INTERNAL MEDICINE JOURNAL

Internal Medicine Journal **43** (2013)

PERSONAL VIEWPOINT

Are doctors the structural weakness in the e-health building?

T. J. Hannan[1] and C. Celia[2]

[1]Department of Medicine, Launceston General Hospital, Launceston, Tasmania and [2]Policy and Advocacy Professional Affairs, HR and Advocacy, The Royal Australasian College of Physicians, Sydney, New South Wales, Australia

Key words
e-health, physicians, information management

Correspondence
Terry J. Hannan, Department of Medicine, Launceston General Hospital, Charles Street, Launceston, Tas. 7250, Australia.
Email: terry.hannan@dhhs.tas.gov.au

Received 17 February 2013; accepted 15 July 2013.

doi:10.1111/imj.12270

Abstract

Progressive evaluations by the Organization for Economic Co-operation and Development (OECD) demonstrate that health care is now or becoming unaffordable. This means nations must change the way they manage health care. The costly nature of health care in most nations, as a percentage of Gross Domestic Product (GDP) seems independent of the national funding models. Increasing evidence is demonstrating that the lack of involvement by clinicians (doctors, nurses, pharmacists, ancillary care and patients) in e-health projects is a major factor for the costly failures of many of these projects.

The essential change in focus required to improve healthcare delivery using e-health technologies has to be on clinical care. To achieve this change clinicians must be involved at all stages of e-health implementations.

From a clinicians perspective medicine is not a business. Our business is clinical medicine and e-health must be focussed on clinical decision making. This paper views the roles of physicians in e-health structural reforms.

Introduction

Within the past three to four decades of the current technology revolution, the term e-health has become a focal point for attempted radical changes to our health system and has been offered as the solution for the maladies affecting healthcare delivery.[1,2]

This viewpoint paper aims to present a balanced perspective and evaluation on where e-health and its associated technologies (health information technology (HIT)) fit into the demands for essential healthcare reforms not only in Australia but also internationally.

Critical to this discussion is the place physicians have within the e-health culture, and how they have so far responded to changes in e-health and its associated technologies.

A dynamic force that will have a major impact on how physicians approach e-health is that of the use of modern web technologies such as social media (Facebook, Twitter, etc.) by patients, which will cause a seismic shift from hospital-based, clinic-focussed and 'doctor knows all' models of care to the patient becoming the primary managers of their own health.[3]

It is clear that physicians and clinicians as a whole must become more involved in the processes associated with HIT implementations so that e-health can achieve the promised successful outcomes that have not yet been achieved. As Coiera stated in 2003, 'The biggest information repository in health care lies in the people working in it, and the biggest information system is the web of conversations that link the actions of these individuals'.[4] As physicians are a major component of this repository, the current low and inappropriate involvement of physicians in the e-health revolution are major factors in many of the costly failures and adverse outcomes of e-health projects.[5]

Core definitions of e-health and associated terms

As e-health is a relatively new concept and was previously seen to lie outside the clinical domain, some core definitions should assist the reader in assessing where this phenomenon fits within healthcare delivery.

What is e-health? – 'e-health' is defined by the World Health Organization (WHO) as 'the combined use of electronic communication and information technology in the health sector. It refers to the healthcare components delivered, enabled or supported through the use of information and communications technology'.[6]

Informatics is defined as the study of the science of information.[7]

Health (biomedical) informatics is seen as the science of how information is used in health and healthcare.[8]

Funding: None.
Conflict of interest: None.

From these definitions, it can be seen that information and its management are core elements of e-health. This is where health professionals, including physicians, nurses, pharmacists, primary care physicians (PCP), allied health workers as well as patients, play a critical role in the delivery of care.

Physicians as information managers

Physicians when delivering care, whether acute, intermediate, chronic or preventive, are seen as health information managers. Therefore, there is a need to understand how physicians currently manage clinical information and whether it is managed appropriately or inappropriately. We also need to understand what the current health outcomes of this management process are.

Healthcare is seen as a service profession, and a key component of this service delivery is management of information by clinicians. But what does this actually mean?

In routine care, clinicians collect data such as patient history, perform physical examination, create reports, access laboratory data, read X-rays results, and then record these data (through the production of notes, operative reports, prescriptions and diagnostic test results). Clinicians are also involved in transmitting these data through various means: through telephone, paper documents, electronic charts and email. Finally, they process this information to arrive at a diagnosis, or deduce a hierarchy of possible diagnoses and initiate treatment(s). This process becomes an iterative cycle of data and information management so that care can be monitored, adjusted and measured.[9]

From this description, it can be seen that information is not an adjunct to care, it is care itself, and effective patient management therefore requires the effective management of patient data and information.

The critical functionality of health information management in patient care is now a part of the WHO charter, and as the WHO acknowledges that health, information and management are critically interlinked when it states that 'there is no health without management, and there is no management without information'.[10]

This understanding of clinical information management, based on physician clinical decision-making (CDM), was shown by Blum more than four decades ago and was reaffirmed more recently by Coiera.[11,12]

Current evaluations of healthcare information management

If physicians, as major actors in the clinical information management processes, are to understand why e-health

