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Any information you find here about this topic ( health informatics in Australia ) take it and do paraphrase ( on your word ) I hope it eassy for you.

Is the Biggest Security Threat

to Medical Information Simply

a Lack of Understanding?

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Abstract.

Connecting Australian health services and the e-health initiative is a

major focus in the current health environment. Many issues are presented as key to

its success including solving issues with confidentiality and privacy. However, the

main problem may not be these issues in sharing information but the fact that the

point of origin of such records is still relatively insecure. This paper highlights why

this may be the case. Research into the security of medical information has shown

that many primary healthcare providers are unable to create an environment with

effective information security. Numerous factors contribute to this complex situation

including a trustful environment, the resultant security culture and the capability

of individual healthcare organisations. Further, the growing importance of new

directions in the use of patient information is considered. This paper discusses these

issues and positions them within the complex environment that is healthcare. In our

current health system infrastructure, the points of origin of patient information are

our most vulnerable. This entwined with progressively new uses of this information

expose additional security concerns, such as re-identification of information, that

require attention.

Keywords.

Medical information security, electronic medical records, e-health, re-

identification

Introduction

Information security in the medical context is not a straightforward subject. A lack of

understanding of security concepts, together with an underestimation of potential threats

and the difficulty in configuration of security technology countermeasures, contributes

to the failure to recognise the seriousness of security threats to patient and practice

information. This problem is not confined healthcare, however it is complicated by the

value society places on patient information, some of which is sensitive in nature. Further,

this situation is compounded by working in an environment which values and fosters

high levels of trust. Information security has always been a balancing act between the

effective protection of information and easy access to that information, and therefore

strategies to meet these competing criteria are difficult.

Preface

Australia has a long history of involvement in the progress of health informatics.

Through substantial endeavours in theory and practice, in numerous arenas including

software development, standardisation, evaluation, policy development and education,

Australian contributors have made impacts on the world health informatics scene.

Much of this work has been reported annually at ‘HIC’ – the annual Health Infor-

matics Conference series hosted by the Health Informatics Society of Australia (HISA).

After 19 years, this meeting has ‘come of age’ to constitute the premier Australian aca-

demic platform for a wide range of topics in health informatics. In acknowledgement of

this status, HIC 2011 offers its proceedings of full scientific papers for the first time in

this monograph format, enabling international access to this highly selective showcase

of current Australian health informatics research. We are proud to take our place in a

publication series that caters for major international conference proceedings in health

informatics, including MedInfo and Medical Informatics Europe.

The theme for HIC 2011 draws on a fundamental aspect of health informatics: its

ability to transform processes and practices within healthcare through innovation.

These transformations address topics over a wide range of different sectors in the

health system, from primary and acute care to preventative and public health. It is a

hallmark of many of the papers that they not only provide solid background and tech-

nical substance in their content, but also exhibit practical implementations and demon-

strations of their worth.

All papers appearing in this collection have been subject to double blind peer re-

view by at least three members of the panel of experts, convened specifically for this

purpose. The peer review process for HIC includes detailed feedback comments from

reviewers, to which authors are required to respond formally when providing the final

revised versions of their papers. The Scientific Program Committee members oversaw

the selection of papers from those which were ranked highly during review, and ulti-

mately 24 papers were selected from 39 submitted. Collectively these offer a compre-

hensive profile of active research areas in Australian health informatics.

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**A Student-Centred Electronic Health**

**Record System for Clinical Education**

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Abstract.

Introduction.

Electronic Health Record (EHR) systems are an increasingly

important feature of the national healthcare system [1]. However, little research has

investigated the impact this will have on medical students’ learning. As part of an

innovative technology platform for a new masters level program in medicine, we are

developing a student-centred EHR system for clinical education. A prototype was

trialed with medical students over several weeks during 2010. This paper reports on

the findings of the trial, which had the overall aim of assisting our understanding of

how trainee doctors might use an EHR system for learning and communication in a

clinical setting.

Background.

In primary care and hospital settings, EHR systems offer

potential benefits to medical students’ learning: Longitudinal tracking of clinical

progress towards established learning objectives [2]; Capacity to search across

a substantial body of records [3]; Integration with online medical databases [3];

Development of expertise in creating, accessing and managing high quality EHRs

[4]. While concerns have been raised that EHR systems may alter the interaction

between teachers and students [3], and may negatively influence physician-patient

communication [6], there is general consensus that the EHR is changing the current

practice environment and teaching practice needs to respond.

Methods.

Final year

medical students on clinical placement at a large university teaching hospital

were recruited for the trial. Following a four-week period of use, semi-structured

interviews were conducted with 10 participants. Audio-recorded interviews were

transcribed and data analysed for emerging themes. Study participants were also

surveyed about the importance of EHR systems in general, their familiarity with

them, and general perceptions of sharing patient records.

Conclusions.

Medical

students in this pilot study identified a number of educational, practical and

administrative advantages that the student-centred EHR system offered over their

existing ad-hoc procedures for recording patient encounters. Findings from this

preliminary study point to the need to introduce and instruct students’ on the use

of EHR systems from their earliest clinical encounters, and to closely integrate

learning activities based on the EHR system with established learning objectives.

Further research is required to evaluate the impact of student-centred EHR systems

on learning outcomes.

that EHRs will facilitate the delivery of quality healthcare by providing storage of

healthcare information, management of results, evidence-based decision support, direct

entry of medical orders and outcomes reporting [2]. In response to calls for the widespread

adoption of EHRs, medical educators are now considering the best way to integrate EHRs

into medical school curricula. However, little research has been conducted on the effects

of EHRs on medical education, to guide implementation strategies.

As part of an innovative technology platform for a new masters level program in

medicine, we are developing a student-centred EHR system for clinical education. Our

university’s new postgraduate medical curriculum (from 2011) has a strong emphasis

on integrating bioscience knowledge with clinical experiences, and the student-centred

EHR system has been designed to support this focus. It will play a pivotal role in

students’ clinical based learning, allowing them to quickly and effectively capture details

of their clinical encounters with a diverse range of patients. Students are required to

obtain consent from patients before entering their information into the system and do not

enter information that could potentially identify the patient, such as name, birth date or

hospital ID number. Clinical teaching staff will monitor records to ensure that information

is de-identified. Patient information is stored in a secure networked database, requiring

authentication to access.

In addition, the student-centred EHR system mediates simple online access to

specialist medical information sources including drug and medical conditions databases,

along with learning resources and primary literature. Over time, through the contribution

of student-generated records, the system will develop into a rich personal and shared

repository of patient encounters. Students as well as teaching and clinical staff will be

able to draw on this repository to support a range of clinically oriented learning activities

and objectives.

