

The Clinician Meets the Computer—Uneasy Bedfellows

M H Tan,*^{MBBS}, C Rajasoorya,*^{FAMS, FRCP (Edin)}

Abstract

The transformation of healthcare has been one of the great, but unfulfilled, promises of the information technology revolution. This disappointment has been due in part to the enormously complex processes involved in bedside clinical care. Selective adoption of advances in information technology has resulted in enhancement of point-of-care healthcare delivery, medical record management and professional communication. However, the introduction of these refinements has encountered resistance, as well as sparked new challenges. The exciting progress in this field is reviewed, with reference to global and local developments.

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Introduction

Information technology has become a cornerstone of civilization as we know it. In its broadest definition, information technology encompasses all forms of technology required to create, archive, exchange and manipulate data. Unfortunately for all concerned, the process of integration between information technology and the healthcare sector has not always been smooth. The landscape is littered with failed healthcare information technology products, each promising to be the panacea for refining patient care and clinical workflows. However, there should not be any doubt that technology today is poised to transform healthcare in terms of knowledge enrichment, re-engineering of clinical processes and health economics.

In this broad review, we share with our readership our perspective on the varying degrees of success that information technology has enjoyed in benefiting the practice of the individual clinician. Any illustrations of software and devices we choose reflect a personal choice, exposure and experience rather than a specific recommendation or endorsement.

Clinicians operate in a variety of settings: the busy family dispensary, the hospital wards, outpatient clinics and the austere operating theatre. In addition, telemedicine, allowing healthcare delivery over distance, is an evolving and novel

setting for a provider-patient relationship.

Despite this diversity of environments, physicians perform many common activities. These may be broadly classified into clinical service, medical education and research. In many other industries, information technology has provided many useful tools to reduce administrative workloads and laborious bean counting. These tools have met with varying degrees of success in the clinical setting. After many years of development of information systems to support administrative functions in healthcare, the development of applications in recent years has been distinctly more oriented towards supporting clinical decision-making, communication, medical education and other aspects of professional activity.¹

Clinical Service

A. Patient Record Data

The electronic medical record (EMR) has been one of the great but incompletely realised visions of the digital revolution. In its broadest definition, the EMR is an electronic record that permits entry, archival and retrieval of clinical data. EMR systems have been, and still are, designed mainly for large organisations like health networks and hospitals, rather than small practices. The administrators in hospitals require a robust information infrastructure to support administrative needs of billing and bed

* Medical Officer

Department of Medicine

** Senior Consultant Physician & Endocrinologist

Head, Department of Medicine

Chairman, Medical Board

Alexandra Hospital

Address for Reprints: Dr C Rajasoorya, Department of Medicine, Alexandra Hospital, 378 Alexandra Road, Singapore 159964.

E-mail: Rajasoorya_C@alexhosp.com.sg

management, obtain global visibility of costs and measure performance parameters. However, clinicians require large quantities of relatively more complex data, of which record keeping is seldom complete, even in large organisations. Data entry like clinician notes, radiology films and parameter monitoring is still accomplished largely offline in most organisations.

For clinicians, functions like patient registries, prescription management, point-of-care decision support, outreach reports and practice analysis reporting tools support can tangibly improve clinical quality and outcome management. At the same time, integration between an EMR system and other radiology and laboratory information systems, and the addition of basic charting and querying capabilities allow for improved access to data. The complexity, customisation and resource costs of a fully-fledged EMR have been prohibitive for most organisations, large or small. In more recent years, the advent of Internet-based products providing EMR functions and Clinical Decision Support (CDS) introduce the benefits and ease of a minimalist EMR at an economical price to small practices. Currently in Singapore, most public hospitals already operate, or are in the process of implementing, basic EMR systems for management of inpatient clinical information and clinical coding. In addition, almost all public and private hospitals have deployed various modules of SAP R/3 for enterprise resource planning. The issues of subvention, the integration of legacy applications within hospitals and the sharing of information within clusters of hospitals and primary care facilities will continue to be major factors influencing the growth of a digital information infrastructure in the public healthcare sector. The Singapore Armed Forces implemented the only operational island-wide primary care EMR system, the Patient Care Enhancement System (PACES), in 1995.²

Clinical decision support systems (CDSS) have been introduced as a natural support to basic EMR systems. These are widely used for order entry and prescription drug dosing, and also provide reminders for preventive care measures.³ Evidence for a significant impact of CDSS on patient outcomes is still lacking,⁴ but is likely to emerge once growing proliferation of these systems allow further studies. For prescriptions and laboratory orders, electronic order entry eliminates the problem of illegibility, and reduces the chances of incorrect dosing. Indeed, the recent landmark report on medical errors⁵ by the Institute of Medicine identified information technology as a major part of any solution for minimising errors.