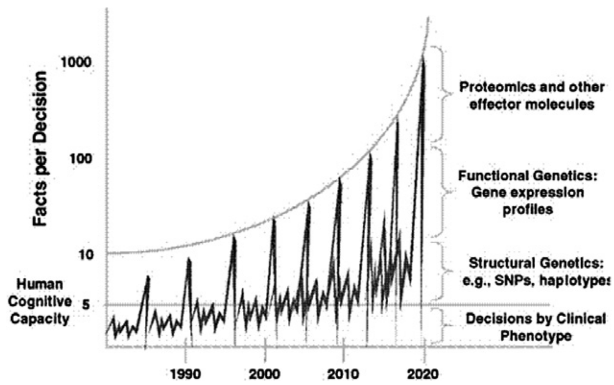

Figure 1 Human cognitive capacity related to expanding genomic data. (With permission of the authors).

has been described as an 'essential' technology for healthcare, it is important to document the complexity of modern healthcare and the inability of the unaided human mind to manage the rapidly expanding health knowledge base (Fig. 1).[13]

Figure 1 displays the sets of facts that require processing by the human mind in the management of the expanding field of genomic data. The curve has an exponential growth slope, yet baseline human cognitive capacity remains flat.

Genomic data are not the only domain of impaired CDM and clinical information management; however, this graph serves to highlight the limitations of the unaided human mind to manage healthcare using traditional or inappropriately designed decision support tools.

Based on this knowledge, it is not surprising that physicians are not performing well in the current clinical environments despite the rapid deployment of healthcare technologies. There is also evidence that physicians, as distinct from primary care practitioners, have demonstrated a reluctance to use effective e-health technologies. This problem is not just local, it is an international one.[14–16]

Historically, one of the initial comprehensive reports on the use of computer-based technologies in healthcare came from the Institute of Medicine (IOM) in 1991. This institute concluded that 'The Computer-Based Patient Record: [is]An Essential Technology for Health Care'.[17]

Since that report was published, there has been an exponential growth in the number of technologies and systems that have the potential to improve significantly a clinician's ability to monitor, measure, integrate and improve healthcare. We now see mobile devices, such as smartphones and tablets, being carried by clinicians throughout their daily activities where they can access the internet, laboratory results and radiology. Within this technological revolution, we are also seeing patients assuming greater control of their care, often without direct contact with their physicians.

There is a distinct urgency and need to evaluate whether these devices are providing appropriate 'clinical decision support' and information management so that adverse events happen less often, health costs are lowered and patient outcomes are improved. Another critical factor in these evaluations is to assess whether HIT is doing any harm to patients.[5]

Using current healthcare measurements, the disturbing evidence is that the overall costs and quality of healthcare delivery are not improving, and health is becoming unaffordable despite the growing availability of advanced e-technologies.[18]

Healthcare has now become unaffordable in many countries. Fineberg documented health costs as a percentage of gross domestic product (GDP) in 2012 for OECD countries, and noted that this ratio is essentially the same (apart from the United States) for all countries and is rising at unacceptable rates and sits between 8% and 10% of GDP for these countries. It can also be concluded from this study that the factors driving healthcare costs appear to be independent of the health funding models for healthcare (i.e. costs are increasing regardless of whether health funding models are essentially public, private or in combination).[19,20]

The most recent data from Australia on healthcare costs reveal that the economic burden is around A$130 billion per year (9% of GDP), with an estimated rise to 16–25% of GDP by 2025.[21]

Additional evidence has shown that ever-expanding state and federal healthcare budgets have not restrained these health costs, as they remain focused primarily on the administrative models of care and those technologies that support healthcare as a 'business'. For health costs to be controlled and lead to improvements in care, the real focus of healthcare budgets should be on addressing the current 'business of clinical care' and health information mismanagement.[22,23]

The problems highlighted above are not uniquely Australian. McCollum reported in 2003 that the United Kingdom is also facing a bureaucratic nightmare and failures within its health funding models.[24]

Similar results for the United States were documented by Orszag. He demonstrated that the quality of healthcare for Medicare patients in individual states in the United States was independent of the total amounts of funding allocated through their federal Medicare programme.[25]

Another major factor that affects the costs, quality and outcomes of care is what is known as variation in care.[26,27] Variation in care is the phenomenon in modern medicine of the observed differences in the way apparently similar patients are treated from one healthcare setting to another.

More recent findings on variation in Medicare spending in the United States by Fisher *et al*. (2003) and Zhang *et al*. (2010) confirm these findings, and challenge the assumption that the answer to improved healthcare delivery is more funding using the existing 'business' models of care rather than addressing the issue of clinical information mismanagement that is driven by current CDM processes.[28–31]

The American IOM provides periodic reports on health quality and safety for many countries, and these confirm the commonality that increased health funding using current models of care do not improve healthcare outcomes or quality. The institute's first alarming report was *To Err Is Human: Building a Safer Health Care System*.[32] This was followed 5 years later by Leape and Berwick's report *Five Years after To Err Is Human: What Have We Learned?* These reports concluded that there had been minimal changes in care outcomes and patient safety despite the rapid advances in available healthcare technologies. Their conclusions documented the important role physicians were having in retarding progress to improve healthcare.

Leape and Berwick specifically referred to physicians as providing a blockage to e-health changes due to an ingrained 'culture of medicine' and the slow ability of the profession to adapt to change.[33]

The latest report from the IOM in 2011 found similar poor health outcomes despite rising healthcare budgets.[18]

Measuring care delivery

We are now able to document more clearly the roles that CDM has in the overall management of healthcare delivery, and how this affects costs, quality, outcomes and access to care through the use of evolving e-health technologies and the availability of more standardised data. These advances are coupled with the enhanced ability to store and manage large masses of information in mobile devices (smartphones, tablets) and the progressive improvements in interoperability between clinical HIT systems.[34]

Examples of systemic failures within current health systems – administrative and clinical

The following examples highlight that these systemic failures are an international problem and not localised to Australia.