During the second half of 2010, a prototype of the student-centred EHR system was

trialed with final year students in our university’s current undergraduate medical course.

This paper reports on the findings of the trial, which had the overarching goal of assisting

us in understanding how trainee doctors might use the student-centred EHR system for

learning and communication in a clinical setting. More specifically, we aimed to elicit

student preferences and perceptions of EHR systems in general, and our prototype

specifically.

1. Background

As an increasingly important feature of both primary care and hospital settings, EHR

systems offer potential benefits to medical students’ learning. It is well known, for

example, that longitudinal tracking of a trainee’s clinical experience can provide a

measure of their progress towards established learning objectives [3]. EHRs provide easy

opportunities for teaching staff to access, evaluate and provide feedback on the quality of

students’ patient records over time [4]. In one study, 39% of students reported receiving

more feedback on electronic notes than their paper notes [5]. In addition, EHRs can be

used to log the number of procedures a trainee has performed in a given time period.

EHR systems that allow users to search for specific keywords across records enable

students to more effectively review their own cases and to compare and contrast their

experiences with cases entered by others [4]. Such systems can support a more equitable

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learning experience for students placed across a broad range of clinical sites, by providing

easy access to a rich, shared repository of patient encounters [6]. Moreover, the capacity

to search across a substantial body of records provides new opportunities for students to

discover and reinforce relationships between different cases and conditions, and to gain

a better understanding of their diagnosis and management.

Many comprehensive EHRs provide some level of integration with online medical

databases, which can facilitate

‘

just in time learning’ for students in busy clinical settings

[4]. Finally, the use of EHRs during their early clinical experiences allow students to

develop expertise in the practice of creating, accessing and managing high quality

electronic patient records; key skills, given their increasing use across hospital, specialist

and general practice settings [6].

Despite the potential benefits, some clinicians have raised concerns that EHR

systems that provide online access to comprehensive patient information, including

progress notes and diagnostic laboratory results etc., may alter the interaction between

teachers and students [4]. Traditionally in a clinical setting, medical students have learnt

to synthesis clinical information and present it in a consequential manner to clinicians.

It has been argued that EHRs may remove the need for students to describe patient

information orally, resulting in fewer opportunities for students to practice the skill of

“

transforming patient-specific details into abstract terms

”

[4]. Moreover, the use of

prompts, templates and existing drug and problem lists in EHRs may reduce students’

ability to learn basic history taking and physical exam skills [7].

Medical students have also highlighted the potential negative influence of EHRs

on physician-patient communication. While third year medical students reported

generally positive attitudes towards using the EHR in the ambulatory setting, they did

report significant concerns about the potential impact of the EHR on their ability to

conduct the doctor-patient encounter [5]. In a follow up study, it was shown that first year

medical students did not spontaneously demonstrate EHR skills [8]. However, following

explicit teaching of EHR-specific communication skills, using guided discovery

methods, brief didactics and practice role-plays, they were then able to demonstrate these

skills in a simulated patient case. Moreover, such skills did not correlate with general

communication skills.

Despite ongoing debate around the pros and cons of using EHRs in medical education,

there is general consensus that the EHR is changing the current practice environment and

teaching practice will need to respond to these changes.

2. Methods

A prototype of a student-centred EHR system was piloted with medical students over

several weeks during 2010.

2.1. Participants

The study was conducted with Human Research Ethics approval. Final year medical

students on clinical placement at a large university teaching hospital in Melbourne, were

recruited for the trial. Participation was voluntary and each participant received a $25

book voucher as an incentive.

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2.2. Measures

As part of a larger data collection on students’ use of communication and information

technology for personal and study related activities, study participants were surveyed

before the pilot about the importance they placed on the use of EHR systems in general,

and their familiarity with them. They were also surveyed about their general perceptions

of sharing, viewing and commenting on patient records. Questionnaire items asked

students to rate their response on a five point Likert scale (1

not at all important, not at

all familiar, very uncomfortable or strongly disagree to 5

very important, very familiar,

very comfortable, or strongly agree). The mean and standard deviation of ratings were

calculated and are shown in Table 1.

Table 1.

Mean student ratings of the importance and familiarity with EHR systems in general, and of sharing,

viewing and commenting on patient records.

Question Mean (n

14) SD

1. How important do you think the use of EHRs is ...

from a patient perspective 3.85 0.90

from a doctor’s perspective 4.31 0.75

2. How familiar are you with the use of EHRs ...

from a patient perspective 2.54 1.05

from a doctor’s perspective 3.23 1.01

3. How comfortable are you with sharing records of your clinical encounters with ...

Other generally 2.86 1.17

Students 3.64 0.93

Teaching staff 3.57 1.09

Clinical staff 3.50 1.02

4. In relation to the EHR created by you, how strongly do you agree with the following ...

Being able to view records of other students’ clinical encounters is a

good idea

3.50 1.34

Being able to comment on records of other students’ clinical encounters

is a good idea

3.14 1.29

Allowing teaching staff to comment on records of your clinical

encounters is a good idea

4.29 0.91

Allowing clinical staff to comment on records of your clinical

encounters is a good idea

4.07 1.07

Semi-structured interviews were conducted with participants to determine their

preferences and perceptions of the student-centred EHR prototype. Interviews were

based around 18 questions developed using Bevan’s Quality in Use framework [9].

Questions elicit responses in four categories; actual experience, goals, performance and

satisfaction. A sample of questions from each category are provided below:

long term will facilitate integrated record management (including all medical and allied healthcare) and provide for: • All billing, including Medicare and Hicaps • Alignment with pathology and radiology results • Alignment with insurance reports • Alignment with e-health requirements including personal health records • Facilitated medicines dispensing • Dispensing Consumer Medicines Information (CMIs) • Capacity to deliver longitudinal data and link with other databases. • Support and integrate quality assurance mechanisms. • Decision support software including herb-drug interaction flags; diagnostic and prescribing tools. Achieving inter-operability among above mentioned systems is a challenging task in terms of data formats, security, privacy and data integrity. Where possible we plan to use SNOMED terminology [15] and OpenEHR archetypes [16] to facilitate interoperability. We also plan to use HL7 messaging format between our TCM data capture system and other systems as HL 7 already address some of the security and privacy issues [17]. Consideration also needs to be given to issues such as access and authentication controls to ensure only authorised users/external systems can access this system, audit trails of user activities and the safe and secure storing of the data, including back-up processes. 2. Results and Discussion There are an estimated 8,000 TCM practitioners in Australia who from July 2012 will be required to comply with national registration requirements in order to practice. Encouraging the movement from paper based to electronic consultation records, supplemented with decision support software, can facilitate safe and effective clinical practice. A reliable effective electronic clinical record system will be widely supported by government and health insurers alike, especially if decision support software that can signal safety risks (such as known herb-drug interactions) is built into such system. TCM practitioners will have a strong interest in the software as, in addition to initially help improving safety and effectiveness of practice, subsequent versions will increase professional efficiency through rapid billing mechanisms, including Medicare and Hicaps; alignment with pathology and radiology results; alignment with insurance reports; and by facilitating dispensing of medicines. Given the lack of electronic consultation data management outside of general medical practice, this project (and software designs) will eventually be extended to other allied health professions and is of international significance. References