B. Image Data

Images are a crucial part of the health record. There are significant resource limitations in the processes of production, archival and transmission of images on paper

or film. As a result of these constraints, digital health imaging has become a rapidly developing field. In radiology, Picture Archival Communications Systems (PACS) manage the massive archives of digital radiology images generated by modalities like digital radiography (DR) machines, computerised tomographic scanners and magnetic resonance imaging machines. In addition, other digital image data like electrocardiogram waveforms can also be captured and archived in various proprietary management systems. Open information standards like DICOM (Digital Imaging and Communications in Medicine) and HL-7 (Health Level 7) are currently evolving to encompass information models for image data from a variety of fields like radiology and cardiology. In Singapore, PACS systems in several public hospitals provide web-based access for the busy clinician at bedside to an archive of radiology images. High-speed local area and wide area networks have been developed both in the public and private sectors to enable this.

While machines generate prodigious quantities of medical image data, clinical wisdom can only be distilled by observing the patient in the ward, outpatient clinic or operating theatre. The individual doctor, armed only with a sharp eye and a digital camera, generates many of these valuable clinical images. Key features can be highlighted by photo editing, and rapidly shared with professional colleagues and students. It is of no surprise that with the rise of the digital camera, clinical slides have had decreasing utility. Fortunately, many older slides can be digitised by scanning, preserving much clinical knowledge. Slide libraries on the Internet have been created, providing digital images which are free for access.

C. Point of Care Decision Support

Huge archives of medical knowledge, previously inaccessible for their sheer quantity and fragmentation, have been made available to the clinician directly at point of care through the advances of miniaturization, networking and storage technologies.

The personal digital assistant (PDA), or palmtop device, has proliferated among clinicians. According to a Harris poll,⁶ 26% of all clinicians in the United States used the devices in 2001. This was projected to grow to 50% in 2005. Certainly, the PDA has made a major impact in the daily practice of the clinician in recent years. Its success can be in part attributed to its minimal intrusion on the physician-patient encounter, having been designed for simplicity and intuitiveness. Currently available storage capacities have allowed the physician to access hitherto untapped resources on a mobile basis. These include electronic medical textbooks, extensive databases, pharmacopoeias and patient tracking applications. Current popular medical applications and e-texts include Epocrates

(a pharmacopoeia), which has been surveyed in several journals,^{7,8} 5-Minute Clinical Consult, as well as evergreens like Harrison's Principles of Internal Medicine and the Washington Manual of Medical Therapeutics. For a more extensive review of the application of the PDA in clinical care, the reader is referred to the review by Wilcox and La Tella.⁹

In addition, the integration of handheld devices in networks, allowing for universal access to central databases, has been explored in various clinical settings. Functions such as e-prescriptions, billing, laboratory order entry and result retrieval, clinical documentation, alerts and monitoring of medication administration have been successfully prototyped. However, several practical issues have prevented widespread implementation so far. These include connectivity and networking, security concerns, clinician-computer interface problems, legacy information systems and the lack of common information standards, workflow problems and financial costing issues. In addition, devices such as digital tablets are posing a growing challenge to PDAs as the preferred tools for mobile computing in healthcare.

Knowledge Enrichment

A. Education

Authors and publishers have similarly evolved to offer additional teaching material for professional medical education through other media in addition to the traditional weighty textbooks and journals. While these tomes still line our bookshelves, rapid access through CD-ROMS as well as web-based portals, updates and subscriptions is increasingly popular. Besides the major and traditional texts like Harrison's Principles and Practice of Medicine and Oxford Textbook of Medicine, newer specialised material like Up-To-Date® has received considerable success, both among individuals and institutions. There is growing freedom of scientific knowledge through the availability of free medical textbooks online, a list which is consolidated at <http://freebooks4doctors.com>. Multimedia has also added much needed interactivity to medical teaching materials.

B. Literature

The clinician has easy access to abstracts of published articles in peer-reviewed journals through free Internet MEDLINE databases, one of the most popular being PubMed, developed by the National Library of Medicine, located at <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi>. It has thus become easier to locate relevant, up-to-date articles to answer clinical questions. Full-text articles in many journals are available free to clinicians in developing countries. The archival of journal articles on-line as

electronic documents allows quick paperless transmission between colleagues, as well as universal access. Most journals now offer an e-mail update of Table of Contents and/or abstracts where the interested reader can access abstracts or original articles. Some journals are available only on subscription. Many journals are however freely available, a list of which is available at <http://www.freemedicaljournals.com>.

Financial

Not all clinicians have the luxury of working without heed of budget or revenue constraints. For the individual practice, the tools of information technology have permitted reductions in the clinician's operating costs. Many commercially available electronic medical record applications provide routine administrative functions such as billing, logistics and pharmacy management, which were previously managed with reams of paper and sweat. In the United States, the application of information technology to clinical coding by the individual practice is critical for revenue generation and appropriate reimbursement.

Networking and Community Building

A. Professional

Integration into a wider medical community, national and regional, will permit the isolated individual doctor to operate in a larger milieu. In Singapore, electronic communication allows for rapid dissemination of information such as medical alerts for communicable disease outbreaks within the wired medical community. Similarly, such a digital community of individual practitioners can function as watchful eyes and ears for the central health agencies, allowing for rapid notification of unusual disease activity or symptom complexes, which may be the first signs of disease outbreaks or biochemical warfare.