Even though countries such as Denmark, the Netherlands, Singapore, Australia, Singapore and Canada have achieved much higher adoption rates of electronic health record (EHR) projects, there are mixed evaluations on the impact that these systems have on healthcare.[35]

For example, problems associated with HIT implementation at the national level have been highlighted recently by the United Kingdom's decision to end its national programme for HIT implementation within the NHS after spending £6.4 billion of the allotted £11 billion. One estimate from government officials is that more than £12 billion has been spent. Much of this waste is related to poor project design, and blame has been largely directed towards civil servants (administration) for this fiasco; civil servants have also been blamed for keeping ministers in the dark over the 'unbelievable' scale of the 'disaster'.

This particular case stresses how difficult it is to resolve the complex issues of contracts, product capabilities and vendor performance. These can actually be more difficult to deal with than issues related to patient safety.[36]

The Canadian healthcare system has many similarities with that of the Australian Medicare universal healthcare model: it also has a universal healthcare model based on a national levy on incomes and is intended to provide universal cost-effective, free access to care. Although it has less private insurance than the Australian model, the Canadian healthcare system still provides an excellent comparison on some core issues within health management.

Using the 2005 annual data taken from the Canadian health system in patients with chronic kidney disease (CKD), Levin *et al*. highlighted the issues of inappropriate and overuse of healthcare resources as a direct consequence of flawed physician CDM.[37] To illustrate this point, Levin *et al*. reported the following:

- 5% of CKD patients occupied 19% of patient beds unnecessarily
- 5% of CKD patients had 25% of unnecessary blood tests
- The costs of these unnecessary tests to the Canadian economy are CAN $4.55 million a year, with each test costing CAN ~$4.50 each

These data from the Canadian healthcare system reveal that many millions of unnecessary tests are being ordered, and this has a major effect on healthcare costs even when the costs of some of these unnecessary tests appear to be minimal (CAN $4.50 each). In 1979, Johns and Blum demonstrated that this excess in tests being ordered led to further information overload and affected future CDM.[38] For the total Canadian economy as a whole, these unnecessary tests create an economic burden totalling billions of dollars, which could be put to much better use elsewhere in the system.

In 2011, Dawson documented similar findings within the Canadian healthcare system on the overuse and inappropriate use of computed tomography scanners and magnetic resonance imaging.[39]

The Canadian examples are relevant to the Australian context because Australia currently uses imprecise and somewhat inaccurate healthcare evaluation parameters and measures. Similar findings of inappropriate and overuse of healthcare resources have been found in the United Kingdom, which is also a relevant comparison for the Australian healthcare system.[40]

Thus, the resource utilisation phenomenon is international. A study in the United Kingdom revealed significant incidences of unnecessary tests being ordered in emergency admissions departments during after-hours, rostered on-call times. All these unnecessary tests were related to the continued use of predominantly paper-based record systems and poorly designed e-health systems, which can be seen as an ineffective support for the core function of CDM and the associated essential technology of computerised provider order entry (CPOE). The process of CPOE is where the physician (or other clinician including patients) has the prime responsibility for the data capture not available electronically from other sources.[40]

Another factor contributing to the high costs and poor quality of healthcare, and directly related to CDM, is the occurrence of adverse drug events (ADE).

Using existing clinical systems to monitor and detect these ADE, Bates *et al*. demonstrated that within most hospitals, reliance is placed on spontaneous voluntary reporting of identified adverse events (often in paper records). However, this method overlooks more than 90% of adverse events detected by other methods, such as retrospective chart review (only a slight improvement) and computerised clinical decision support (CCDS), but is expensive and does not facilitate prevention.[41]

Similar benefits of ADE detection as shown by Bates, using a computerised alerting system based on a longitudinal electronic record, were found using the e-health system developed in-house at the Latter Day Saints Hospital in Utah.[42]

The non-clinical costs of preventable ADE have also been evaluated, and demonstrate the high costs involved for physicians, patients and medical indemnity groups. This was demonstrated by Rothschild *et al*. in 2002. His study revealed that there was an equal incidence of ADE in inpatient and outpatient settings, of which more than 73% were preventable, and 43% of these were life-threatening or fatal. The cost of resolving (i.e. settling through indemnity) these preventable events was a mean of US$367 000 versus US$64 000–US$74 000 for non-preventable ADE.[43]

In Australia, there is no clear evidence on the incidence of ADE outcomes. However, a recent Cochrane review by Callen *et al*. confirmed the high-risk situations that physicians are placing patients in at the time of discharge from healthcare institutions by failing to follow up on tests already performed. This means that the continuity of care among the physician, the patient and the primary care practitioner is broken at the time of discharge.[44]

A final example of systemic failures that occur within the current healthcare systems and which affect physicians is that of communication (or lack of communication) among hospitals, PCP and patients. The cornerstone of these communications is considered to be the discharge summary.