Amsterdam, NLD: IOS Press, 2011. p 14.

new linkage projects. This may lead the way to the gradual replacement of existing traditional LRR’s (that rely on person identifiers) to LRR’s utilising GRHANITE™ privacy-protecting technology where data is aggregated for research purposes only. 3.4. Implications for Research The availability of GRHANITE to BioGrid will make it possible to link with Australian federal authorities’ data as well as general practice. The successful end-to-end tests show that BioGrid is ready to offer this service to sites that will not (or cannot) export patient demographic data from their jurisdiction (across state or international boundaries). 4. Conclusion In conclusion, we have been able to validate the efficacy of the GRHANITE™ record linkage systems and warrant them suitable for inclusion to the BioGrid systems. GRHANITE™ privacy-protecting record linkage has now been incorporated into BioGrid and new linkage projects are utilising this technology. As usage of GRHANITE™ increases in BioGrid, consideration may be given to use it as the exclusive record linkage system, subject to review and assessment. The potential for research is huge: • Privacy-protecting record linkage technology means that BioGrid can link-in national data across jurisdictions • BioGrid can enhance service provision to remote jurisdictions so they may also pursue research collaboration linking across institutions and data collections using the BioGrid infrastructure. • The use of the same privacy-protecting record linkage system as GRHANITE™ means large-scale, record linked research spanning the primary and secondary care divide is now possible across Australia. Finally, in the New England Journal of Medicine dated 12th January 2011 [12], a national sentinel surveillance system for the USA is described. Such a resource has not been possible in Australia to-date due to the challenges of integrating primary and secondary care data. With the arrival of privacy-protecting record linkage systems in Australia spanning all health sectors, such a capability is finally within our reach. References

Amsterdam, NLD: IOS Press, 2011. p 33.

learning. Patient safety is one of the most important aspects of healthcare and the use of the CEP can promote the quality and immediacy of bedside information and improve the accuracy of record keeping [4– 6]. Currently in Australia and overseas, there are limited information knowledge management systems for recording healthcare competencies for students and registered healthcare practitioners. The CEP was developed for a study [7] that investigated the use of personal digital assistants (PDAs) by critical care nurses when undertaking a 12 month postgraduate program. The findings showed that the nurses used the CEP to record their critical care competencies, however did this via the patient’s bedside computer, rather than the PDA, as it was more accessible and convenient. The nurses also believed that the PDA and accessing the CEP did not enhance their learning although the clinical competencies data was very useful to the educator supervising the program – provided an accurate record of competencies undertaken by each nurse undertaking the critical care program. With further refinement the CEP developed for this study has the potential to be a most valuable education tool for both learner and teacher in Australia and overseas. This paper will examine the CEP that was used in the PDA study [7] and then discuss the benefits of using this software program for the education of all healthcare professionals. 1. Clinical Experience Portal The CEP provides an integrated approach to clinical learning within hospital settings and could be used by any healthcare professional. This can be achieved technically through providing CEP access via a web portal where healthcare professionals, such as nurses, doctors and educators can freely log, record and share what they have experienced in the ward or clinical setting. The CEP used in the PDA study [7] was developed by the research team with nSynergy and the competencies used reflected those endorsed by the Australian College of Critical Care Nurses. Microsoft SharePoint Server is a collaboration and document-management platform that can be used to host web sites that access shared workspaces and documents, as well as specialised applications like wikis and blogs from a browser. 1.1. Overview of Using CEP The CEP could be accessed via the PDA or through the patient’s bedside computer. Nurses were encouraged to use the PDA to access the CEP to record their competencies and obtain educational material. However, as stated previously most preferred to use the patient’s bedside computer. The data recorded were stored on the network server and this could be accessed by the clinical teacher, the unit manager and the postgraduate student. An overview of the concept underlining the competency logging is outlined in Figure 1.

Amsterdam, NLD: IOS Press, 2011. p 66.

1.2. Example of Student Learning Related to Patient Case Scenario In this case scenario patient A has a spinal injury and was treated with steroid medication but after 24 hours the patient has not shown any improvement. The educator supervising students can post documents, such as X-rays supported by alternative medical opinions for students to assess, via the CEP. This was previously done manually. There was an option for each student to rate their competency level within particular situations, for example ‘I didn’t feel very confident in treating this patient 5/7’. CEP also allows educators to monitor and review each student on their progress and identify areas for improvement, while focussing on their individual strengths and weaknesses. For example, if a nurse has rated their confidence level at treating an intensive care patient as poor, this then alerts the educator to give them more exposure and assistance in this area. Alternatively a nurse may not have had any exposure to spinal injury patients during their training which alerts the educator to coordinate assistance in treating such injuries. In essence the CEP allows educators to use this information to tailor individual training needs thereby improving the quality and standards of healthcare. Being able to record these clinical experiences gives each student or healthcare professional the ability to self assess their own progress. The constant feedback, monitoring and review for clinical educators provide a detailed account on what procedures have been conducted and how these impacted on the patient care. In turn this culminates into ensuring best practice is delivered to the patient. 1.3. Collaborative Features The key collaborative features underpinning CEP are listed below: • Discussion boards and forums aided by search features, tagging and keyword inclusion, allows users to view and share knowledge, experiences and feedback. • Workflow features allows educators to conduct automatic sign off of record entries within the system. • Data retrieval features provides any clinical unit with a mechanism of “pulling” information from all types of sources and transforming that information into meaningful content to assist in the decision making process. Allows for real time reporting of work conducted and confidence scores by the clinical staff. • Portability of clinical records allows student or healthcare professional to take their clinical experience records with them wherever they go. Ensures that knowledge can be passed along easily and will also allow the educators to facilitate and coordinate educational material in a more efficient manner to enhance skill development. 2. Benefits for Using the Clinical Experience Portal The Australian federal government in 2008 endorsed a National E-Health Strategy for Australia [8] with a focus on (1) improving the quality and increasing the use of computers being used by healthcare providers, (2) the need to promote health information sharing between the various players in the healthcare system such as the hospitals, practitioners, and service providers, (3) to facilitate improvements in the quality, safety and efficiency