Apart from such official channels of communications, the unfettered electronic communication that the Internet permits has resulted in rapid and productive discussions between virtual communities of physicians, consequently boosting collaborations in patient care and research. These unregulated discussions occur via myriad channels ranging from e-mail, electronic mailing lists, electronic chat rooms, and even to fully-fledged video-conferencing. Clinicians in Singapore have forged relationships with those in overseas institutions through the use of teleconferencing, in varied fields such as interventional cardiology, oncology and radiology.

B. Physician-Patient

Electronic mail, or e-mail, has added a new dimension to physician-patient communication. This novel avenue of

communication may result in enhancement in the relationship between provider and patient, if well managed. Guidelines for the appropriate use of e-mail between physician and patients have been created, and are currently being updated.¹⁰ It should be acknowledged that clinicians have legitimate concerns of being overwhelmed by e-mails from patients. This mode of communication is also relatively impersonal, and caution should be exercised to avoid over-reliance on e-mail over the personal touch. Other issues such as accountability and reimbursement for time expended on such activities in the setting of a market driven economy have yet to be resolved.

The increasing prevalence of the Internet Printout Syndrome has alarmed many doctors in clinics, where patients enter consultation rooms bearing voluminous documents acquired from the Internet advising on various maladies. No longer is the physician always the primary source of information. Certainly, the availability of free-flowing information empowers patients at times, and misleads them at others. Nonetheless, the state of affairs poses a growing challenge to the traditional physician-patient relationship, resulting in an acute sense of threat among some in the medical community.

Typical Internet users do not have the expertise to assess the quality of information presented on the Web. David Satcher, Surgeon General of the United States, states there has been little evaluation or quality control of interactive health communication, because applications have developed faster than theory and assessment tools.¹¹ Many other research studies publicised in the media have suggested that health information on the web does not conform to various standards of quality. It has been recently pointed out that the lack of operational definitions on what constitutes quality, the descriptive approach used, and varying sampling strategies may flaw the interpretation of the studies.¹² It is suggested that the medical community should capitalize on the high-quality websites providing consumer medical information as an “information prescription”, rather than further descriptive research dwelling on inevitable inaccuracies found on the Internet. Indeed, the inadequacies of information on the Web should be considered with the background of imperfect consumer health information in the media.

C. Telemedicine

Telemedicine is, in its broadest sense, the delivery of healthcare involving an element of distance. It seeks to bridge geographic gaps between professionals, as well as between professionals and patients. Its progress in routine health services has been impeded by a lack of evidence of clinical and cost-effectiveness.¹³ There is some evidence that home telenursing, minor injuries telemedicine and teledermatology may be cost-effective.¹⁴ However, these

results may not be widely applicable outside the particular geographic, resource and population setting of the trial. While telemedicine holds the promise of delivering healthcare in areas with geographic barriers and developing countries, issues of appropriateness of such healthcare and prioritisation remain unclear.¹⁵

Challenges to Adoption

A. Clinician Barriers

Singapore is one of the most wired countries in the world. For the individual clinician, lack of physical infrastructure is a relatively insignificant barrier to adoption. Problems encountered include clinician disinterest, time requirements for basic IT skill training, competing priorities for time and the paucity of clinical applications that can be efficiently integrated into a physician's workflows with minimum fuss. Specifically for electronic medical record systems, four major barriers have also been highlighted: costs, data entry effort, product design and clinician-computer interface.

B. Privacy Concerns

The privacy of healthcare data is a major area of concern in healthcare organizations. Patients have a high level of trust in the way doctors and hospitals maintain the confidentiality of their health information. With information technology, an overwhelming demand has been generated for the seamless exchange of such information between internal and external agencies in order to meet legitimate medical and administrative needs. With more accessible data, concomitant concerns have been raised with regards to privacy infringement and authorisation and authentication of health information users. In the United States, President Bush endorsed the Health Information Portability and Accountability Act (HIPAA) in 2001, a piece of landmark legislation on healthcare information privacy, requiring entities like healthcare providers to comply with standards for data protection and privacy by 2003. The impact of these standards on healthcare costs and workflows will be carefully observed both in the United States and overseas.

Conclusion

Healthcare providers are living in a world of ever-increasing advances in therapies, greater emphasis on evidence-based medicine, increasing patient expectations, and better informed and more empowered patients. Information technology is only beginning to shape the healthcare sector now, and promises to dramatically change the way we practice medicine in the years to come. At the same time, falling into the trap of allowing the “kitchen appliances to dictate what the cook can cook” is something we should all avoid and endeavour to resist.

We are optimistic that the relentless advances in information technology will soon permit the complexities of patient care and communication to be managed in part by information systems. The information revolution may be arriving somewhat late to healthcare, but it is certainly well on its way. Those who will lead this revolution in this domain include physicians, nurses and information technology professionals. For these leaders, the challenge is not managing the seductions of new technology. Rather, seeking to bridge the growing digital divides for the main stakeholders—physicians, nurses and patients—will guarantee success for their endeavours in the implementation of viable, practical technology in the challenging healthcare setting.

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