Despite the known benefits of electronic discharge summaries, this aspect of e-health remains poor among clinicians. Fries and Whiting-O'Keefe *et al*. demonstrated that computerised summary formats did not diminish the quality of healthcare communication, and tabulated results better enabled physicians to predict outcomes of care.[45,46] More recently, Sands has demonstrated benefits to care management and patient support using email communications directly with patients.[47]

Additional evidence confirming that communication across healthcare is inadequate comes from Holland. In 1994, Branger *et al*. documented the poor timeliness and poor quality of hospital discharge summaries. A key finding of this study was that 60% of standard letter format discharge documents are never read, indicating that the routine letters sent from hospitals to PCP (in cases where they are actually sent) are not only delayed but are also a poor communication tool for the continuity of care.[48] Similar findings were found by Kripalani *et al*. in 2007 in the United States.[49] This is despite the establishment of guidelines for email communications between physicians and patients.[23,50]

This evidence demonstrates some of the prominent roles that physicians have in the current healthcare system and their responsibility for some of its shortcomings. Therefore, major efforts must be made to change the current models of information management to make them more reliable and transparent and less prone to errors so that they can ultimately lead to improvements in patient care.[17]

Models of clinically focussed, effective e-health systems

The following series of examples demonstrate how effectively designed e-health systems with a 'clinical care focus' provide better patient care and can decrease costs while enhancing quality and access to care through better CDM and health information management. They also demonstrate that all these components are interrelated: what you do to one directly affects the others.

These systems address the problems of overuse, underuse, inappropriate use and variation in the use of clinical resources and communication that result from clinical information management overload and impaired CDM by the physician. The historical evidence for this dates from the late 1970s.[37,38]

These examples of e-health demonstrate how effective clinical computing can improve healthcare outcomes, as well as provide modelling for future e-health systems. They also demonstrate how computerised clinical information management knowledge can be transferred successfully to resource-poor nations and environments where they continue to expand to meet the demands of individual local and regional healthcare environments.

A critical component of these projects is that they are built on local and international collaborations that have evolved beyond disease-specific solutions, to education and prevention, and involve local ownership of the health information.[51–56]

On the issue of hospital to PCP communication, e-summarisation has been shown to be an effective tool since the 1980s.[45,46,57] Knowledge from that research formed the basis for the successful implementation of e-health systems through form designs in developing nations.[58]

Through the use of a well-established, in-house developed longitudinal e-health system (electronic record system) at the Regenstrief Institute in the United States, physician online ordering was influenced by electronic decision support that led to significant reductions in patient length of stay, laboratory testing, medications, bed and other charges. These benefits represented a US$3 million per year in savings in 1993 figures, which in the current era would represent billions of dollars.

The Regenstrief Medical Record System (RMRS) has been used by clinicians for decades, so any major changes that may be required (a known problem with vendor-based HIT projects) could be considered a potential cause for system failure. The designers of the RMRS recently needed to update the clinical decision support system with new technologies, and they were able to achieve this with minimal disruption to the clinical care functionalities on a database of more than eight million patients. This is an example of excellent user interface design and clinician end-user involvement in HIT projects.[59]

The management of antibiotic prescribing protocols remains an area of poor quality management in healthcare. Therefore, the results from a study on computerised antibiotic guidelines on more than 160 000 patients using the HELP (Health Evaluation through Logical Processing) record system in Utah are a strong affirmation of the benefits of appropriately designed clinical e-health systems. This study was designed to measure the clinical and financial outcomes resulting from the implementation of computerised antibiotic practice guidelines.[60]

The significant outcomes of this study are listed below.
- Overall antibiotic use: decreased 22.8%
- Mortality rates: decreased from 3.65% to 2.65%
- Antibiotic-associated ADE: decreased 30%
- Antibiotic resistance: remained stable
- Appropriately timed preoperative a/biotics: increased from 40% to 99.1%
- Antibiotic costs per treated patient: decreased from $122.66 to $51.90
- Acquisition costs for antibiotics: decreased from 24.8% to 12.9% ($987 547) to ($612 500)

The authors concluded from this study that the Case-Mix Index,[a] which measures patient acuity levels, increased during this period. This meant that they were treating sicker and sicker patients while better utilising the delivery of antibiotics. These conclusions regarding the Case-Mix Index are relevant because, as we measure care more accurately with better clinical data, there is emerging evidence that coarse measurements of healthcare costs, such as Case-Mix, Diagnostic Related Group[b] and Activity Based Funding,[c] are most likely inappropriate measures for determining the quality of healthcare and ongoing funding allocations.[27]

Broad recommendations for effective e-health solutions

From a broad perspective, for e-health systems to be effective, they must be mediated through effective CCDS and also support clinician provider order entry (CPOE), particularly at the physician level of patient care. The following core elements are essential to the effectiveness of e-health systems:
- Clinical information should be captured at computer terminals, at the point of each transaction through clinician provider order entry (CPOE) and not on paper. [A transition period is often required from paper to computer, and effective design of paper forms for CPOE has been shown to be accurate and efficient.][58]
- The ability to capture clinical information anywhere in the hospital or at any patient encounter is essential. This information should be available immediately wherever it is needed.
- The response time for CCDS should be rapid and measured in blink times. This is where the pre-defined data interrogation rules search the e-health database and deliver to the user an alert, reminder and other rule that is necessary for care at that time, for example serum potassium (K+) and digoxin.[52]
- The CCDS tools should be reliable and accurate.
- The e-health system should guarantee confidentiality, and the security of patient information should be protected.
- The CCDS should be friendly to the user and reinforce the user's (clinician's) behaviour. If clinicians are not involved, then system failure is guaranteed.
- There should be a common registry for all patients. This would permit ease of access for a wide range of functionalities, from day-to-day care to authorised research.[53]

E-health systems that have these core functionalities will eliminate the logistical problems of paper records by ensuring clinical data are timely, reliable, complete and available to all users of the system. They will also reduce the workload associated with clinical bookkeeping by reducing the incidence of missed diagnoses, ADE, medical errors and forgotten preventive care. Access to clinical data will be research 'gold' within these longitudinal lifelong records, and they will enable the development of better measures of care for clinical and epidemiological outcomes, as well as for research management.