Amsterdam, NLD: IOS Press, 2011. p 69.

of care, and for (4) clinicians and health care providers to shift from paper records and adopt electronic information storage, exchange and decision support software. The CEP complements this strategy, especially focus (3) and (4). Other benefits include the reduction in healthcare costs – particularly related to adverse events – and the enhanced communication of knowledge and information for healthcare professionals and their educators. 2.1. Enhancing Patient Safety and Quality of Care Maintaining patient safety and quality care is becoming a major challenge to most healthcare providers due to decreasing hospital resources and increasing patient numbers. The complexity of patient care is also impacting on healthcare delivery. How well educated healthcare professionals are, and their continuing education needs, impacts on all these factors. The Australian Safety and Quality Framework for Health Care (ASQFHC) [9] in 2010 specified three core principles – that is care is consumer centred, driven by information, and organised for safety. The CEP software has the potential to enhance knowledge, attitudes and skill which can results in improved patient care, meeting the ASQFHC principles of “driven by information” and “organised by safety” Furthermore the project is important to ensure health professionals are well trained and prepared in their role to safely care for the community. There is an increasing recognition that the lack of evidence based interventions by healthcare professionals’ impacts on the quality of care and ultimately the sustainability of resource allocation. The key driver of the CEP is to ensure that the highest quality of care is provided by all healthcare professionals. Financially, this has the prospect of reducing costs in both public and private spending. Better patient care will also correspond to a decreasing the cost of health in Australia and globally. 2.2. Reducing Healthcare Costs In Australia the total cost of healthcare is envisaged to increase from $71.4 billion in 2002– 03 to $162.3 billion in 2032– 33. As a proportion of total gross domestic product (GDP), this represents an increase from 9.4% in 2002– 03 to 10.8% in 2032– 331, an annual growth of 0.5% above the overall economic growth rate. Other concerns beside cost are the sustainability and quality of the Australian healthcare system [10]. Approximately 2– 3 per cent of all hospital admissions in Australia are linked to medication errors. Costs associated with drug misuse, under use, overuse and reactions to therapeutic drugs equates to 190,000 hospital admissions each year and costs the Australia government $666 million. About 8 per cent of medical errors are because of inadequate patient information [10]. Clear, quickly available information will reduce such incidents, avoid unnecessary tests and save scarce health resources. The use of health IT was high on its agenda in addressing these concerns. It is estimated that 10– 20% of all adverse events are adverse drug events and most are potentially preventable. Other areas that inflate the health systems costs in Australia relate to health care associated infections, patient falls, and pressure ulcers. Many of the latter are preventable. The flow on effect of a CEP could potentially reduce healthcare costs as the focus in on patient safety and quality of care delivered.

Amsterdam, NLD: IOS Press, 2011. p 70.

The CEP has the potential to improve communication of knowledge and information between the learner and the educator. The healthcare professional will be able to tract their clinical learning and the educator will be able to facilitate and collaborate education material in a more efficient manner. The CEP will also allow educators to evaluate how education programs are delivered and how they can be improved. As many of the large hospitals in Australia are teaching institutions, the CEP will facilitate the collaboration of clinical education date between these organisations. The CEP can be used as a quality tool that ensures the healthcare professionals achieves minimum standards as it provides an accurate record of clinical experiences. The portal will also identify incompetent practices or lack of exposure to the clinical skill. The recording arm of this solution will make this achievable via an integrated global online network. From a learning perspective quality standardisation across classes and groups can be achieved through monitoring and auditing of clinical learning. More effective feedback is possible when health professionals in this domain are shift workers and are not easily able to connect to formal traditional classes and teachers. In rural settings many new healthcare practitioners are learning. Despite excellent learning opportunities being deemed competent in a distant and unstructured context can be difficult to determine. For example time (weeks) and location (city or rural, hospital size and services) are often the key descriptors of their learning. Using the CEP for recording the clinical experience of healthcare professionals has the potential to promote a safer healthcare environment where clinical competence is paramount. 3. Conclusion The CEP described in this paper was developed for a study [7] that examined the use of PDAs by critical care nurses for recording their competencies in a postgraduate program. The major benefit of using the CEP within a healthcare setting is the potential to enhance patient safety and quality and reduce healthcare costs, whereas for the clinician – student, graduate, educator and other health care professional – it is an educational tool that can improve the communication of knowledge and information. The research team who undertook this study are now seeking funding from Microsoft in consultation with nSynergy to further refine this CEP software program. Acknowledgements We thank the nurses for their participation and the Australian Research Council for providing the majority of funds for this research project.

Amsterdam, NLD: IOS Press, 2011. p 71.

Health Informatics Competencies – Underpinning E-Health Heather GRAIN 1 and Evelyn HOVENGA eHealth Education Pty Ltd (RTO: 32279) www.ehe.edu.au Abstract. There is a widespread consensus that we have an urgent need to improve our workforce capacity in all aspects associated with the skills and knowledge required for successful e-health and health informatics developments, associated change management and systems implementation strategies. Such activities aim to support various health reform policy initiatives. This paper considers the work being undertaken by many researchers around the globe to define the range of skills and knowledge requirements to suit this purpose. A number of requirements and areas of specialisation are detailed. This is followed by descriptions for competencies in general and more specifically descriptions of a set of high level agreed Health Informatics competencies. Collectively these competencies provide a suitable framework useful for the formal recognition of Health Informatics, including e-health, as a nationally recognised study discipline. Nationally agreed competencies for this discipline enables all education and training efforts to be consistently implemented and to fit with the Australian Qualifications Framework covering both the Vocational Education and Training (VET) and Higher Education sectors. Keywords. Education, Workforce, Health Information Technology, Competency Based Education. Introduction On a national and local basis healthcare in Australia is moving to adopt clinical information systems and sharing of clinical data [1– 2]. The demand for Health Informatics professionals is extending across existing health and ICT professional groups and into new areas including those who support the e-Health policy initiatives. To support national consideration for the skills required to enable successful implementation of these initiatives, existing health informatics professional associations and related organisations around the world are defining the health informatics profession, and identifying the competencies required to work safely in an e-enabled healthcare environment. This paper considers the work being undertaken by the International Medical Informatics Association (IMIA) [3], [4– 5] Health Infoway, the Australian Health Informatics Education Council AHIEC [6] and other organisations such as Health Level 7 (HL7) and the International Health Terminology Standards Development Organisation [7] to define the range of required workforce skills and knowledge.

