, size, client mix, and utilization profile***, implementing an information system may initially cost from several hundred thousand dollars to tens of millions of dollars Consequently, it is critical that such a system produce a positive return on investment (ROI) through healthcare quality improvements, increases in organizational efficiency, stakeholder satisfaction, or enhanced reimbursement from third-party payors. ***Maximization of ROI has been a major concern to health managers in developed and developing countries***, independently of the underlying healthcare system and reimbursement model. Financial data from the 2001 Third Annual Survey of the U.S. Hospitals and Health Networks, the flagship publication of the American Hospital Association, showed a significant difference between technologically advanced hospitals and traditional institutions with decreases expenses per adjusted facility discharge (US$3,995 versus US$ 4,511); lower annual increase in hospitals expenses (0.6% versus 2.8%); lower FTEs per occupied bed (3.3 versus 3.8); and lower adjusted LOS (3.24 versus 3.73).

54. For the U.S., it has been generally estimated that there is approximately a 2.3% reduction in long-term hospital cost and a 0.6% increase in revenue with the deployment of a integrated HIS. ***About 35% of the financial benefits from an integrated HIS are attributed to improved length-of-stay efficiency, and about 40% of financial benefits are attributable to greater efficiency in operating costs and staff work flow***, given that many of the manual processes will be automated. Although a system can save money, it may take several years to see a net positive ROI. In addition, calculating ROI for HIS is not as straightforward as in many other financial areas since ***many benefits from an integrated hospital system such as patient satisfaction, provider convenience, and improved communication are not easily quantifiable in terms of revenue and expense***. The ROI for each institution is highly individual and depends on factors such as the extent of pre-existing information systems capability, size of the institution, and case-mix.

55. ***Case-mix analysis and indicators and the use of case severity diagnostic-related grouping (DRG) linked to individual patient accounts has been shown to be essential tools in reimbursement and management***. An example is the Johns Hopkins Hospital, with 1,000 beds, known for the quality of its patient care and its consistent rank as the top hospital in the country. As an academic medical center, the hospital treats the most complex and difficult patient cases in the world. Besides the challenges to data management in such environment, about 10 years ago, under the State of Maryland rate-regulated cost containment system, the hospital found that it could not explain the charge variances among patient cases using then current DRG methodology. Maryland was a 100-percent DRG state at the time, with DRGs determining what hospitals could charge. When Johns Hopkins Hospital administrators approached the clinical staff about the variances, the physicians complained that the more serious illnesses of their patients were not being measured. Johns

Hopkins was anxious to ensure that its data reflected the severity claims of its physicians, so it undertook a search for a health problem grouping methodology that would adjust for severity of illness and benchmark LOS and charges for adjusted severity of illness and was able to successfully demonstrate to Maryland's Health Services Cost Review Commission (HSCRC) the justification for the charges and the evidence that they were under reimbursed thus reach its income goals.

56. ***Some applications may require large initial outlays for capital purchases, development, implementation, and training***—the cost of implementing a fairly sophisticated CPOE system for a 500-bed hospital have been estimated to be around US$8 million with an annual maintenance of US$1,350,000. ***Most important cost elements include allocations for hardware, software, workstation, network upgrades, and ICT and non-ICT personnel***. There also may be some temporary productivity losses during implementation of the system. However, ***savings from the system can be significant***. One 1,100-bed academic health system saved approximately US$6 million annually from a CPOE system and a medication administration record. This figure combines the time savings realized for nurses, pharmacists, and unit secretaries. According to a report by Cerner Corporation, a regional medical center in the Boston area saved about US$3 million annually and avoided 36 deaths through the implementation of a computer-based data repository that contained medication rules. ***The majority of financial benefits from CPOE systems and electronic medical records are long term***. One large nationwide managed care organization projected that it will take about nine to ten years to realize a positive net cash flow from its HIS.