Within these systems, the problems will not relate to the technology and data storage, which are rendered reliable by current technologies, but to the information management needs of physicians (clinicians) that must be addressed. This means that the e-health system must provide timely, reliable, complete information and knowledge access at the point of care and in formats that are relevant to the specific patient care process.[61]

The Australian healthcare system needs appropriate reform based on an effective e-health agenda.

Until 'clinicians', and in particular physicians, become involved and educated in clinical information management, we will continue to see expensive administrative, commercially driven and government-led implementation disasters. As a country, we are not alone in facing challenges with this aspect of healthcare delivery.[2,62]

[a]The term Case-Mix refers to the type or mix of patients treated by a hospital or unit.
[b]Diagnostic Related Group is a classification system that identified the 'products' that the patient received and standard practice for establishing reimbursements for other Medicare-related reimbursements, such as to home healthcare providers.
[c]Activity Based Funding is an information tool (similar to Case-Mix) that involves the use of scientific methods to build the classifications of patient care episodes.

International successes that can benefit Australian e-health projects

Examples of using existing e-health knowledge to provide the successful adaptation of HIT to resource-poor clinical environments are the Academic Model for the Provision and Treatment of Healthcare (AMPATH) and the Open Medical Record System (OpenMRS) projects.[63–65] These were initially designed to manage the HIV/AIDS epidemic in Africa but have now evolved to worldwide implementations and are supported by the WHO for all disease states. These projects form part of the core information management systems for the Millennium Villages Project.[66]

The benefits to care delivery, education and prevention delivered by these systems are built on the adaptations of the knowledge taken from systems such as the RMRS[63] and the international translocation of the Johns Hopkins Oncology system.[67] The application of clinical data capture and clinical decision support in the original Hopkins system cannot be underestimated. It used clinical summarisation, user-defined flow charts and data plots that supported decision-making. It had an advanced system of protocol-directed care management for oncology patients, which included pharmacology and allied healthcare management protocols. Data captured within the system were used for research and electronically supported the national cancer data registry. The core of this system was its complex data dictionary.[68]

In Hong Kong, there has been rapid implementation of a territory-wide e-health system with expanding complexity to meet the community and health authorities' needs. Features underlying the success of this project were strong government involvement and financing of the initial development of the clinical radiology system, and its demand for the territory to have a unified e-health system for all citizens. Crucial to this project's success was the project director's clinical focus on the systems development and measurement of effectiveness at all stages.[69,70]

These projects confirm that any successful national e-health system must have the following functionalities[71]: collaboration, scalability, flexibility, the facility for rapid form design, the use of standards, web-based connectivity and of low cost (preferably open-source and downloadable for free). Importantly, these e-health systems must be clinically useful.

Discussion

Based on existing experience and knowledge, the development of effective e-health systems must be supported through collaboration that involves both government and non-government organisations, and through openly shared developments and the 'best of breed' modules within these shared infrastructures. The developments must remain patient-focused and involve clinicians.

Any e-health system must aim to improve patient outcomes, and be able to be scaled to manage millions of patients and supports care, education, prevention, and research both locally and internationally.

Due to the complex nature of healthcare, any national e-health system must have the flexibility to cover all aspects of healthcare delivery. As part of this flexibility, the e-health system must provide the facility of rapid form design that will enable easy data capture in the patient care environment. This is the basis for good CPOE. Data are the core resource for healthcare evaluations.

It is the physicians who are the most important users of clinical data, and therefore they should be supported and involved in the design of systems to capture data for clinical care (i.e. CPOE) and support CDM.

Such systems must use the established available standards for healthcare and be able to incorporate newer standards that will be developed in the future. This will allow any effective e-health system to maintain its flexibility for the changing needs of care delivery.

By extension, the use of non-ambiguous coded data capture will also enable the system to be able to support high-class research for large populations.[52,53,55]

In the current era, web-based connectivity is essential for sharing data and information. In situations where internet connectivity is intermittent, modern technologies, such as mobile devices (phones, tablets devices), enable data capture, storage and manipulation until connectivity is restored.

To enhance cost-effective implementations, the overall system must be of low cost so as not to prohibit adoption. For developing nations, the nuts and bolts of the system must be downloadable for free (e.g. http://openmrs.org). This has become a very strong argument for the use of open-source, e-health systems.

Although the IOM refers to the 'essential' nature of HIT, these technologies are not without their failings. For the past several years, the Electronic Computerised Record Institute (ECRI) (https://www.ecri.org/Pages/default.aspx) has defined HIT as being among the 'top ten technology hazards in healthcare'. For instance, in their 2013 annual report on technology hazards (https://www.ecri.org/Documents/secure/Health_Devices_Top_10_Hazards_2013.pdf), the ECRI stated: 'Patient/data mismatches in EHRs and other health IT systems and Interoperability failures with medical devices and health IT systems were hazards number 4 and 5 respectively'.

The 2012 article by Coiera *et al*. provides a comprehensive overview of the nature and complexity of the problems associated with e-health and its relevance to the Australian healthcare environment. The article also emphasises the need to minimise harm from e-health.[72]

The lack of physician involvement in e-health projects often leads to clinically, non-useful systems or processes that can introduce patient harm and increase errors. This is described as, 'health IT done well' and 'health IT done poorly', a concept that has been extensively documented by Silverstein.[73]

Conclusions

The title of this paper asks 'Are doctors the structural weakness in the e-Health building?' The clear answer is yes; however, physicians are not the sole problem.