Amsterdam, NLD: IOS Press, 2011. p 73.

1. Health Informatics – Scope AHIEC has taken existing definitions of health informatics and recognised that verbal definitions are problematic as they are dependent upon the audience to whom they are addressed. The result of consideration of the characteristics of health informatics has lead to a definition of health informatics – as a domain that seeks to improve health outcomes and healthcare system efficiency. This definition highlights the multi-dimensional nature of the domain showing the relationship between information, IT (hardware, software and communication) and the application of that technology across the whole continuum of healthcare. Figure 1. Definition of health informatics 2. Required Workforce Skills and Knowledge The need for a skilled e-health professional community are widely acknowledged [8– 10] and identified generally here, but this paper also identifies training requirements to support the development of those skills. These needs have been reviewed and are summarised here. An educational approach to meet these requirements includes: 1. Identification of the skills required of individuals in specific workplace and healthcare environments based on task and role analyses. 2. Availability of quality educative approaches that deliver a. National, professional and industry recognition of new Health Informatics competencies, and their relationships to existing professional group competencies (e.g.: nurses, health information managers (HIM), clinical informaticians, and information technology (IT) professionals). b. Relationships of required competency to jobs/roles, career and learning pathways c. Ability to select various skill components and join them to provide viable job descriptions and educational programs to meet those job competency and pathway requirements.

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d. Flexible approaches to delivery options which consider i. Short and long term delivery options ii. Multi-delivery method options are needed to meet diverse learner characteristics and needs. iii. Cost for individuals to gain new skills iv. Cost and timelines associated with course development v. Leveraging existing infrastructure where possible. Mechanism to confirm competence (including identification of minimum safe operational skills). Harmonisation with existing professions and professional role requirements Career pathways for existing and emerging professions that enhance and encourage people to take up professional development pathways. 3. The Health Informatics Discipline: Specialisations and Scope Health Informatics is multidisciplinary; there are many variations or specialisations that have emerged and are likely to continue to do so. There is a need to identify the relationships between specialist health informatics knowledge, and the knowledge required of all healthcare workers which relates to the use of systems and information in healthcare. Figure 2. Health informatics skill pyramid The Health informatics skill pyramid (Figure 2) shows a base of general information required of all health professionals, whether clinical, administrative or technical. We do not view this component of new skills and knowledge requirements as health informatics education. There is a need to build these skills amongst today’s healthcare workforce, and to ensure that those graduating into any of these professional groups in the future, or who

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change their career pathway into healthcare have these basic skills at graduation or prior to such career pathway changes The nature of health informatics is that no one professional is going to have a deep understanding of the whole scope of the profession [3]. Specialisations already exist and will continue to evolve [3, 11]. The pyramid groups some of these specialisations together into broad headings. The growth of information management for example has jobs with which we are all familiar – the HIM, Clinical Coder, and the Data Manager, while new jobs such as Clinical Terminologist and Terminology Implementer are still being defined at the IHTSDO [12– 13]. Figure 3 indicates the domains of Health Informatics and related fields as identified by AHIEC. This indicates that the domain requires understanding of three core areas and that this is true across all levels and settings of healthcare. Figure 3. The domains of health informatics [6] 4. Defining Skills and Knowledge Requirement: Competencies Competencies identify the knowledge and skills required of an individual to perform identifiable tasks or roles. Competencies are used by educators to identify the topics that need to be covered, the level of performance expected of an individual and by employers to assess individual competence as well as to describe professions, roles and jobs. In Australia’s Vocational and Education and Training (VET) sector clearly defined competency standards are used to: • Form the basis for the development of training packages, qualifications and skills sets, job descriptions and course programs – by taking different competencies (like ‘Lego’) to build the requirements for a course, a nationally recognised qualification or individual learning pathway. • Develop course material • Develop assessment methods that collect the necessary evidence to demonstrate competency (which need to be mapped against competencies required). Audit courses and educational programs offered. Quality education processes involve competency assessment. Simply attending an educational initiative may be useful but does not guarantee that any knowledge or skills

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were obtained. Competencies form a key requirement for development of assessment and evaluation of the skills of those who complete assessments. 4.1. Methods: Competencies for Health Informatics An investigation of existing Australian Health Informatics and related competencies, and competencies under review and development internationally where available as well as a literature review revealed the incorporation of specific input from the Health Information Management [14– 15], Nursing [16], Medical [17], Clinical Terminology [12– 13] and Health Informatics [3, 18] professions. These were used to identify a detailed set of Health Informatics competencies by undertaking an ontological analysis to consolidate all into a new comprehensive set of competencies for this discipline. These competencies were described in two axes, (1) the level of skill and (2) the area of skill. Our Australian analysis was based upon IMIA’s three general areas of Health Informatics skills: • Competency 1: Knowledge and knowledge management • Competency 2: Medicine, Health and Biosciences, Health System Organisation • Competency 3: Informatics/Computer Sciences, Mathematics, Biometry The level of competency is shown in the two columns on the right side of Tables 2, 3 and 4, each of which shows the level of skill required by that general or specialist area (student cohorts). Each table represents a general area of Health Informatics skills as used by IMIA. The codes used represent the Bloom Levels of skill (with minor modifications to reflect the methods used by the Australian Computer Society(ACS) to represent skills in IT [19]. Table 1 shows the levels used to describe health informatics competencies. Level 1 2 3 4 5 6 Know about Understand Apply Enable Advise Strategise Table 1. Bloom levels of competency [20] (Axis 1) Short Description Other Words that Describe this Level Knowledge (Novice) Assist (Advanced Beginner) Competent to apply knowledge Analyse (Competent/Proficient) Ensure, Advise, Initiate, Influence – Synthesis (Proficient/Expert) Set Strategy, Inspire, Expert The following tables 2– 4 outline the units competencies that relate to the group of workers identified in the bottom two elements of the Health Informatics skill pyramid (Figure 1). These key components are a subset of the very detailed set developed and under review by the AHIEC, of which the Health Informatics Society of Australia (HISA), Health Information Management Association of Australia (HIMAA), the Australasian College of Health Informatics (ACHI) and Health Level 7 (HL7) are auspicing organisations. The knowledge areas includes how healthcare operates, as well as how information systems operate within healthcare, and IT tools used to support data collection and use. Many of these skills are already present in those with a health background, but for IT professionals there may be new skills to be developed for them to work effectively and

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5. Findings and Conclusion These competencies, though still in development, were found to provide a suitable framework from which to define the range of skills and knowledge requirements to improve health workforce capacity required for the successful e-health developments. This framework enables the identification of many units as well as levels of competency to suit the many and varied roles and positions found within the entire health workforce. It fits with the Australian educational infrastructure and can be used to support: • Clearer identification of the Health Informatics profession. • Clarify the relationships between health informatics skills and knowledge and those applicable to other professional groups, including gaps and overlaps. • Support healthcare in Australia to determine workforce needs, and to adopt the most effective and efficient methods for Universities, the VET sector, Professional and Industry Organisations to develop the skills needed. • Employers to understand what is needed, and to evaluate those who offer or provide services to them. The Australian healthcare community is engaging actively in the identification of a pathway to health informatics skills in the workforce and ongoing refinement will occur. The work of the AHIEC was built on a strong internationally focused foundation. A complete set of competencies has now been identified. The next step is to develop these into full competency standards in accordance with the Department of Education, Employment and Workplace Relations (DEEWR) guidelines so that various training packages, qualifications and skill sets can be identified and endorsed by the National Quality Council. This ensures that education and training providers of all types can identify their own niche of expertise and that all competency based courses can be nationally recognised via the newly established regulator, the Australian Skills Quality Authority (ASQA). The next stages include identification of priorities, ongoing review and refinement of competencies, specialisations and role based requirements identification in a collaborative environment reflecting the multidisciplinary nature of healthcare and e-health. References

Amsterdam, NLD: IOS Press, 2011. p 80.

Abstract. This paper identifies the contribution of health and clinical informatics in the support of healthcare in the 21st century. Although little is known about the health and clinical informatics workforce, there is widespread recognition that the health informatics workforce will require significant expansion to support national eHealth work agendas. Workforce issues including discipline definition and self-identification, formal professionalisation, weaknesses in training and education, multidisciplinarity and interprofessional tensions, career structure, managerial support, and financial allocation play a critical role in facilitating or hindering the development of a workforce that is capable of realising the benefits to be gained from eHealth in general and clinical informatics in particular. As well as the national coordination of higher level policies, local support of training and allocation of sufficient position hours in appropriately defined roles by executive and clinical managers is essential to develop the health and clinical informatics workforce and achieve the anticipated results from evolving eHealth initiatives.

What is known about the topic? Health informatics is considered an emerging profession. There are not enough Health Informaticians to support the eHealth agenda.

What does this paper add? This paper considers the issues, barriers and facilitators of capacity building in the health informatics workforce with a special emphasis on Clinical Informaticians. The authors conclude that resources and awareness at the national, state and local health service levels is required to facilitate health and clinical informatics' capacity building.

What are the implications for practitioners? Recognition and support of the health and clinical informatics workforce is required to improve the appropriate implementation and use of Health Information Technology for clinical care, quality and service management.

Knowledge is the enemy of disease. [Sir Muir Gray, DirectorNHSNational Knowledge Service andNHSChief Knowledge Officer]1

Health information is fundamental to healthcare at every level from the macro level of global health system appraisal and strategy to the micro level of individual personal healthcare services available to consumers as patients .2 This paper examines the health informatics workforce requirements to support systems delivering the health information needs of health services in Australia, with a special emphasis on clinical informatics. The role of clinical informatics in healthcare delivery is described; the known status of the current workforce is examined; workforce issues are identified and potential solutions and barriers are explored, including findings from investigations and strategies overseas.

What are clinical informatics and health information technology?

Patient-centred informatics and the Clinical Information Systems focussed on improving health outcomes are understood to support the ability to deliver effective, quality care3 and are an essential component of the Chronic Care Model4 as shown in Fig. 1.

Health informatics can be simply defined as the science and practice around information in health that leads to informed and assisted healthcare.5 Clinical informatics, a sub-discipline of health informatics, is the scientific facilitation of the effective use of information in patient care, clinical research and medical education. The ultimate goals of clinical informatics are to streamline the processes of patient care, provide clinicians with accurate data in a timely manner, improve the quality of care, and reduce costs and educate healthcare providers and patients.6 This practice of organising current medical information and related technology and applying it to clinical use is not a trivial task in the context of 21st century healthcare burgeoning with medical research literature and new technologies.7

Health and clinical data are powerful resources that can transform healthcare. However, data alone are not information or knowledge; data require a combination of analytics, visualisation and interpretation to create the knowledge which contributes to decision-making in healthcare services and policy.8 Fig. 2 shows the relationship of data and knowledge and identifies the multidisciplinary nature of the workforce roles required for this to occur. Sackett9 describes the effect of modern clinical epidemiology 'in evidence generation, its rapid critical appraisal, its efficient storage and retrieval, evidence-based medicine, and evidence synthesis', which clearly aligns with the support provided by clinical informatics.

Despite the recognised importance, the quality of the health information landscape in Australia does not effectively support activities such as health surveillance, guidance for policy, service planning, innovation and clinical and operational decisionmaking. 10,11

As part of Australia's response to improving this situation, The National eHealth Strategy recognised 'a clearly identified need to ensure sufficient numbers of skilled health Information Technology (IT) resources as this is looming as a critical barrier to the successful implementation of a national E-Health work program'.10 A US report suggests the Health Information Technology (HIT) workforce requires an approximate increase of 40% to move the American health system to higher levels of HIT adoption.12 A Canadian reports suggests 20-40% increase will be required by 2014.13

Current status of the health informatics workforce

Understanding of the health informatics workforce and its needs is poor and even more so in the area of clinical informatics. Anecdotal data support lack of skilled and qualified Clinical Informaticians in the Australian private health sector: one private hospital's Applied Medical Intelligence Research facility took 19 months in 2008 tofill three Informatics positions (Clinical Data Manager, Clinical Information System Manager, Clinical Data Analyst) with suitable staff (R. Brighouse, pers. comm., 23 October 2009). Similar delays in filling other health informatics roles have been reported.5,14 Currently there is no way to monitor demand; a job vacancies survey15 may contribute to an understanding, although such a study may not be truly indicative of the need if positions are not yet being created in the volume required to progress the eHealth agenda.