We need collaboration among governments, vendors and developers to build and implement effective e-health systems locally and nationally.

The critical role of the physicians (and other clinicians) is to provide guidance to the groups above on how e-health systems should best be designed to enable the effective safe delivery of care. The failure to engage physicians and other clinicians effectively and meaningfully will see the structures of healthcare reform fail repeatedly.

Physicians also have a major role in that they must overcome the resistance described by Leape and Berwick as the 'culture of medicine'.[33]

Modern web technologies are allowing patients to better manage their health, and so the role of the physician as we now know it will change radically and quickly, so physicians need to immerse themselves and be active players in the e-health revolution, or find themselves stranded in an era of healthcare information management that is costly and of inferior quality.

References

1 Liaw ST, Hannan T. Can we trust the PCEHR not to leak? *Med J Aust* 2011; **195**: 222.

2 NEHTA. PCEHR draft concept of operations. NEHTA; 2011 [cited 2011 Jan 2012]. Available from URL: http://www.nehta.gov.au/ehealth-implementation/pcehr-concept-of-operations

3 Coiera E. Why system inertia makes health reform so difficult. *BMJ* 2011; **342**: d3693.

4 Coiera E. Interaction design theory. *Int J Med Inform* 2003; **69**: 205–22.

5 Silverstein S. Health care information technology, hospital responsibilities, and joint commission standards. *JAMA* 2009; **302**: 382; author reply -3.

6 World Health Organization. Health topics e-health. 2012 [cited 2013 Jan 24]; Available from URL: http://www.who.int/topics/ehealth/en/

7 Detmer DE, Lumpkin JR, Williamson JJ. Defining the medical subspecialty of clinical informatics. *J Am Med Inform Assoc* 2009; **16**: 167–8.

8 Shortliffe EH, Perreault LE, Wiederhold G, Fagan LM, eds. *Medical Informatics: Computer Applications in Health Care and Biomedicine*. New York: Springer-Verlag; 2000.

9 Tierney WM, Kanter AS, Fraser HS, Bailey C. A toolkit for e-health partnerships in low-income nations. *Health Aff (Millwood)* 2010; **29**: 268–73.

10 Leao B. Terms of reference for designing the requirements of the health information system of the Maputo Central Hospital and preparation of the tender specifications. Geneva: World Health Organization; 2007.

11 Blum BI. *Implementing Health Care Information Systems*. New York: Springer_Verlag; 1989.

12 Coiera E. *A Guide to Health Informatics*, 2nd edn. New York: Oxford University Press; 2003.

13 Stead WW, Starmer JM. *Beyond Expert-Based Practice. Institute of Medicine (IOM) 2008. Evidence-Based Medicine and the Changing Nature of Health Care: 2007 Annual Meeting Summary*. Washington, DC: The National Academies Press; 2008; 94–105.

14 Jha AK, Classen DC. Getting moving on patient safety – harnessing electronic data for safer care. *N Engl J Med* 2011; **365**: 1756–8.

15 Jha AK, Prasopa-Plaizier N, Larizgoitia I, Bates DW, Research Priority Setting Working Group of the WHOWAfPS. Patient safety research: an overview of the global evidence. *Qual Saf Health Care* 2010; **19**: 42–7.

16 McKinsey Company. The eHealth Readiness of Australia's Allied Health Sector. Department of Health and Ageing, 2011.

17 Dick RS, Steen EB, Detmer DE. *The Computer-Based Patient Record: An Essential Technology for Health Care*, revised edn. Washington, DC: National Academy Press; 1997.

18 Committee On Patient Safety. *Health Information Technology Institute of Medicine, Health IT and Patient Safety Building Safer Systems for Better Care*. Washington, DC: The National Academies Press; 2011.

19 Fineberg HV. Shattuck lecture. A successful and sustainable health system – how to get there from here. *N Engl J Med* 2012; **366**: 1020–7.

20 OECD. Health policies and data OECD Health Data 2012. OECD; 2012 [cited 2013 Feb 12]; Available from URL: http://www.oecd.org/els/healthpoliciesanddata/oecdhealthdata2012-frequentlyrequesteddata.htm

21 Australian, Health, Ministers, Conference. National e-health strategy. Melbourne: Victorian Department of Human Services; 2008 [2012 April 27]. Available from URL: http://www.ahmac.gov.au/cms_documents/National%20E-Health%20Strategy.pdf

22 Slack WV. *Cybermedicine, How Computing Empowers Doctors and Patients for Better Health Care*, 2nd edn. San Francisco, CA: Jossey-Bass; 2001.

23 Safran C, Sands DZ, Rind DM. Online medical records: a decade of experience. *Methods Inf Med* 1999; **38**: 308–12.

24 McCollum C. UK National Health Service R&D funding – a bureaucratic nightmare. *Lancet* 2003; **361**: 1906.

25 Orszag PR, Ellis P. Addressing rising health care costs – a view from the Congressional Budget Office. *N Engl J Med* 2007; **357**: 1885–7.
26 Blumenthal D. The variation phenomenon in 1994. *N Engl J Med* 1994; **331**: 1017–8.
27 Wennberg JE. Practice variation: implications for our health care system. *Manag Care* 2004; **13**(Suppl): 3–7.
28 Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EL. The implications of regional variations in Medicare spending. Part 2: health outcomes and satisfaction with care. *Ann Intern Med* 2003; **138**: 288–98.
29 Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EL. The implications of regional variations in Medicare spending. Part 1: the content, quality, and accessibility of care. *Ann Intern Med* 2003; **138**: 273–87.
30 Zhang Y, Baicker K, Newhouse JP. Geographic variation in the quality of prescribing. *N Engl J Med* 2010; **363**: 1985–8.
31 Zhang Y, Baicker K, Newhouse JP. Geographic variation in Medicare drug spending. *N Engl J Med* 2010; **363**: 405–9.
32 Kohn LT, Corrigan JM, Donaldson MS. *To Err Is Human: Building a Safer Health System: Committee on Quality of Health Care in America Institute of Medicine*. Washington, DC: National Academy Press; 2000.
33 Leape LL, Berwick DM. Five years after To Err Is Human: what have we learned? *JAMA* 2005; **293**: 2384–90.
34 James BC. The Quality Measurement and Management Project (QMMP). Chicago, IL: The Hospital Research and Educational Trust 1989. Catalog no. 169501.
35 Bates DW, Ebell M, Gotlieb E, Zapp J, Mullins HC. A proposal for electronic medical records in U.S. primary care. *J Am Med Inform Assoc* 2003; **10**: 1–10.
36 Whalen J. U.K. ends health-service IT upgrade. *New York Times* 2011 [cited 2013 Feb 6]. Available from URL: http://online.wsj.com/article/SB10001424053111904563904576587054273647780.html
37 Levin A, Chaudhry MR, Djurdjev O, Beaulieu M, Komenda P. Diabetes, kidney disease and cardiovascular disease patients. Assessing care of complex patients using outpatient testing and visits: additional metrics by which to evaluate health care system functioning. *Nephrol Dial Transplant* 2009; **24**: 2714–20.
38 Johns RJ, Blum BI. The use of clinical information systems to control cost as well as to improve care. *Trans Am Clin Climatol Assoc* 1979; **90**: 140–52.
39 Dawson H. Family doctors and lower diagnostic imaging costs: how do we get there from here? *Healthc Policy = Politiques De Sante.* 2011; **6**: 32–4.
40 McConnell AA, Bowie P. Unnecessary out-of-hours biochemistry investigations – a subjective view of necessity. *Health Bull (Edinb)* 2002; **60**: 40–3.
41 Bates DW, O'Neil AC, Boyle D, Teich J, Chertow GM, Komaroff AL *et al*. Potential identifiability and preventability of adverse events using information systems. *J Am Med Inform Assoc* 1994; **1**: 404–11.
42 Classen DC, Pestotnik SL, Evans RS, Burke JP. Computerized surveillance of adverse drug events in hospital patients. *JAMA* 1991; **266**: 2847–51.
43 Rothschild JM, Federico FA, Gandhi TK, Kaushal R, Williams DH, Bates DW. Analysis of medication-related malpractice claims: causes, preventability, and costs. *Arch Intern Med* 2002; **162**: 2414–20.
44 Callen JL, Westbrook JI, Georgiou A, Li J. Failure to follow-up test results for ambulatory patients: a systematic review. *J Gen Intern Med* 2012; **27**: 1334–48.
45 Fries JF. Alternatives in medical record formats. *Med Care* 1974; **12**: 871–81.
46 Whiting-O'Keefe QE, Simborg DW, Epstein WV, Warger A. A computerized summary medical record system can provide more information than the standard medical record. *JAMA* 1985; **254**: 1185–92.
47 Sands DZ. ePatients: engaging patients in their own care. Medscape. *J Med* 2008; **10**: 19.
48 Branger PJ, van't Hooft A, Duisterhout JS, van der Lei J. A standardized message for supporting shared care. *Proc Annu Symp Comput Appl Med Care* 1994; 473–7.
49 Kripalani S, LeFevre F, Phillips CO, Williams MV, Basaviah P, Baker DW. Deficits in communication and information transfer between hospital-based and primary care physicians: implications for patient safety and continuity of care. *JAMA* 2007; **297**: 831–41.
50 Sands DZ. Electronic patient-centered communication: managing risks, managing opportunities, managing care. *Am J Manag Care* 2000; **5**: 1569–71.
51 Borst F, Appel R, Baud R, Ligier Y, Scherrer JR. Happy birthday DIOGENE: a hospital information system born 20 years ago. *Int J Med Inform* 1999; **54**: 157–67.
52 McDonald CJ, Overhage JM, Tierney WM, Dexter PR, Martin DK, Suico JG *et al*. The Regenstrief Medical Record System: a quarter century experience. *Int J Med Inform* 1999; **54**: 225–53.
53 Slack WV, Bleich HL. The CCC system in two teaching hospitals: a progress report. *Int J Med Inform* 1999; **54**: 183–96.
54 Teich JM, Glaser JP, Beckley RF, Aranow M, Bates DW, Kuperman GJ *et al*. The Brigham integrated computing system (BICS): advanced clinical systems in an academic hospital environment. *Int J Med Inform* 1999; **54**: 197–208.
55 Gardner RM, Pryor TA, Warner HR. The HELP hospital information system: update 1998. *Int J Med Inform* 1999; **54**: 169–82.
56 Braitstein P, Einterz RM, Sidle JE, Kimaiyo S, Tierney W. 'Talkin' about a revolution': how electronic health records can facilitate the scale-up of HIV care and treatment and catalyze primary care in resource-constrained settings. *J Acquir Immune Defic Syndr* 2009; **52**(Suppl 1): S54–7.
57 Bart S, Hannan T. The use of existing low-cost technologies to enhance the medical record documentation using a summary patient record [SPR]. *Stud Health Technol Inform* 2007; **129**: 350–3.
58 Mamlin BW, Biondich PG. AMPATH Medical Record System (AMRS): collaborating toward an EMR for developing countries. *AMIA Annu Symp Proc* 2005; 490–4.
59 Duke JW, Mamlin B, Martin D, eds. Regenstrief's Institute's next-generation clinical decsion support system. AMIA Winter Symposium 2012, Chicago, IL; 2013.
60 Pestotnik SL, Classen DC, Evans RS, Burke JP. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. *Ann Intern Med* 1996; **124**: 884–90.