Furthermore, Australia does not capture statistics on the HIT workforce as a component of AIHW National Health Labour Force reports. Neither is the wider Health Information Technology group an occupation included in census data, which only includes health information managers and coders. Other factors that contribute to difficulties in estimating demands include many similar to those found in the Public Health profession16:

\* wide variety of occupational roles and groups;

\* lack of clear boundaries and definitions of professional categories;

\* lack of professional credentialing requirements;

\* lack of consistent formal health informatics training in much of the workforce.

The Australian Department of Health and Ageing commissioned a review of the health informatics workforce by the Health Informatics Society of Australia (HISA) which provides some perspective.5 A national survey (n = 1279) confirmed the diversity of the workforce composition, with the predominant personal attributes shown in Box 1. Extrapolation from the survey data estimates the workforce size in Australia to be ~12 000 (9000 to 15 000).

Little is known about the clinical informatics sub-discipline in Australia or elsewhere, despite recognition of the importance of this group. Efforts are being made to capture data about Biomedical Informaticians (including Clinical Informaticians) in the US HIMSS Analytics database, which has been the major vehicle to characterise the health informatics workforce in the US.12 A major UK study found 3% of the HIT workforce to be Clinical Informaticians.17 Of particular note was the finding that there was a high expected shortage in information analysis skills which are increasingly required for NHS-wide objectives, such as performance assessment.

Although a small sample (n = 111), the NHS study findings suggested their health informatics workforce to be 'embattled'; a group who felt undervalued, overworked and unable to control their own destiny. They were not well served by the recent NHS Agenda for Change job and pay evaluation process. This may well be echoed in the Australian setting, e.g. Queensland Health has excluded the Health Information Manager profession and related clinical informatics roles (e.g. Clinical Data Manager), from the higher status Health Practitioner discipline groupings during the recent Enterprise Bargaining process, despite considerable workforce discontent.14,18 This results in an inequity for the clinical informatics workforce where nursing, allied health and non-clinical professional staff may fulfil similar Clinical Information System management roles, often under significantly disparate award conditions. This lack of parity between professional streams creates the potential for interdisciplinary tensions and poor networking in an environment of increasing clinical information system use.

Other issues affecting the clinical and health informatics workforce include:

\* lack of self-identification of the group; individuals may relate more strongly to their original occupational groups such as Health Information Managers and coders, medical/nursing, pathology/health sciences, medical imaging and diagnostics, pharmacy and allied health, IT/computer sciences or health administration5,17,19;

\* status as an emerging profession5,17,20; interestingly this closely parallels Public Health workforce development in Australia, which in 1998 was characterised by: 'diversity and complexity, composed of mature, highly qualified, multi-skilled individuals from a variety of backgrounds performing a multiplicity of functions and its high turnover which is not assisted by many working in isolation, poor career prospects and lack of identity'21;

\* complexity and advanced level of skills and interdisciplinary/ multidisciplinary knowledge domains required across health and clinical sciences, computational and statistical sciences and management and social sciences5,19,22; and

\* reduction and restructure of tertiary education and training in health informatics related programs, which affects both new recruitment and vocational training of current staff.5,14

Clinical informatics capacity building

Building capacity in all aspects of theHITworkforce will promote development in the clinical informatics sub-discipline; however, this key group should not be overlooked.AUS workforce summit recommends involvement from multiple stakeholders including government, employers, HIT vendors, employees, academic institutions and professional associations.23 In Australia a similar approach could include:

\* Government and policy support: Australia's National eHealth Strategy10 identifies HIThuman resources 'looming as a critical barrier to the successful implementation of a national eHealth work program' and includes professional accreditation, education and training as part of it's Implementation Roadmap. General governmental policy such as the Queensland Government Information Management Skills Action Plan24 needs to be implemented in the health sector.

\* Professional organisations: These play a leading role in supporting the quality of the health informatics workforce. They include Health Informatics Society of Australia, Health Information Management Association of Australia, Australian College of Health Informatics, and many more with a strong stake in this area. The Coalition for eHealth, which includes these and more,25 is well-placed to progress the agenda for professionalisation, accreditation and vocational training, given appropriate resources from government, academia and health services.

\* Tertiary education: Lau26 identifies the need for the national coordination of changes to vocational and tertiary training programs. Recruitment of students to undergraduate and postgraduate training, or 're-tooling' health professionals via vocational and post-graduate training, contributes to capacity. Health informatics competencies should also be included in the undergraduate curricula of all health and medical education programs.

\* Health services: Although awaiting the anticipated benefits of eHealth initiatives, much can already be done to prepare the workforce to ensure success. For example:

\* State Health Systems - have the capacity to practically implement the general national strategy, supported by the relevant central divisions responsible, such as Information Technology and eHealth, Quality and Safety, Human Resources and Organisational Reform. It is possible to begin growing capacity immediately by promoting and providing incentives specific to health informatics education through scholarships and other professional development schemes and developing state-wide career structures.

\* Hospital administration - the attitude of the hospital Chief Executive Officer has been shown to significantly correlate with the progressive use of information technology27; and the role of local management to 'unlock the benefits of IT' is recognised.28

\* Clinical service units - should include health informatics as an element of competencies and training objectives in staff; should develop clinical champions fostering the implementation of clinical tools rather than administrative systems; should create positions and dedicate resources for adequately trained clinical informatics personnel; should recognise that good clinical informatics support provides clinicians more time to better perform clinical duties.

The establishment of career pathways and professionalisation, as is occurring internationally.5 should assist in defining professional roles and improve equity and inter-relationships. For example, in England the NHS developed the Health Informatics Career Framework which defines job roles for clinical informatics (Box 2).29 Canada's Health Informatics AssociationCOACHhas developed a career matrix incorporating 65 jobs in seven competency areas over five proficiency levels.30

Tradeoffs, undesirable effects and barriers

In any strategy there will be tradeoffs to the potential planned benefit. Certainly there will be financial costs in the training of current staff and in creating positions for the required additional workforce. However, there is consensus that eHealth will provide efficiencies and facilitate the core common competencies the World Health Organisation suggest healthcare professionals will need in the 21st century: (1) patient-centred care; (2) partnering; (3) quality improvement; (4) information and communication technology; and (5) public health perspective.31

Incentives to develop the health informatics workforce could potentially cause loss from other disciplines including nursing, clinical sciences, allied health and other health professionals. However, many of these may already have been performing clinical informatics tasks in their prior professional designations; thus already reducing their time for their primary clinical roles.

Although clinicians may be pleased to access the potential benefits for clinical services gained from clinical informatics implementations, there will likely be resistance to the allocation of service funds for what is not perceived as core clinical staffing. One may also speculate that the public may object to the relative growth of non-hands on clinical practitioner numbers in health services, regardless of the fact that this strategy 'stretches' the limited clinical resources.

The perception of senior management towards Health Information Technology can be a significant barrier to its adoption: a reticence by management to accept the utility of informatics will potentially inhibit the adoption and diffusion of information technology in health. A current lack of empirical evidence demonstrating the value of informatics in clinical practice may contribute to this reticence.32 Similarly, support by leaders is also required to promote professional development in health informatician roles.33

Prior to developing it's Health Informatics Career Framework, the NHS recognised that the lack of a clear career pathway was a barrier to developing a workforce with a recognised identity and measurable competencies.33

Australia's fragmented government structures and mixed public and private systems may be a significant barrier to an integrated approach to building the informatics workforce as it is for eHealth implementation itself.34 It has been observed in Canada that the lack of a coordinated strategy for building health informatics is a significant barrier: neither the government healthcare ministry, nor the higher education ministry have embraced capacity-building of the workforce in their portfolios.26 As with medical workforce planning in Australia,35 progress will require collaboration between the stakeholders involved - government health ministries, education facilities, healthcare professional associations and healthcare organisations.

Action needs to be taken quickly because workforce response is likely to be slow due to the shortage of qualified and experienced health informatics professionals able to provide training and education.26,36 Due to the knowledge and background diversity and multidisciplinary nature of the field, development of competencies, a coordinated education program and certification of professional status will not be a trivial task. The Australian Health Informatics Education Council created a comprehensive Strategic Work Plan in 2009, which is expected to take up to 18 months if funding of AU$956 000 could be made available, or considerably longer otherwise. The plan would deliver: (1) a workforce and career pathway; (2) educational capability and delivery; and (3) educational program accreditation.36 There will be a further time lag for the implementation of individual educational programs and until the graduation of significant numbers of students. The development of the public health workforce in Australia demonstrates similarities and, with considerable Commonwealth funding over the last decade, has produced successful collaborative approaches in training such as the Biostatistics Collaborative of Australia.37

Discussion

Regardless of how good are the available Clinical Information Systems and eHealth tools, without adoption and appropriate utilisation in the clinical environment, eHealth initiatives are unlikely to succeed and have the potential to be harmful.38 An increase of HIT support staff has been found to be a strong facilitator of implementation, second only to financial incentives39 and provides the 'missing links' between clinicians and technologists.38 The knowledge of how to best use these tools to both improve care and efficiency is still in its infancy.40 The importance of health informaticians as 'special' people required for success of HIT initiatives should therefore not be underestimated. 12,19 This is especially true of the informaticians working directly in the clinical environment and bridging the clinical practice and information technology gulf. According to the Australian Health Information Council (AHIC), eHealth professionals 'bridge the worlds of technology and health service delivery, are expert in the unique challenges of using IT in healthcare, and are crucial to effective eHealth strategy development, service design, implementation and outcome evaluation'.34 A practical response to this requires:

\* recognition of clinical informatics and its benefits at all levels;

\* training of the incumbent clinical staff and managers in salient health informatics competencies;

\* development of supporting specialised health informatics roles; and

\* allocation of sufficient and appropriate staffing resources for clinical informatics tasks including implementation and ongoing maintenance and development, clinical information system management, analytics for service management, quality improvement and research purposes.

In its report on Electronic Decision Support Systems,41 AHIC recommends that 'one of the jointly funded initiatives that sit under the National E-Health Strategy should support health informatics knowledge provision and the development of eHealth competency standards and leadership'. However, Australia's Commonwealth funded leading eHealth facilitator NEHTA provides little direction and detail for workforce capacity-building compared with other work agenda areas.42

Yet although a more broadly coordinated Australian approach awaits Government prioritisation and financial support, State and district health systems are able to act immediately through increased recognition of the potential for gain at clinical service level. This could assist in the common situation where clinical information systems are managed by clinical staff as a secondary duty, without formal data management and analytics training or the allocation of sufficient hours. The risks of not recognising and adopting adequate informatics standards and supports include:

\* costly rejection or failure of clinical information system initiatives5; and

\* decreased quality of care and increased adverse events.38

In 2007 AHIC guided development of Australia's National E-Health Strategy, noting the need for jurisdictional and national eHealth programs to have access to appropriately skilled eHealth professionals through an ongoing capacity-building program.34 The National E-Health Strategy reflected this. Although the passing of the Individual Healthcare Identifiers Bill indicates that some progress is occurring along the eHealth agenda, little attention has been directed to the informatics workforce shortage issues repeatedly identified. It is quite possible that the observed slow pace of eHealth development in Australia is due more to a lack of power and capacity in the workforce that facilitates uptake, implementation and sound utilisation of clinical information systems and eHealth than is recognised. In comparison to Australia, some overseas health systems have produced HIT workforce building strategies which are much more advanced5,11 and are arguably more progressed in their eHealth agendas.

Conclusion

Health and clinical informatics are vital to the progression of 21st century healthcare. The workforce is little understood, so capacity- building will be required to support the desired outcomes of eHealth. Prioritisation of the issue is required in the areas of national and state policy, education and local health services.

Conflicts of interest

Four of the authors (S. E. Smith, L. E. Drake, J.-G. B. Harris and K. Watson) work in the field of clinical informatics and therefore have a professional interest in the development of a career structure. The opinions presented are those of the authors and are not intended to represent their employer Queensland Health.

**Sidebar**

Box 1. The Australian archetypal health informatician

Source: HISA5

Most health informaticians:

\* are female;

\* work in large organisations that provide healthcare;

\* are aged 45 or more and expect to work for more than 10 years;

\* work broadly across 12 areas of work but are more likely to work fulltime in systems, records or improvement related activities;

\* have postgraduate or multiple degree qualifications; and

\* have education and training in two or more distinct domains of knowledge with their first training most likely to be in a health discipline.

Box 2. The eight job roles of the NHS Clinical Informatician career discipline

Source: NHS Health Informatics Career Framework29

Job role:

\* Clinical Audit Facilitator

\* Clinical Director Lead

\* Clinical Engagement Lead

\* Clinical Informatics Specialist

\* Clinical Informatics Specialist Manager

\* Clinical Knowledge Engineer

\* Clinical Lead

\* Senior Clinical Audit Facilitator