61 Safran C, Porter D, Rury CD, Herrmann FR, Lightfoot J, Underhill LH *et al*. ClinQuery: searching a large clinical database. *MD Comput* 1990; **7**: 144–53.
62 MITRE, Corporation. Electronic health records overview. McLean Virginia: NIH National Center for Research Resources; 2006 [cited 2012 Jan 10]. Available from URL: http://www.ncrr.nih.gov/publications/informatics/ehr.pdf
63 Tierney WM, Rotich JK, Hannan TJ, Siika AM, Biondich PG, Mamlin BW *et al*. The AMPATH medical record system: creating, implementing, and sustaining an electronic medical record system to support HIV/AIDS care in western Kenya. *Stud Health Technol Inform* 2007; **129**: 372–6.
64 Seebregts CJ, Mamlin BW, Biondich PG, Fraser HS, Wolfe BA, Jazayeri D *et al*. The OpenMRS Implementers Network. *Int J Med Inform* 2009; **78**: 711–20.
65 Wolfe BA, Mamlin BW, Biondich PG, Fraser HS, Jazayeri D, Allen C *et al*. The OpenMRS system: collaborating toward an open source EMR for developing countries. *AMIA Annu Symp Proc* 2006; 1146.
66 Kanter AS, Negin J, Olayo B, Bukachi F, Johnson E, Sachs SE. Millennium Global Village-Net: bringing together Millennium Villages throughout sub-Saharan Africa. *Int J Med Inform* 2009; **78**: 802–7.
67 Hannan T. International transfer of the Johns Hopkins Oncology Center clinical information system. *MD Comput* 1994; **11**: 92–9.
68 Enterline JP, Lenhard Jr R, Blum BI. *A Clinical Information System for Oncology*. New York: Springer-Verlag; 1989.
69 Cheung NT, Fung V, Wong WN, Tong A, Sek A, Greyling A *et al*. Principles-based medical informatics for success – how Hong Kong built one of the world's largest integrated longitudinal electronic patient records. *Stud Health Technol Inform* 2007; **129**: 307–10.
70 Sek AC, Cheung NT, Choy KM, Wong WN, Tong AY, Fung VH *et al*. A territory-wide electronic health record – from concept to practicality: the Hong Kong experience. *Stud Health Technol Inform* 2007; **129**: 293–6.
71 Biondich PG, Mamlin B, Hannan TJ, Tierney WM. A call for collaboration: building an EMR for developing countries. *AMIA Annu Symp Proc* 2005; 894.
72 Coiera EW, Kidd MR, Haikerwal MC. A call for national e-health clinical safety governance. *Med J Aust* 2012; **196**: 430–1.
73 Silverstein S. A new ECRI Institute study on health information technology-related events. Drexel University; 2012 [cited 2013 Feb 14]. Available from URL: http://hcrenewal.blogspot.com/2013/02/ecri-institute-pso-uncovers-health.html

LETTERS TO THE EDITOR

Clinical-scientific notes

Deep vein thrombosis in association with acute intravascular haemolysis in glucose-6-phosphate dehydrogenase deficiency: a unique case

Glucose-6-phosphate dehydrogenase (G6PD) deficiency is well known to cause haemolysis in susceptible individuals, but the association with thrombosis has not been previously described.

A 40-year-old, previously fit, non-smoking man presented with 5 days of fatigue, back pain, breathlessness and jaundice. He was anaemic with a haemoglobin (Hb) of 63 g/L, associated with intravascular haemolysis. Lactate dehydrogenase (LD) was 2210 (normal <420) and bilirubin was 97 (<20), with normal liver function tests. He had haemoglobinuria and undetectable plasma haptoglobin. Blood film showed oxidative haemolysis (see Fig. 1). He had consumed a large quantity of raw broad (fava) beans the evening before symptom onset. Quantitative analysis of G6PD enzymatic activity on the

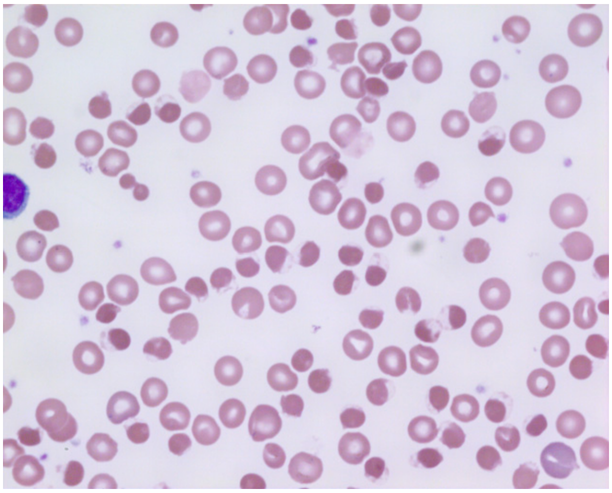

Figure 1 Blood film on admission showing many blister cells, characteristic of oxidative haemolysis.